EDUCATION AND NEW DEVELOPMENTS 2025

Volume 2

Edited by

Mafalda Carmo

Designed by Freepik

WIARS
World Institute for Advanced Research and Science

Education and New Developments

2025

Volume 2

Edited by

Mafalda Carmo

Edited by Mafalda Carmo, World Institute for Advanced Research and Science (WIARS), Portugal

Published by inScience Press, Rua Tomas Ribeiro, 45, 1º D, 1050-225 Lisboa, Portugal

Copyright © 2025 inScience Press

All rights are reserved. Permission is granted for personal and educational use only.
Commercial copying, hiring and lending is prohibited. The whole or part of this publication material cannot be reproduced, reprinted, translated, stored or transmitted, in any form or means, without the written permission of the publisher. The publisher and authors have taken care that the information and recommendations contained herein are accurate and compatible with the generally accepted standards at the time of publication.
The individual essays remain the intellectual properties of the contributors.

ISSN (electronic version): 2184-1489
ISSN (printed version): 2184-044X
ISBN: 978-989-35728-8-7

Legal Deposit: 428062/17
Printed in Lisbon, Portugal by GIMA - Gestão de Imagem Empresarial, Lda.

BRIEF CONTENTS

Foreword v

Organizing and Scientific Committee vii

Sponsor xiii

Keynote Lecture xv

Index of Contents xvii

FOREWORD

Dear Colleagues,

This book contains the full text of papers and posters presented at the International Conference on Education and New Developments (END 2025), organized by the World Institute for Advanced Research and Science (WIARS).

Education is a fundamental right that accompanies us from the very beginning of our lives. It encompasses every experience we encounter, influencing and shaping our thoughts, emotions, and actions. Whether we engage in formal education within classrooms or learn from the world around us, the process of acquiring knowledge plays a vital role in our personal growth and development. It equips us with the tools to navigate the complexities of life, broadens our perspectives, and empowers us to make informed decisions. This International Conference seeks to provide some answers and explore the processes, actions, challenges and outcomes of learning, teaching and human development. Our goal is to offer a worldwide connection between teachers, students, researchers and lecturers, from a wide range of academic fields, interested in exploring and giving their contribution in educational issues.

We are delighted to have successfully facilitated connections among academics, scholars, practitioners, and individuals who share a common interest in a field abundant with fresh perspectives, ideas, and knowledge. Our event has attracted a diverse range of contributors and presenters, enriching our understanding of human nature and behavior by showcasing the influence of their unique personal, academic, and cultural backgrounds. This diversity is a testament to the international reach of our conference, fostering multi-disciplinary collaborations and fostering intellectual growth and exchange.

END 2025 received 704 submissions, from more than 45 different countries, reviewed by a double-blind process. Submissions were prepared to take form of Oral Presentations, Posters, Virtual Presentations and Workshops. The conference accepted for oral presentation 264 submissions (38% acceptance rate).

The conference also includes one Keynote presentation by Dr. Diane Boothe, Boise State University, USA. We would like to express our gratitude to our invitee.

This conference addressed different categories inside the Education area and papers are expected to fit broadly into one of the named themes and sub-themes. To develop the conference program, we have chosen four main broad-ranging categories, which also covers different interest areas:

• In **TEACHERS AND STUDENTS**: Teachers and Staff training and education; Educational quality and standards; *Curriculum* and Pedagogy; Vocational education and Counselling; Ubiquitous and lifelong learning; Training programs and professional guidance; Teaching and learning relationship; Student affairs (learning, experiences and diversity; Extra-curricular activities; Assessment and measurements in Education.

• In **PROJECTS AND TRENDS**: Pedagogic innovations; Challenges and transformations in Education; Technology in teaching and learning; Distance Education and eLearning; Global and sustainable developments for Education; New learning and teaching models; Multicultural and (inter)cultural communications; Inclusive and Special Education; Rural and indigenous Education; Educational projects.

• In **TEACHING AND LEARNING**: Critical, Thinking; Educational foundations; Research and development methodologies; Early childhood and Primary Education; Secondary Education; Higher Education; Science and technology Education; Literacy, languages and Linguistics (TESL/TEFL); Health Education; Religious Education; Sports Education.

• In **ORGANIZATIONAL ISSUES**: Educational policy and leadership; Human Resources development; Educational environment; Business, Administration, and Management in Education; Economics in Education; Institutional accreditations and rankings; International Education and Exchange programs; Equity, social justice and social change; Ethics and values; Organizational learning and change, Corporate Education.

The contributions were published across two volumes, and this is the Volume 2 of the book titled Education and New Developments 2025, that showcases the outcomes of dedicated research and developments undertaken by authors who are driven by their passion to enhance research methods that directly relate to teaching, learning, and the practical applications of education in the present day. Within its pages, you will find a diverse array of contributors and presenters of contributors and presenters who expand our understanding of educational matters by sharing their unique personal, academic, and cultural perspectives. Through their valuable insights and experiences, they enrich our exploration and contribute to the growth of educational discourse in our contemporary world.

This second volume only focuses on the main areas of PROJECTS AND TRENDS and ORGANIZATIONAL ISSUES, being the contributions of the other two areas published in Volume 1.

We would like to express thanks to all the authors and participants, the members of the academic scientific committee, and of course, to our organizing and administration team for making and putting this conference together.

Hoping to continue the collaboration in the future.

Respectfully,

Mafalda Carmo
World Institute for Advanced Research and Science (WIARS), Portugal
Conference and Program Chair

ORGANIZING AND SCIENTIFIC COMMITTEE

Organizer

World Institute for Advanced Research and Science (WIARS)
www.wiars.org

Conference and Program Chair

Mafalda Carmo
World Institute for Advanced Research and Science (WIARS), Portugal

International Scientific Committee

Aaron R. Deris, Minnesota State University, USA

Abha Gupta, Old Dominion University, USA

Adanela Musaraj, Indiana Tech, USA

Adel Jebali, Concordia University, Canada

Adrian Ponz Miranda, Zaragoza University, Spain

Ahmet Ok, Middle East Technical University, Turkey

Alan Singer, Hofstra University, USA

Ali Ahmad Al-Barakat, University of Sharjah, United Arab Emirates

Ana Conboy, College of Saint Benedict and Saint John's University, USA

Ana Hernández, Universidad Autónoma de Madrid, Spain

Ana Pongrac Pavlina, University of Zagreb, Croatia

Ana-Maria Bercu, Alexandru Ioan Cuza University of Iasi, Romania

Andis Klegeris, University of British Columbia Okanagan, Canada

Andrea Bencsik, University of Pannonia Veszprem, Hungary

Andrea Fiorucci, University of Salento, Italy

Andreas Zehetner, University of Applied Sciences Upper Austria, Austria

Andrei Nastas, Lower Danube University, Romania

Angela Piu, University of Valle D' Aosta, Italy

Angelica-Lizeth Sanchez-Lopez, Tecnológico De Monterrey, Mexico

Anja María Mackeldey, Colegio Alemán Medellín / Universidad de Antioquia, Colombia

Antoni Kolek, Kozminski University, Poland

Antonija Huljev, University of Osijek, Croatia

Aphrodite Ktena, National and Kapodistrian University of Athens, Greece

Asta Vaitkevičienė, Vilnius University, Lithuania

Aurelija Dauksaite-Kolpakoviene, Vytautas Magnus University, Lithuania

Barba Aldis Patton, University of Houston-Victoria, USA

Beata Maslanka-Wieczorek, Polish-Japanese Academy of Information Technology, Poland

Beatriz Carrasquer Alvarez, Zaragoza University, Spain

Begona Sampedro, Univesity of Cordoba, Spain

Binshan Lin, Louisiana State University Shreveport, USA

Birgit Schmiedl, University College of Teacher Education Lower Austria, Austria

Bojana Culum Ilic, University of Rijeka, Croatia

Borislava Kirilova, Sofia University, Bulgaria

Borja Manzano Vázquez, University of Granada, Spain

Burcu Koc, Sakarya University, Turkey

Carola Hernandez, Universidad de los Andes, Colombia

Carolina Bodea Hategan, Babes-Bolyai University, Romania

Celina Da Silva, York University, Canada

Cezar Scarlat, University "Politehnica" of Bucharest, Romania

Chantal Ouellet, Universite du Quebec a Montreal, Canada

Charalampos Karagiannidis, University of Thessaly, Greece

Chiara Uliana, University of Granada, Spain

Chien-Ming Cheng, National Academy for Educational Research, Taiwan

Cory A. Bennett, Idaho State University, USA

Cristiana Pizarro Madureira, ESECS – Instituto Politécnico de Leiria, Portugal

Cristiano Luchetti, American University of Ras Al Khaimah, United Arab Emirates

Dale Kirby, Memorial University, Canada

Dalia Hanna, Sheridan College, Canada

Damijana Kerzic, University of Ljubljana, Slovenia

David Aparisi, University of Alicante, Spain

David Cline, Saginaw Valley State University, USA

David Nocar, Palacky University Olomouc, Czech Republic

Diana Straksiene, Vilnius University, Siauliai Academy, Lithuania

Diana Maria Cismaru, National University of Political Studies and Public Administration, Romania

Diane Boothe, Boise State University, USA

Dijana Drandic, Juraj Dobrila University of Pula, Croatia

Dijana Oreški, University of Zagreb, Croatia

Dimitris Kilakos, National & Kapodistrian University of Athens, Greece

Dorina Anca Talas, Babes-Bolyai University, Romania

Dorota Gawryluk, Bialystok University of Technology, Poland

Elena Baguzina, Moscow State Institute of International Relations, Russian Federation

Elena Garcia Guerrero, University of Granada, Spain

Elena Seghedin, Alexandru Ioan Cuza University from Iasi, Romania

Emmanouil Choustoulakis, University of Peloponnese, Greece

Eva Patrikakou, Depaul University, USA

Eva Trnová, Masaryk University, Czech Republic

Evangelina Bonifácio, Polytechnic Institute of Bragança, Portugal

Fabiana Leta, Universidade Federal Fluminense, Brazil

Fernando Martin Villena, Universitat Pompeu Fabra, Spain

Gabriella Velics, Eotvos Lorand University, Hungary

Georgiana Ciobotaru, Dunarea de Jos University of Galati, Romania

Gianluca Carella, Politecnico di Milano, Italy

Gibrán Aguilar Rangel, Autonomous University of Queretaro, Mexico

Gina Aurora Necula, Dunarea de Jos University of Galati, Romania

Grainne Ni Dhomhnaill, University College Dublin, Ireland

Gyongyi Bujdoso, University of Debrecen, Hungary

Hana Vancova, Trnava University, Slovakia

Hashini Mohottala, University of Hartford, USA

Héctor Tronchoni, Florida Universitaria in Catarroja, Spain

Helin Puksand, Tallinn Univesity, Estonia

Henri Jacobs, Central University of Technology, Free State (CUT), South Africa

Igor Miladinovic, University of Applied Sciences Campus Vienna, Austria

Ilijana Cutura, University of Kragujevac, Serbia

Ina Blau, The Open University of Israel, Israel

Ioana Letitia Serban, Babes-Bolyai University, Romania

Ioannis Makris, State Special School / Directorate of Secondary Education West Athens, Greece

Irena Petrusic, University Adriatic, Montenegro

Janaina Cardoso, Rio de Janeiro State University, Brazil

Javier Casanoves-Boix, University of Valencia, Spain

Jeannette Jones, Texas Lutheran University, USA

Jenni Sanguiliano Lonski, Rollins College, USA

Jitka Hlouskova, Independent Education Professional, Czech Republic

Joanna Paliszkiewicz, Warsaw University of Life Sciences, Poland

John Blake, University of Aizu, Japan

John Smallwood, Nelson Mandela University, South Africa

Jorge Viguri Cordero, Universitat Jaume I, Spain

Jose Augusto Oliveira Huguenin, Universidade Federal Fluminense, Brazil

Juana M. Ortega Tudela, University of Jaén, Spain

Juana Maria Sancho Gil, University of Barcelona, Spain

Jurgita Lenkauskaite, Siauliai University, Lithuania

Kadi Lukanenok, Tallinn University, Estonia

Kalliopi Trouli, University of Crete, Greece

Karel Němejc, Czech University of Life Sciences Prague, Czech Republic

Katerina Vitásková, Palacky University in Olomouc, Czech Republic

Kavita Karan, Southern Illinois University Carbondale, USA

Krešimir Pavlina, University of Zagreb, Croatia

Kyparisia Papanikolaou, School of Pedagogical and Technological Education, Greece

Ladario da Silva, Universidade Federal Fluminense (UFF), Brazil

Laura Rio, University of Bologna, Italy

Lee Ann Rawlins Williams, University of North Dakota, USA

Leela Ramsook, University of Trinidad and Tobago, Trinidad and Tobago

Lefkothea Kartasidou, University of Macedonia, Greece

Lefkothea-Vasiliki Andreou, University of Ioannina, Greece

Leila Kajee, University of Johannesburg, South Africa

Lela Abdushelishvili, International Black Sea University, Georgia

Les Sztandera, Thomas Jefferson University, USA

Liga Paula, Latvia University of Life Sciences and Technologies, Latvia

Lisa Winstead, California State University, USA

Loredana Terec-Vlad, Stefan Cel Mare University from Suceava and Lumen, Romania

Loreta Chodzkiene, Vilnius University, Lithuania

Lucia Dancisinova, University of Presov, Slovakia

Luis Gonzaga Roger Castillo, Universidad de Granada (UGR) / Centro de Estudios, Spain

Magdolna Chrappán, University of Debrecen, Hungary

Magne V. Aarset, NLA University College, Norway

Maia Chkotua, International Black Sea University, Georgia

Maira Lescevica, Vidzeme University of Applied Sciences, Latvia

Maja Kerneza, University of Maribor, Slovenia

Malgorzata Cieciora, Polish-Japanese Academy of Information Technology, Poland

Manfred Meyer, Westfalische Hochschule, Germany

Manuel Fernández-Alcántara, University of Alicante, Spain

Marcin Fojcik, Western Norway University of Applied Sciences, Norway

Maria Gonzalez Alriols, University of the Basque Country, Spain

Maria Lopes de Azevedo, Polytechnic Institute of Portalegre, Portugal

Maria Orfila, Rey Juan Carlos University, Spain

Maria Carme Boqué Torremorell, Ramon Llull University, Spain

María José Latorre, University of Granada, Spain

Marko Slavkovic, University of Kragujevac, Serbia

Marta Talavera, University of Valencia, Spain

Marzena Wojcik-Augustyniak, University of Siedlce, Poland

Matthias Baume, Technical University of Munich, Germany

Mayara de Carvalho Santos, State University of Campinas, Brazil

Melissa Caspary, Georgia Gwinnett College, USA

Michael Reiner, IMC University of Applied Sciences Krems, Austria

Michael Wagner, Drexel University, USA

Michail Kalogiannakis, University of Thessaly, Greece

Mike Green, University of Kent, UK

Milan Kubiatko, J. E. Purkyne University, Czech Republic

Mohammad Ahmad Abdeldayem, Zagazig University, Egypt

Monica Maier, Technical University of Cluj-Napoca, Romania

Monika Mladenovic, University of Split, Croatia

Nadja Cekolj, University of Rijeka, Croatia

Napak-On Sritrakarn, Acknowledge Education, Australia

Natalia Casado, University King Juan Carlos, Spain

Natalie Lavoie, University of Quebec in Rimousk, Canada

Natasa Vlah, University of Rijeka, Croatia

Nazario Zambaldi, Free University of Bolzano, Italia

Ned Ladd, Bucknell University, USA

Nicolás Ruiz-Robledillo, University of Alicante, Spain

Noam Topelberg, Bar Ilan University, Israel

Nora Gavira-Durón, Universidad de las Americas Puebla, Mexico

Olga Dorul, Dunarea De Jos University of Galati, Romania

Omid Noroozi, Wageningen University & Research, The Netherlands

Onur Ergünay, Izmir Democracy University, Turkey

Patrik Schulcz, Esade Business School (Ramon Llull University), Spain

Pavel Brebera, University of Pardubice, Czech Republic

Pavlina Rackova, University of Defence, Czech Republic

Pawel Pokutycki, Royal Academy of Art (KABK), The Hague, The Netherlands

Petros Kefalas, University of York Europe Campus, Greece

Pule Phindane, Central University of Technology, South Africa

Raluca Trifu, UMF Iuli Hatieganu from Cluj Napoca, Romania

Rasa Nedzinskaite-Maciuniene, Vytautas Magnus University, Lithuania

Remigijus Bubnys, Kaunas University of Technology, Lithuania

Richard C. Kalunga, University of the District of Columbia, USA

Ronghuai Huang, Institute of Beijing Normal University, China

Rosanna Tammaro, University of Salerno, Italy

Rusul Alabada, Al-Muthanna University, Iraq

Rút Lenková, University of Presov, Slovakia

Ryuichi Matsuba, Kumamoto University, Japan

Sam Ramaila, University of Johannesburg, South Africa

Seppo Sirkemaa, University of Turku, Finland

Sercan Saglam, American University of the Middle East, Kuwait

Shin Lan, School of Education, Shanghai Normal University, China

Si Xiao, Columbia University, USA

Sigrid Schefer-Wenzl, University of Applied Sciences Campus Vienna, Austria

Silvania Alves de Carvalho, Universidade Federal Fluminense, Brazil

Silvia Doncevova, Comenius University in Bratislava, Slovakia

Silvia Pokrivcakova, Trnava University, Slovakia

Simon Richir, Arts et Metiers (ENSAM), France

Simone Brasili, University of Camerino, Italy

Sinan Olkun, Ankara University, Turkey

Sonia Morante-Zarcero, Rey Juan Carlos University, Spain

Stamatis Papadakis, University of Crete, Greece

Stathis Konstantinidis, University of Nottingham, UK

Stefan Kubica, Technical University of Applied Sciences Wildau, Germany

Stefania Pinnelli, University of Salento, Italy

Stephanie Linek, ZBW – Leibniz Information Centre for Economics, Germany

Susan Scott, Lakehead University, Canada

Susanne Schumacher, Free University of Bozen, Italy

Suzie Savvidou, The University of Sheffield International Faculty, Greece

Syed Ziaur Rahman, University of Kalba, United Arab Emirates

Taina Lintilä, Haaga-Helia University of Applied Sciences, Finland

Tatjana Portnova, Russian Center of the University of Granada, Spain

Temenujka Zafirova Malcheva, Sofia University, Bulgaria

Tena Velki, Josip Juraj Strossmayer University of Osijek, Croatia

Tricia Hudson Matthew, Metropolitan State University of Denver, USA

Turan Paker, Pamukkale University, Turkey

Valeria Di Martino, University of Palermo, Italy

Vashti Singh, University of Guyana, Guyana

Veronica Marin Diaz, University of Cordoba, Spain

Veronica Violant Holz, University of Barcelona, Spain

Verónica Yanez- Monje, Universidad of Concepcion, Chile

Victor Fester, University of Waikato, New Zealand

Wendy Setlalentoa, Central University of Technology, South Africa

Wiktor Bolkunow, Warsaw School of Economics, Poland

Wilton José Diolindo Nascimento Júnior, University of Campinas, Brazil

Xénia Liashuk, Trnava University, Slovakia

Xiaoyuan Suo, Webster University, USA

Xiaozhu Lin, Politecnico di Milano, Italy

Yevgeniya Daineko, International IT University, Kazakhstan

Youngsoon Kim, Inha University, South Korea

Zoltán Rónay, Eotvos Loránd University, Hungary

SPONSOR

http://www.wiars.org

KEYNOTE LECTURE

"REIMAGINING CROSS-DISCIPLINARY ACTIVE LEARNING METHODOLOGIES TO ENGAGE EFL STUDENTS"

Dr. Diane Boothe
Director of P-20 Outreach and Professor, Department of Literacy, Language and Culture, College of Education, Boise State University, USA

Abstract

The continued demand and unique learning environment for English as a Foreign Language (EFL) learners is ever changing as educators focus on best practices to promote optimal learning for 21st century students and meet the needs of our complex interdisciplinary globalized world. Central to the demand for revitalizing the classroom experience is to prepare students to enter the evolving workforce. Cutting-edge EFL skills are often tantamount to achieving success in this endeavor and keeping up with the rapid pace of learning. Not only are EFL students expected to demonstrate observable and measurable English skills, but there is a growing interest and stipulation to demonstrate strengths critical to cross-disciplinary fields as well as collaborative active learning methods. This address investigates student-centered instructional methods that focus on the multidimensional perspectives of active learning environments. Experiences from a variety of disciplines will be highlighted including Science, Technology, Engineering and Mathematics (STEM), emphasizing direct EFL preparation to ensure success and promote purposeful collaboration and engaged English learning. Dynamic teaching strategies and methodologies focusing on active, hands-on learning will be discussed. Challenging student-centered activities will be suggested that can be adjusted for a variety of abilities across age groups featuring key transferable English language competencies. Exploration of best practices that build a culture of innovation and prepare students for EFL content areas will be addressed.

Keywords: *Cross-disciplinary, student-centered, interdisciplinary, multidimensional, competencies.*

Biography

Diane Boothe is Professor of Literacy, Language and Culture at Boise State University, and served as Dean of the College of Education from 2005-2014. Prior to coming to Boise State University, she was the Department Chair of Curriculum and Instruction and Professor at the University of West Georgia. She served as a bilingual teacher, and elementary and middle school principal. Diane has worked consistently with multilingual populations to bring about change and support the development of innovative educational programs and policies. She creates collaborative partnerships and fosters positive relationships with the community, schools, and agencies that she serves. She received her Doctor of Public Administration degree from the University of Southern California. Her primary research efforts have been in the areas of English Language Learning, Multilingual Education, Diversity and Comparative Education Systems. She coauthored a book titled In the Eyes of the Beholder: Critical Issues for Diversity in Gifted Education, focusing a chapter on gender and gifted females when identifying the multidimensional perspectives of giftedness. Diane has served in leadership positions as the President of Georgia Teachers of English to Speakers of Other Languages (TESOL), the TESOL International Higher Education Chair, the TESOL International Nominating Committee, and, for ten years, as the editor of the TESOL in Action Journal. She has been selected as the keynote or featured speaker and delivered the plenary session for international and national conferences.

INDEX OF CONTENTS

ORAL PRESENTATIONS

Projects and Trends

Exploring the use of Artificial Intelligence in rubric production and detection of reviewer's bias **3**
Juuso Rytilahti, Erkki Kaila, & Erno Lokkila

A framework for understanding STEM focused schools **8**
Wendy P. Ruchti, & Cory A. Bennett

Navigating contradictory expectations: Challenges in preparing for the games, animation and VFX industries **13**
Silke Hassreiter, A. Treshi-Marie Perera, Tuki Clavero, Lindsey Bouwels, & Mata Haggis-Burridge

Implementation of the Tale-Bot robot for developing executive function in planning and organisation: Pilot test **18**
Elena Pérez-Vázquez, & Alba Gilabert-Cerdá

Enhancing active learning in advanced database courses through an educational escape room approach **23**
Vicente R. Tomás, Sandra Catalán, María I. Castillo, Rocio Carratalá, & Iván Monzón

Model of functional literacy for teachers concerning the application of 3D printing in secondary schools **28**
Tetjana Tomášková, Jan Krotký, & Jarmila Honzíková

Hybrid action-oriented learning and teaching: A transformative approach to vocational education **33**
Thomas N. Jambor

Conditions affecting learning on the collective learning platform - a study with secondary school students **38**
Santos Orejudo, Raquel Lozano, & Carmen Elboj

Narration to promote restorative attitudes in adolescents **43**
Paola Nicolini, Lina Caraceni, Alessandro Maranesi, & Veronica Guardabassi

The ethnographic AI: Exploring the future of academic writing with Artificial Intelligence **47**
Patricia Arnold

Enhancing rural life sciences teachers' practical work competencies through a collaborative approach to teacher professional development **52**
Nomzamo Xaba, Mayaba Brian Nhlumayo, & Aviwe Sondlo

Risk of misinformation in the use of LLM by university students **57**
Gibrán Aguilar Rangel, Claudia Cintya Peña Estrada, Omar Bautista Hernández, & Luis Ambrosio Velázquez García

Artificial Intelligence assessing content-focused short answers **61**
Juuso Rytilahti, Erkki Kaila, & Erno Lokkila

Natural hazards and environmental sustainability: Using escape room as a learning tool **66**
Giovanna Lucia Piangiamore, & Alessandra Maramai

The AI productivity divide: Emerging inequities in AI-enhanced education **71**
Darya Ramezani, & Michael G. Wagner

Academic responsibility in Artificial Intelligence (AI): Lecturers' views on cultivating ethical chatbots **76**
Paseka Patric Mollo

Application of Augmented Reality for working memory improvement to develop executive functions: A case study **81**
Alba Gilabert-Cerdá, & Elena Pérez-Vázquez

Exploring the potentials and limitations of AI-based CAD design for mechanical engineering **86**
Michael Wendland

Making new friends: An experience report on the use of the group piano methodology with young people with intellectual disabilities from the Associazione Nuovi Amici in Recanati (Italy) **91**
Priscila Gambary

Critical enbiagogy (εμβιαγωγική): Biocentric (interspecies) critical-praxical education & communication beyond human beings – de-anthropocentrism **96**
Antonis Hourdakis, Yannis Ieronymakis, & Marina Souka

The effect of length measurements digital gamification on Van Hiele levels of geometric thinking **101**
Amtiaz Fattum, Fahda Sawid, & Amal Sharif-Rasslan

Reimagining educator support: A framework for a multi-tiered system to promote teacher well-being and mental health **106**
Lee Ann Rawlins Williams

Education in the times of posthumanism **111**
Valerija Vendramin

Beyond the algorithm: Exploring student acceptance of AI grading through an adapted TAM framework **115**
Hayden Noel, Adam King, Julia Sabin, Jamal Bell, & Kay Gomes Saul

Digital fluency in higher education: Investigating technology integration in pedagogical practices of Portuguese educators **120**
Tatiana Sanches, Mariana Batista, Cristina Duarte, & Joana P. Miranda

Empowering or impairing? The effect of Generative AI on class teamwork, learning and engagement **125**
Evelina Atanassova, & Diana Cabori

The role of Generative AI in transforming educational practices **130**
Nora Gavira-Duron, Ana Lorena Jiménez Preciado, Angélica Alonso-Rivera, & Claudia M. Ramirez-Culebro

Creating educational paths for university students to address societal problems **135**
Les M. Sztandera

The use of AI in teaching mathematics in teacher training colleges with bilingual students **139**
Nader Hilf, & Leonid Kugel

Artificial Intelligence and children's mental health: The two sides of the coin **143**
Eva N. Patrikakou

Promoting equal opportunities through textbooks **148**
Paola Nicolini, Greta Mancini, Evelyn Manoni, & Veronica Guardabassi

Exploring tinker toys as a tool for reducing anxiety and enhancing group dynamics in college students **153**
Tricia Hudson Matthew, & Harvey Bowden II

Trolling in virtual learning spaces: A proposal for analysis from collective learning **156**
Sonia Valero-Tapia, Pablo Bautista, & Santos Orejudo

Transforming electronics education with AI: A challenge-based learning approach **161**
José Manuel Bravo-Pacheco, Sergio Esteban-Romero, Iván Martín-Fernández, Manuel Gil-Martín, & Fernando Fernández-Martínez

Artificial Intelligence and educational management: Threat or challenge for school leaders **166**
Paraskevi Chatzipanagiotou

Butterfly-piano: A differentiated learning proposal, based on the American group piano methodology, for children with Autism Spectrum Disorder **171**
Priscila Gambary

The inclusive framework of the ABMOVE! Project: Enhancing mathematics learning through active breaks **176**
Maria Moscato, Valeria Di Martino, Clarissa Sorrentino, Federica Raho, Rosa Bellacicco, & Francesca Capone

The interaction between school social workers and teachers: The development of Hungarian school social work in a global context **181**
Andrea Farmosi

Towards global intercultural & interdisciplinary project-based learning: The evolution of the GIPE educational model **185**
Manfred Meyer

Examining the role of life sciences subject advisors in collaborative teacher professional workshops: A multiple case study of northern KwaZulu Natal **190**
Nomzamo Xaba

The impact of disaster on education: Understanding loss and pathways to recovery **195**
Lee Ann Rawlins Williams

AI in economics and finance education: Innovations, challenges and future directions **200**
Luis Enrique García Pérez

Artificial Intelligence in special education: Perspectives from South African special needs educators **205**
Thabiso Nkohli, Paseka Patric Mollo, & Lukanda Kalobo

LLM agents: Advancing truly personalized online education **209**
José Ochoa-Luna, Ricardo Lazo, & Manfred Meyer

Hacking the hackathon: A tool fit for management education in the era of grand challenges? **214**
Sandrine Stervinou, Jennifer Goodman, Laurent Noël, Aline Polipowski, & Jean-Marc Charlot

Mathematical anxiety mitigation through the development of self-regulated learning skills **219**
Amal Sharif-Rasslan, & Amtiaz Fattum

Merging physics and anatomy: Innovations in teaching human body mechanics **224**
Hashini Mohottala, Agnieszka Machowski, Muhammed Umair, & Joseph Lothamer

Health promotion through facilitating mastery, participation and motivation in secondary school **229**
May Olaug Horverak, Gerd Martina Langeland, Emre Sari, & Tommy Haugen

Virtual laboratories as a way to enhance students learning in biosciences **234**
Angel Herráez

Adolescents' emotional responses to a suicide attempt shared on social media: Insights from collective intelligence **239**
Raquel Lozano, Sonia Valero, & Montserrat Aiger

Organizational Issues

When cyberbullies are girls: A survey with adolescents **243**
Veronica Guardabassi, Alessandro Maranesi, Benedetta Smargiassi, Elisa Cirilli, & Paola Nicolini

Tuition waivers and educational equity: Supporting former youth in care in higher education **248**
Dale Kirby

Middle leadership and inclusive education in Portuguese schools abroad: Cases from Cape Verde and Mozambique **253**
Ana Paula Silva, Teresa Santos, & Alcina de Oliveira Martins

Quality of life of parents with children with and without disabilities during Covid-19 restrictions: An exploratory study **258**
Lefkothea Kartasidou, Maria Platsidou, Eleni Kyriakidou, Aristi Trokana, Georgia Diamantopoulou, & Pagona Leonidou

Rethinking academic review processes: Institutional agility in the era of AI-driven change **263**
Michael G. Wagner

Introducing design thinking to identify teacher and student needs **268**
Sophie Farag

Prospects for the use of artificial intelligence in Russian higher education **273**
Valentina Gerasimenko, & Maria Ulyanova

Switching costs in school choice systems **278**
Matías Morales Cerda

The right to basic education in South Africa: Equality discrimination by the state **283**
René Elmari Viviene Pillay

Conceptualising the science kitchen as a makerspace **288**
Jaana Taar, Kristi Paas, & Tiina Vänt

Competence management in remote healthcare **293**
Sonja Kari, Nina Helander, & Jussi Myllärniemi

Factorial validity and reliability of the Greek version of school life questionnaire **298**
Maria Platsidou, Georgia Diamantopoulou, Pagona Leonidou, Lefkothea Kartasidou, Aristi Trokana, & Eleni Kyriakidou

Imagining a friend with an Autistic Spectrum Disorder: Inclusion strategies for social relations **303**
Veronica Guardabassi

Examining the experiences of paraprofessional of color in an online grow your own teacher education program **307**
Joy Myers, Bryan Zugelder, Oris Griffin, & Leonard Richards

"Qui Val di Fiastra": A territory education project with children and adolescents **312**
Alessandro Maranesi, & Paola Nicolini

The impact of extended curriculum programmes: Graduation trends and student narratives **317**
Jeanine Mwambakana-Mutombo

POSTERS

Projects and Trends

The use of 3D printing as a didactic tool in technical drawing education with an emphasis on ecodesign **323**
Tetjana Tomášková, Jan Krotký, & Jarmila Honzíková

Empowering innovation: The role of Generative AI in transforming projects for university students **326**
Karen McGivern

Creative thinking: Learning from a new perspective **329**
Rui Braz, & Ana Lúcia Luís

Innovative tutor training: The development of a gamified digital escape room for enhancing teaching competencies **332**
Michelle Pippig, & Sabrina Hänsel

Enhancing cross-cultural in English language teaching: Digital innovations and its reaction on communication systems and cultural learning **335**
Sugandika Sewwandi Alles

Developing a physical therapy program with emphasis on increasing accessibility for rural and underserved communities **338**
Peggy R. Trueblood, & Jennifer Fleckenstein

The revolution of Artificial Intelligence in the classroom: An experience in engineering **341**
Jorge Ventura, Fernando Martínez-Gil, & María Dolores Gil

A systematic literature review of interventions promoting the social inclusion of elementary school children with ethnic minority and immigrant background **344**
Lili Madár, Réka Kassai, Anikó Fehérvári, & Anna Kende

Analysis of the impact of virtual reality on the learning of abstract concepts in engineering **347**
Jorge Ventura, Fernando Martínez-Gil, & María Dolores Gil

Enhancing education in genetics and genomics through a virtual campus **350**
Javier Sierra

Organizational Issues

Development of the university research center and transfer of its results and new knowledge into teaching **352**
Miloslav Kepka, & Vladislav Kemka

Feasibility and efficacy of an intervention promoting cognitive skills of socioeconomically disadvantaged Romani children **355**
Lili Madár, & Réka Kassai

Factors influencing career motivation in the Lithuanian energy sector **358**
Tomas Butvilas, & Ugne Supranaviciene

Artificial Intelligence and individual's education values: Latvian experience **361**
Lasma Balceraite, & Velta Ļubkina

VIRTUAL PRESENTATIONS

Projects and Trends

Challenging gender role stereotypes in 'Piggy book': A visual literacy approach on family role equality **367**
Christina Kalaitzi, & Domna (Mika) Kakana

Spatial reasoning with a human-scaled geometric puzzle **372**
Elise Levin-Güracar, Teresa Lara-Meloy, Ken Rafanan, & Jennifer Knudsen

Pedagogical interpretation in teaching Grade 10 accounting using advanced technology: South African perspective **377**
Olwethu Solundwana, & Limkani Sincuba

Generative AI and curriculum integration possibilities **382**
Ronald J. Glotzbach

Life sciences teachers' needs and challenges when integrating indigenous knowledge using interactive whiteboards **387**
Lwazi Nsindiso Mkhwebane, Lydia Mavuru, Patrick Thabo Makhubalo, & Khanyisile Nolwazi Sethole

Redefining workplace learning: Slashing errors by using Augmented Reality **392**
Christian Ploder, Teresa Spiess, Michael Kohlegger, & Robin Schmid

Smartphones as analytical tools to study the photodegradation of food dyes in a laboratory setting **397**
Inés Adam-Cervera, Roberto Sáez-Hernández, Paula García-Balaguer, Sergio Armenta, Ángel Morales-Rubio, & M. Luisa Cervera

Use of art therapy with special educational needs children - research on the attitudes of psychologists from the municipality of Blagoevgrad **402**
Sabina Eftimova, Teodora Genova, & Stefka Belyova

Impact of active methodologies on sustainability in initial teacher training: An educational innovation **407**
Mercedes Llorent-Vaquero, Juana Mª Ortega-Tudela, & Elena Mª Díaz-Pareja

Young women belong in makerspaces: Developing and detecting young women's agency in making **411**
Ken Rafanan, Elise Levin-Güracar, Nuria Jaumot-Pascual, Teresa Lara-Meloy, Harriette Stevens, & Jennifer Knudsen

The evolution of foreign language learning in higher education: A risky approach **416**
Véronique Delplancq, Ana Maria Costa, José Pereira, Justine Anne S. Céline Martin, Ricardo Casañ-Pitarch, Romain Gillain, & Susana Fidalgo

Learning among older adults: The potential of peer tutoring **421**
Cristina Vidal-Marti

Clarity, Specificity, and Context (CSC): Engineering effective prompts for Generative AI in higher education **425**
Laura Zizka

Artificial Intelligence in physics learning: Perception and application **430**
Joan-Josep Suñol

Fostering computational thinking practices of high school learners through coding and robotics workshop **435**
Ayodele Abosede Ogegbo

Special education teachers as agents of change: A narrative study of teacher agency in emergency shelter schools **440**
Michal Levy, Hagit Inbar-Furst, & Ruth Gottfried

Critical reflections on trialling an AI application in teacher education assessment in the technological age **443**
Tríona Stokes

Leveraging AI tools in first-year programming education: A case study on student perceptions and learning experiences at a private higher education institution **448**
Denzyl Soobramoney Govender

University students' acceptance and aversion to Artificial Intelligence **453**
Carlos A. Torres-Gastelú, & Karla Enríquez-Ortega

Learning sustainability through in-class debates **458**
Jonna Käpylä

Tourism students' use of AI tools: A preliminary study **463**
Ana Pires, Laura Chagas, & Sónia Pais

How to foster interdisciplinary project-based learning in distance education: Findings from a 24-hour digital hackathon **467**
Gianluca Carella, Marta Conte, & Francesco Zurlo

Inclusive education in the era of Artificial Intelligence and technology **472**
Kamelia Nusheva, & Boryana Yankova-Hadzhieva

Teaching scenarios for digital learners **477**
Ana Pongrac Pavlina, Krešimir Pavlina, & Silvija Muselinović

From the pedagogy of resistance to digital conformism: A study of analog literacy in a digital education **482**
Cristina Coutinho, & Pedro Amado

Unpacking motivations behind absenteeism in higher education **487**
Krista Sorri, & Pasi Hellsten

Math and making for middle school youth: A longitudinal single-case study **491**
Elise Levin-Güracar, Nuria Jaumot-Pascual, Teresa Lara-Meloy, & Jad Eways

William Shakespeare's *Hamlet* (c. 1600): A didactic approach through an escape room activity **496**
Germán Asensio Peral, & Ángeles Jordán Soriano

Barriers to digitalization in a preschool institution **501**
Nina Mainerová

Transforming university education with Generative AI: Strategies, challenges and impacts **506**
Haoning Xi

Gamification as a strategy for teaching materials in engineering **511**
Daniel Garcia-Garcia, David Garcia-Sanoguera, Mario Miranda-Pinzon, Nestor Montanes, Juan Ivorra-Martinez, & Luis Quiles-Carrillo

Artificial Intelligence in fashion: A case study on industry-academic collaboration for digital transformation **516**
Xiaozhu Lin, & Matteo Oreste Ingaramo

Future educators' perceptions about vicariance as a design tool in early childhood education services in the case of the presence of visually impaired children **521**
Addolorata Amadoro, Umberto Veneruso, & Diana Carmela Di Gennaro

Chatting with the assistant: Enabling students to use ChatGPT for self-assessment before assignment submission **526**
Ruth Forrest

Technology integration challenges and issues **531**
Ronald J. Glotzbach

Integrating generative chatbots in secondary English teaching: A 2D3S4L model for pedagogical design **536**
Wei Zhang, Dzintra Iliško, & Lipolelo Thamae

Harnessing TikTok to enhance Grade 10 learner engagement in life sciences classrooms **541**
Thapelo John Vukeya, Lydia Mavuru, Lwazi Nsindiso Mkhwebane, & Khanyisile Nolwazi Sethole

Approaches of gender diversity in kindergarten: A literature intervention through picturebooks **546**
Despoina Pechlivanidou, & Christina Kalaitzi

Dramatic arts in inclusive education: A case study of one high school **551**
Limkani Sincuba, & Buka Andrea Mqondisi

Education students' perceptions of sustainability training and the use of active methodologies: An exploratory study **556**
Elena Mª Díaz-Pareja, Juana Mª Ortega-Tudela, & Mercedes Llorent-Vaquero

An escape room activity in analytical chemistry **560**
Roberto Sáez-Hernández, Inés Adam-Cervera, Paula García-Balaguer, Ángel Morales-Rubio, Adela R. Mauri-Aucejo, & M. Luisa Cervera

Bibliotherapy in Bulgaria: A study of perceptions, application and educational perspectives **564**
Sabina Eftimova, & Teodora Genova

Math and making in afterschool - a pedagogic innovation with Latinx middle school youth **569**
Nuria Jaumot-Pascual, Teresa Lara-Meloy, & Ken Rafanan

Development of an e-exercises application for an introductory statistics course at university level **574**
Janne Engblom, Kaisa Saastamoinen, & Erkki Kaila

A 2D3S4L model: Does Generative AI enhance English language teaching and learning in Lesotho? **579**
Lipolelo Thamae, Wei Zhang, & Dzintra Iliško

Bridging academia and society: Insights for citizen science and innovative PhD program design **584**
Maria Potes Barbas, Andreia Teles Vieira, Paulo Duarte Branco, & Maria Paula Pinto

Bring your own device: Integrating mobile learning technology for engagement and baseline assessments in science learning **588**
Mafor Penn

South African life sciences teachers' experiences when employing differentiated instruction to foster inclusivity **593**
Unathi Notshweleka, & Thasmai Dhurumraj

Organizational Issues

Ethical leadership as a delicate embroidery for integrity: New directions for school principals **598**
Sipiwe Mudadigwa, & Edwin Darrell De Klerk

Our school should be for us: Early childhood physical learning environment **603**
Tuğba Baş, & Nergiz Teke

Academic perceptions of the value of teaching for university performance **608**
Jonna Käpylä, Jenni Poutanen, & Elisa Enlund

Navigating employment challenges: Sustainable employability and gender disparities among third country nationals in Greece **613**
Magdalini Bakali, & Konstantina Karameri

Human capital's theoretical model and sustainability: Investment in training and future value of intangibles **618**
Lidia García-Zambrano, Yolanda Chica-Paez, & Maite Ruiz-Roqueñi

Advancing principals' human rights leadership practices in an era of digital transformation **622**
Ngozi Blessing Enebe, & June Monica Palmer

Development of student health management – the university as a setting for mental health literacy promotion **627**
Natalie Banek, Janine Michele, & Ariane Steuber

The trainer profile in inclusive education (examples from Bulgarian education system) **632**
Vanya Dobreva

Multifunctionality of rural school in the local community **637**
Liga Paula, & Anda Grinfelde

Factors that contribute to prejudice against female leadership in Zimbabwe's tertiary institutions **642**
Rosina Mavunga, & Siphokazi Kwatubana

South African science curricula intentions and enactment in responding to gender inequalities **647**
Lydia Mavuru

Human rights prerequisites for middle leaders in promoting inclusion and equity in diverse school contexts **652**
June Monica Palmer, & Edwin Darrell De Klerk

WORKSHOPS

Projects and Trends

Fast-track your research with GenAI: Essential tools and best practices for responsible use **659**
Jeroen Lievens, & Björn Sjödén

Developing teachers' prompting competence using ChatGPT: A collective anti-shortcut approach **662**
Björn Sjödén, & Jeroen Lievens

AUTHOR INDEX **665**

ORAL PRESENTATIONS

Designed by Freepik

EXPLORING THE USE OF ARTIFICIAL INTELLIGENCE IN RUBRIC PRODUCTION AND DETECTION OF REVIEWER'S BIAS

Juuso Rytilahti, Erkki Kaila, & Erno Lokkila
Department of Computing, University of Turku (Finland)

Abstract

This study explores the use of artificial intelligence in education from a unique angle, providing insight into whether a large language model (LLM) can be used to create a rubric or detect a scoring bias in teachers' evaluation. For this, we examine a specific, publicly available model by OpenAI, called GPT-4o. The study was conducted using student submissions for assignments in an introductory programming course. As the first approach, we provided the selected LLM with a sub-set of submissions with feedback from differently graded answers to produce a rubric. The second approach was to provide the LLM with a reference answer to produce the justification for grading from "nothing". Finally, we tried combining these two approaches. After the AI model output grading justifications, we compared the justification produced by LLM to ones created by teaching personnel. We also tested if a bias in reviews could be detected. Our results indicate, that there is a lot of variances in the AI-generated rubrics, and in general they are stricter than the human-generated ones. Regarding bias detection, the model seemed to be mostly able to detect bias, if only one answer was examined at the time. If multiple answers were introduced at once, this led to a considerable inability to detect incorrect reviews. The insights gained from this study can guide tool development and make teachers more aware of the possibilities and limitations of utilizing LLMs in assessment.

Keywords: *Large language models, automatic assessment, AI in education.*

---

1. Introduction

There is always a human factor involved when student submissions are reviewed by teaching personnel. All people have their own biases, and that will affect the reviewer's output, thus potentially affecting a grade given to a student. In this study, we discuss the possibility of reducing bias, reducing incorrectness, and increasing uniformity in the grading done by different assessors. Although the reviewer bias has a bigger role in more subjective areas, such as creative writing, it applies to more content-focused student submissions, such as programming exercises, as well.

While it is typical to automatically assess programming tasks at the introductory level (see Paiva et al. 2022), students of varying skill levels can also benefit from exercises that do not require that the code be compiled. Such examples include for example designing and commenting programs as well as evaluating the quality of the code. This creates a need for human reviewing instead (or in addition to) automatically assessed tasks.

In this paper, we explore the potential of LLM generating evaluation rubrics automatically, and to use that to automatically detect biases in the human reviewers' gradings. We focus on the following research questions:

1. Can a large language model produce good evaluation criteria for novice-level programming exercises?
2. Is it viable to use a large language model for detecting reviewer bias in programming exercises?

2. Background and related work

LLM performance is affected by different factors, such as the model itself, parameters, e.g., temperature, used vocabulary, language, and even the order of presented options seem to affect the performance of models. However, the effects are not always straightforward e.g., Renze et al (2024) studied the effect of temperature on the problem-solving performance of LLMs and found that changing the temperature did little to the problem-solving capabilities of LLMs. Deng and Ling (2022) also point out in

their overview of an earlier ChatGPT model (GPT3-.5), that an LLM output could include biases present in the model's training data.

LLMs have several limitations, for example, the output of an LLM can include the so-called hallucinations. Xu, Z., Jain, S., & Kankanhalli, M. (2024) defined hallucination as a situation where the LLM output includes content that sounds plausible but is factually incorrect or nonsensical information. LLMs might also resort to utilizing shortcuts, a phenomenon where LLMs resort to utilizing spurious correlations within the input, see for example, Tang et al. (2023) for a more detailed analysis of the factors affecting the LLM tendency to utilize shortcuts. For a more concrete example, Han et al. (2024) noticed how spurious correlations in the input decreased the LLM performance in simple reasoning MCQs significantly. For example, when in the examples presented in input there was one option always correct (e.g. option A), the model was inclined to select the same option even in trivial questions, even though the option was incorrect. Performance decrease can also be caused e.g., position bias, Alzahrani et al. (2024) noted a performance decrease in their study of LLM performance in multiple-choice-question (MCQ) benchmarks when e.g. the symbol or order of presented options was changed. A similar effect was noticed by Jiang et al (2024) when assessing the mathematical reasoning capabilities of the models. They note, that LLMs are not able to formally reason. Although performance in MCQs is not directly applicable to other tasks, these examples highlight the challenges current state-of-the-art LLMs have.

Wu et al. (2024) examined how the rubric produced by humans vs. LLM differs and found that notable alignment gaps between the two exist. They utilized Mixtral-8x7B-instruct in their study (Jiang et al. (2024)). They also note that adding human responses to the model's input when producing analytical rubrics seems to reduce the similarity of the generated rubrics to the human-created ones. They also note that the model seems to tend to use shortcuts on rubric generation, focusing on specific keywords instead of deeper analytical meaning, and they warn that this tendency could be in turn transferred to students as well, leading students to focus on including specific keywords instead of the actual content of their written works.

3. Research setup

The course utilized in this study is called Fundamentals of Programming, a programming course where students are taught the basics of programming. Such courses are often referred to as CS1 courses in the literature (see e.g., Nagappan 2003). As the name suggests, the course contains the basics of programming, focusing on initial concepts, e.g., variables, loops, and programmatic thinking. The programming course used in the course is Python. The course is 8 weeks long. On the course, there are automatically assessed tutorial exercises and human-graded demonstration exercises. There are in total eight different demonstration assignments, divided into sets of two. The demonstration assignments start from week 4 and a new set is introduced weekly.

The examined exercises were quite diverse, with themes depending on the concepts students were introduced to that week. In the first demonstration, the assignments were about creating a simple program from scratch or completing a simple program with missing implementations. In the second demonstration, the exercises revolved around fixing syntax and logical errors. In the third demonstration, students were introduced to planning programs. The final demonstration introduced students to an external programming library, Pygame, and the main theme was to familiarize students with utilizing external libraries.

The human-made rubrics for assignments were very content-focused, as all of the exercises utilized in this study were programming exercises. The rubrics contained a rather detailed explanation of the grading, clearly indicating which faults in the student submission caused a reduction in the given points. The rubrics had been created by an experienced programming teacher.

For the rubric production, the following prompt was given to the LLM: *"Based on the reference answer and student submissions below, create content-focused evaluation criteria. The maximum amount of points given from the exercise is 10 points. The students already know <topic keyword list> <reference answer>*". The beginning of the prompt was the same also when the student submission was excluded. We also decided to try rubric generation with exercise descriptions, as in most of the exercises they produced rubrics more aligned with the human-made rubrics. Rubric generation was tested with all of the demonstration assignments.

For detection of the reviewer's bias, the following prompt was used: "*Are these evaluations accurate to the rubric? rubric:<rubric> answers: <answers>*". The rubric used was always human-made and not AI-generated. Bias detection was tested with exercises used in demonstrations from weeks 2, 3, and 4. In bias detection, we mainly utilized one assignment from each week but increased the minor modifications made by adding varying orders, and amount of examples, and increased amount of different chat threads to verify the result.

Data was collected from students who gave explicit, opt-in consent to utilize their data as part of research, and the data was anonymized before it was used. This research is conducted utilizing the temporary chat feature of the browser version of the ChatGPT. The study was conducted through a paid subscription account in February of 2025. OpenAI states that "*Temporary Chats won't appear in your history, and ChatGPT won't remember anything you talk about. For safety purposes we may still keep a copy for up to 30 days.*" (accessed: February 2025[*]). They also state that temporary chats won't be used for improving their models. Additionally, we note that, unlike the normal user UI, temporary chats do not transfer any information between different chat threads.

4. Results

The LLM-produced rubrics were quite detailed. For example, for the first assignment, the rubric contained four sections: basic functionalities (3 points), arithmetic operations (3 points), error handling and input validation (2 points), and user experience and clarity (2 points). The point amounts were also automatically assigned by LLM. For each category, the model listed 1-point rules for grading (such as "The program correctly exits when an empty input is given. (1 point)".

On a general level, there was a lot of variance between rubrics, even on the same question between different chat threads. The assigned scores differed between rubrics quite a lot. However, especially in rubrics produced by using the reference answers, the common structure was almost always similar. The scores had some variance between different threads. This can be mostly credited to the higher temperature setting of the UI version.

The human-made rubrics were often more forgiving, especially on the later assignments. For example, on one of the tasks, the rubric instructed awarding points for producing an answer that worked only with the exact example input values mentioned in the assignment. The model-produced answer did not include this rule.

On the second set of assignments, where exercises were focused on fixing different syntactical and logical errors, the produced rubric contained the main themes of correcting syntax errors, logical errors, and input handling corrections. However, the rubric still contained rules for code structure and readability. The broken program given as input for the assignment contained many mistakes, but its structure did not require fixing.

In the third set, the main themes of the rubrics were similar to human-made rubrics. If a reference answer was used containing a detailed description of the code, the outputted rubric was aimed at implementing the requirements, instead of focusing on planning and design of the program. Implementing a new feature to the existing structure aligned better with the original human-made rubric

On the fourth set of assignments, the main focus on the human-made rubrics was on implementing the requested functionality, and no emphasis was put on the code structure, as this was a challenging task already. However, while the AI-generated rubric from the assignment description contained these features, on an assignment revolving around creating and moving around snowmen, the rubric mentioned rewarding additional features and creativity. This was similar in both generated rubrics.

Regarding the use to detect reviewer bias, when utilizing examples with minor mistakes, the model hallucinated on some reasoning, but the final verdict was correct. On most occasions, the model did go through each answer and checked each point mentioned in the rubric separately. The overall performance seemed good. However, this was a wrong assessment. If an incorrectly evaluated answer was the only one in the input, it was usually correctly identified and received correct point reductions. However, when the incorrect input was part of a large input set with multiple other answers, the other answers affected the evaluation, resulting in missed corrections. This seemed to be a consistent behavior. Even when the wrong justification for a (too high) score of an answer was correctly identified, the number of points reduced was inconsistent between different threads with identical input.

5. Limitations

The experiments conducted were qualitative. Additionally, the used data consisted of programming exercise submissions. To produce more generalizable results, a more quantitative approach should maybe be used. LLMs' ability to detect reviewer bias is likely highly dependent on the model used, the prompt, exercise type, etc. This study noticed the effects of LLMs' tendency to shortcut when trying to detect reviewer bias, however, these results are highly preliminary due to the small sample size on a specific domain. To say anything definitive about the subject, a larger-scale experiment should be conducted.

[*] https://help.openai.com/en/articles/8914046-temporary-chat-faq

6. Discussion

One possible problem with utilizing LLM is over-reliance on the tool. Reviewers have different biases, and of course, as noted before, the review is often affected by human factors. The LLM provides an additional perspective, easily produced. It is important to note that hallucinations can and will still occur within the produced output, regardless of the input and model used.

Another problem is what is the appropriate amount of context. It is worth noting that even on courses focusing on the fundamentals of programming (CS1) there are often differences between universities in the order the different topics are presented to students. If AI-generated rubrics are to be used as is (e.g. to produce evaluation criteria for adaptive learning environments) the input to the model should include the topics the student is familiar with. It should be noted that in our experimentation mentioning the skill level at a very shallow level (e.g., "functions", "variables", "loops") did not seem to change the produced rubrics that much. A more fruitful route could be also to include the topics that the student has not yet mastered, as this could align the model better with the goal.

On rubric generation, depending on the exercise the results can differ quite much. The exact number scoring should not be treated as ground truth, as the variance was quite high between the different chat threads. When asking a model to produce a rubric from a reference answer, the structure of the generated rubric was often similar between different assignments. However, quite often the rubric revolves around the function names used in the answer. Sometimes this is preferred, but often this can also seen as a surface-level approach. If a student is asked to produce a program, the focus should be on using suitable features instead of forcing a student to follow a certain structure or naming convention in the program.

In the fourth week, the model's inclusion of the "creativity" criteria could be seen as quite problematic. It should be noted that the exercise description contained a mention "*... of course, you can decorate the figure however you lik*e". This means that the decoration was optional, and should not be included in the rubric itself. The utilized reference answer also contained a similar mention as a code comment, as well as an example of such a feature. These, as well as the theme, could be the reasons for such a misalignment, highlighting the importance of inspecting the input to only include text relevant to the aimed goal. It should be noted, that providing the LLM with additional instructions on creating the rubric could help with this.

All in all, the results display a clear misalignment between human-made and LLM-produced rubrics. The LLM seems to easily be misaligned. However, the rubrics seemed to produce within rather consistent structure, and themes. If a human oversees the rubric production, and critically evaluates the result before utilizing the result, the LLM-produced rubrics can produce a good starting point. If used fully, or even semi-autonomously, careful consideration and testing on the specific type of exercise is required to reveal if the outputted rubric is suitable for purpose. Additionally, one could argue that the creation of a rubric is a task requiring advanced reasoning, so the newer models with improved reasoning capabilities may produce better results.

Regarding the detection of reviewer bias, we noticed a similar effect as Han et al. (2024). When multiple examples were introduced, the output seemed to be highly affected by the previous answers that appeared in the input. However, as mentioned in the results, the model seemed to be able to detect incorrectly reviewed answers much more often when they were introduced one by one instead of evaluating a group of answers at once. We also would like to note, that to confirm these results, the experiment should be duplicated with a larger amount of data. Of course, in this case, the performance can also be highly dependent on the rubric, and as we noted in our previous studies (Rytilahti, Kaila & Ingman, 2025), LLM will make mistakes when automatically assessing these types of demonstration assignments, indicating that the current models are not (at least yet) ready to assess these assignments autonomously. However, our results seem to indicate that an LLM can be used as an additional tool to help detect incorrect evaluations of a single review.

7. Conclusion and future work

Regarding the question, of whether AI can produce good evaluation criteria for novice-level programming exercises, the answer is: "Sometimes". Utilizing an exercise description produced better results than the reference answer, as the model could better align with the aimed learning goals. Additionally, the produced rubrics tend to overscope when compared to the human-made ones. Utilizing only reference answers creates shallow rubrics more often than providing LLM with an exercise description.

Regarding the detection of reviewer bias, it seems to be somewhat possible, as long as the rubric is utilized and only one answer at a time is evaluated. However, this is of course highly dependent on the answers being evaluated, and probably also the type of mistake made and the exercise's type. If multiple

answers were evaluated in one prompt, the model's ability to detect incorrect answers was severely impaired by the effect of the other answers present in the input. Our preliminary results indicate that an LLM can be a helpful tool to detect bias, but it should be treated as an additional assistant to human reviewer instead of relying upon it to complete the whole process.

The future work should include looking into more subjective areas, as well as different kinds of answers including essays and reports. Additionally, a look into how tuning the settings of the LLM (for example the temperature) affects the output should be examined. A more quantitative approach to rubric evaluation could be fruitful, including measuring the semantic similarity (Wu et al. 2024). Furthermore, more research is needed to include the recent advancements in the field of LLMs, including recent models such as DeepSeek r1 or OpenAi o1. Finally, more diverse prompting strategies, as well as the effect of different combinations in the input should be examined.

Acknowledgements

This work has been supported by FAST, the Finnish Software Engineering Doctoral Research Network, funded by the Ministry of Education and Culture, Finland.

References

Alzahrani, N., Alyahya, H. A., Alnumay, Y., Alrashed, S., Alsubaie, S., Almushaykeh, Y., ... & Khan, H. (2024). *When benchmarks are targets: Revealing the sensitivity of large language model leaderboards*. arXiv preprint arXiv:2402.01781.

Deng, J., & Lin, Y. (2022). The benefits and challenges of ChatGPT: An overview. *Frontiers in Computing and Intelligent Systems*, *2*(2), 81-83.

Han, P., Song, P., Yu, H., & You, J. (2024). *In-context learning may not elicit trustworthy reasoning: A-not-b errors in pretrained language models*. arXiv preprint arXiv:2409.15454.

Jiang, A. Q., Sablayrolles, A., Roux, A., Mensch, A., Savary, B., Bamford, C., ... & Sayed, W. E. (2024). *Mixtral of experts*. arXiv preprint arXiv:2401.04088.

Jiang, B., Xie, Y., Hao, Z., Wang, X., Mallick, T., Su, W. J., ... & Roth, D. (2024). *A Peek into Token Bias: Large Language Models Are Not Yet Genuine Reasoners*. arXiv preprint arXiv:2406.11050.

Nagappan, N., Williams, L., Ferzli, M., Wiebe, E., Yang, K., Miller, C., & Balik, S. (2003). Improving the CS1 experience with pair programming. *ACM Sigcse Bulletin*, *35*(1), 359-362.

Paiva, J. C., Leal, J. P., & Figueira, Á. (2022). Automated assessment in computer science education: A state-of-the-art review. *ACM Transactions on Computing Education (TOCE)*, *22*(3), 1-40.

Renze, M., & Guven, E. (2024). *The effect of sampling temperature on problem solving in large language models*. arXiv preprint arXiv:2402.05201.

Rytilahti, J., Kaila, E., & Ingman, V. (2025). *Large language model performance in automatic assessment on an introductory programming course*. Paper submitted to ITiCSE 2025, Nijmegen, Netherlands.

Tang, R., Kong, D., Huang, L., & Xue, H. (2023). *Large language models can be lazy learners: Analyze shortcuts in in-context learning*. arXiv preprint arXiv:2305.17256.

Wu, X., Saraf, P. P., Lee, G. G., Latif, E., Liu, N., & Zhai, X. (2024). *Unveiling scoring processes: Dissecting the differences between llms and human graders in automatic scoring*. arXiv preprint arXiv:2407.18328.

Xu, Z., Jain, S., & Kankanhalli, M. (2024). *Hallucination is inevitable: An innate limitation of large language models*. arXiv preprint arXiv:2401.11817.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

A FRAMEWORK FOR UNDERSTANDING STEM FOCUSED SCHOOLS

Wendy P. Ruchti, & Cory A. Bennett
Department of Teaching and Educational Studies, Idaho State University (USA)

Abstract

The importance of science, technology, engineering and mathematics (STEM) education continues to grow around the world. Increasingly, schools are examining ways to implement STEM into their programs and curriculum and policymakers are discussing the urgent need for greater and more effective STEM instruction to meet the growing needs of various industries. As a result, ministries and departments of education are responding by creating pathways for schools to become specialized STEM-focused schools. These schools, theoretically, would offer curriculum designed to foster critical thinking, experiential learning opportunities in STEM, and innovative problem-solving by integrating the four STEM disciplines. Students in these schools often learn through project-based learning and consider real-world applications that include opportunities for collaboration with the community. The goal of these schools is often to increase student achievement and prepare students for careers in STEM fields, especially those that come from underrepresented populations. However, STEM-focused schools often face several key challenges when it comes to implementation. These challenges include ensuring students from underrepresented populations have equal access, navigating the shifts in resource allocation which can be significant, as well as evaluating the effectiveness of the programs. However, these challenges can potentially become strengths of STEM-focused schools when guided by purposeful and intentional implementation, starting with the key structures and conditions that must be in place even before starting to make significant changes. A pre-implementation framework will ensure that all critical components are thoughtfully addressed before implementation begins. This is important in order to provide a clear roadmap for future changes, organize the process and define priorities. This presentation will review the existing literature on STEM-focused schools and propose a framework for the pre-implementation structures and practices necessary before schools start the work of transforming into equitable and effective STEM-focused institutions. This information will provide teachers, administrators, and policymakers with a research-based framework around which to make informed decisions as they move toward the successful implementation of STEM in a school-wide setting.

Keywords: *STEM, STEM education, project-based learning, school change.*

1. Introduction

STEM-focused schools are those that emphasize or are organized around science, technology, engineering or mathematics disciplines. In the United States, the number of STEM-focused schools has increased in the last two decades following multiple calls for expansion of STEM at the national level and given increasing awareness that many jobs continue to be based on advances in science and engineering (National Academies of Sciences, 2024). As early as 2011, models for STEM-focused schools (inclusive, selective and CTE), with specific criteria, in order to effectively advance STEM education were proposed (National Research Council, 2011).

As the number of schools grew, many states created specific standards for schools to officially become a STEM-focused or STEM-Designated school with criteria that often involve implementing rigorous STEM-focused curricula, developing partnerships with industry or higher education, and demonstrating a commitment to fostering critical thinking and innovation in science, technology, engineering, and mathematics. In most cases, to obtain this recognition, schools must clearly demonstrate how they meet these high standards through an extensive and rigorous review process.

For most schools, the requirements are substantial. Beginning to implement change toward becoming a STEM-focused school means having an understanding of effective STEM teaching and learning, supportive and dedicated leadership, a clear action plan for implementation, and capacity to sustain the process over time. All of this can be challenging when first beginning the process. Thus, without sufficient content and pedagogical knowledge of what integrated STEM teaching and learning should look

like (Bennett & Ruchti, 2022) or how teachers and administrators create, monitor, and track systems for implementation (Fullan, 2021) obtaining a STEM designation will be challenging. Additionally, and of equal importance, without understanding the critical prerequisite components, the structures and mindsets that allow for the first steps of implementation to be successful, schools will almost certainly meet with multiple barriers and challenges. As such, schools can benefit from a clear pre-implementation framework in order to be strategically prepared for the obstacles as well as the nature and complexity of becoming a STEM-focused school.

2. Components of STEM focused schools

Studies have identified a variety of characteristics or components of STEM schools (Grant, 2023; House et al., 2020; Peters-Burton et al., 2019). While the number and range of characteristics differ, there is general agreement some key components need to be in place. These common components focus on strong leadership, an integrated curriculum, effective teaching practices and an awareness of leveraging external partnerships to support students' college or career aspirations. Each will be briefly discussed below.

For STEM-focused schools to thrive, a supportive administrative leadership team with a clear mission and vision is essential (Wieselmann, et al., 2021). This begins with leaders who are deeply committed to inclusive STEM education and recognize the long-term benefits of a STEM-focused school. Tension, confusion, and other challenges can arise early on (Slavit et al., 2016; Lesseig et al., 2019) so administrators need to create a culture of collaboration with open communication and mutual respect that guides decision-making and implementation. Effective leaders will also recognize the need and importance for on-going professional learning opportunities especially with respect to using integrated curricular resources and adopting more inquiry-based teaching practices.

STEM-focused schools typically implement an integrated curriculum, incorporating both science and mathematics, though exact definitions vary (Lesseig et al., 2019). And while some schools rely on professionally developed curricular materials, many schools develop their own integrated STEM materials, which means the curriculum will vary in quality. In turn, this can lead to issues related to implementing effective inquiry-based teaching practices as it requires an extensive understanding of science, engineering and mathematics standards as well as the pedagogical knowledge on how best to approach integration (Bennett & Ruchti, 2022).

High functioning STEM focused schools understand the importance of attending to students' college and career aspirations. Attending to the skills needed to be successful in post-secondary college and career contexts should begin in the primary grades and be expanded upon in secondary grades (Dare et al., 2021). One important aspect in building and growing these skills comes from external STEM partnerships as they connect schools with universities, businesses, non-profits, and industry leaders who provide students with real-world STEM opportunities. Likewise, these partnerships also provide valuable insights into emerging technologies and industry trends preparing students for the dynamic demands of STEM careers (Detgen et al., 2021).

3. Pre-implementation framework

Several conceptual frameworks for STEM education (Jackson et al., 2021; Kelley & Knowles, 2016; Roehrig et al., 2021) help to define how schools might implemente STEM, however, these frameworks do not address implementation practices and structures in STEM-focused schools. Other scholars address the various implementation practices or certain parts of implementation, but are not comprehensive about the process or structures that must be in place before starting implementation (e.g. Slavit, 2016; Wieselmann, 2021). While existing frameworks provide valuable guidance and insight, a significant gap remains between the general concept of "implementing STEM" and the systematic, structured approach to transitioning from a non-STEM school to a STEM-focused institution. Based on our past work in supporting schools in obtaining STEM designation, we have found the following foundational elements and prerequisites as it were, necessary before formal training, professional learning, and other curricular or instructional practices change. This pre-implementation framework clarifies the essential elements to support the intentional implementation of practices and structures that create equitable and effective STEM-focused schools. In our experiences, the absence of any one of these elements substantially jeopardizes the outcomes of the work.

To begin, school leadership needs to establish a culture and structures conducive to change. This includes deliberate attention to common beliefs within the leadership team, consistent and frequent communication around the vision for the school and purpose for change, collaboration with multiple internal and external stakeholders, and an accountability to professional learning. Each of these will be discussed in further detail below.

A clear vision for change is not only necessary, but the first element to clearly define and establish. A comprehensive vision highlighting the benefits of STEM education for students, teachers, and the broader community must be accessible and understandable to all (Grant, 2023). Within that vision and the long-term plan for achieving that vision, measures of success, and how success will be evaluated, including ensuring students from underrepresented populations have equal access should be clearly described. The leadership team should also consider other school initiatives that may not fit the new STEM education vision, and may take away from the vision as this may lead to confusion around purpose and intended outcomes. Next, the school will need to create a STEM Leadership Team, comprising teachers and administrators, to guide the development of the vision statement. They will also be the ones to ensure a phased approach to implementing changes over time.

Next, the STEM leadership team will need to engage a variety of stakeholders early in the planning process. Building relationships, as well as maintaining open and regular communications, with a variety of stakeholders is critical anytime a major initiative begins (Crotty, 2018). Parents and families are a natural group to include but the STEM leadership team should make deliberate efforts to include community leaders, industry partners, and aligned community organizations from the planning phase onward. These stakeholders bring insights and perspectives not often found within the internal school community and the leadership team should be prepared to leverage these partnerships to enhance learning opportunities, mentorship programs, and access to real-world STEM applications. Additionally, the STEM leadership team should begin hosting regular outreach and educational events, such as STEM "Open Houses" to showcase student work and STEM Family Nights to provide hands-on STEM experiences for families, fostering transparency and buy-in. This creates informal opportunities to continually educate these external stakeholders.

Simultaneously, some internal structures can be adapted or adopted to support the long-term intended change. For example, schools must create schedules to ensure teachers have sufficient common planning time, both within their subject areas and across interdisciplinary teams. Eventually, this common planning time will become proper Professional Learning Communities (DuFour et al., 2024) wherein teams can co-plan, examine data from student learning, and otherwise refine learning experiences and assessment practices. Additionally, time should be built into the schedule for regular whole-school professional learning sessions to enhance teacher expertise and promote collaboration (Ruchti et al., 2018). In time, this will lead to teacher-driven professional learning, which further builds the internal professional capacity of the teachers. Furthermore, schools should consider ways to create flexibility in the daily schedule in order to support interdisciplinary curriculum and instruction, allowing time for collaboration, exploration, and reflection. It is worth considering options such as block scheduling, interdisciplinary periods, or advisory time for collaboration and for exhibition days when students showcase their work.

Next, the STEM leadership team needs to consider the financial implications associated with the transition. This includes considering what additional STEM-aligned curricular resources will be needed and when. Likewise, the team needs to inventory their technology resources as they may need to invest in, or update, additional classroom technologies such as laptops, tablets, and interactive whiteboards or data collection probes and software. For some schools, it is worth considering whether a dedicated STEM lab or "Makerspace" is needed; each space may need to be designed and equipped for hands-on experimentation and prototyping. Lastly, the STEM leadership team needs to understand the school's internet capacity. Will the current bandwidth and speeds support digital tools and online learning? Lastly, given the potential initial investment in resources, the STEM leadership team should have a plan for any shifts in resource allocation.

Lastly, the STEM leadership team needs to understand how they are going to assess their progress by developing and using appropriate evaluation and continuous improvement tools. To begin, they should define clear measures of success and establish data collection processes to evaluate progress; leveraging the expertise of external stakeholders, such as higher education experts or STEM consultants, is often needed. The STEM leadership team should use this data to inform ongoing adjustments and ensure continuous improvement of STEM initiatives as would be done in a professional learning community (DuFour et al., 2024). However, the team should also use multiple other measures of effectiveness outside of student achievement tests. For example, one common measure of success or goal of STEM-focused education is expanding the number of students who pursue advanced degrees and careers in STEM, in particular for women and other underrepresented groups (National Research Council, 2011). Regardless of which measures of success and instruments used to assess this success are used, the intentionality in developing these are necessary.

4. Discussion and conclusion

Although we have presented a pre-implementation framework for becoming a STEM-focused school, it is important to remember that this change involves not only curricular modifications, but also necessitates a fundamental shift in school culture and operations. One of the foundational considerations is understanding and honoring the unique characteristics of a school and its community. Each school operates within a distinct ecosystem of traditions, values, and expectations. Therefore, as schools move forward with this transformation, it must be a dynamic, adaptive process shaped by the unique contexts, histories, and relationships within each school community. Change is never a static event, but is a continuous evolution influenced by real-time interactions and negotiations among stakeholders, including faculty, staff, administrators, and the broader community. Most often, schools must respect and integrate existing traditions while simultaneously fostering innovation. Prioritizing the school's current social and cultural context ensures that implementation is meaningful and sustainable, and also allows for the evolution of practices and the incorporation of community values. By embracing this adaptive and flexible approach, schools can foster a systematic, equitable, and lasting shift toward high-quality STEM education.

References

Bennett, C. A. & Ruchti, W. (2022). Designing intentional STEM connections: An initial case study in an American curriculum school. In J. Hodgen, E. Geraniou, G. Bolondi & F. Ferretti. (Eds.), *Proceedings of the Twelfth Congress of the European Society for Research in Mathematics Education (CERME12)* (pp.1-8). Free University of Bozen-Bolzano and ERME.

Crotty, E. A. (2018). Understanding the ways in which teacher leadership teams influence STEM integration in emerging STEM schools (Doctoral dissertation, University of Minnesota).

Dare, E. A., Keratithamkul, K., Hiwatig, B. M., & Li, F. (2021). Beyond content: The role of STEM disciplines, real-world problems, 21st century skills, and STEM careers within science teachers' conceptions of integrated STEM education. *Education Sciences*, *11*(11), 737.

Detgen, A., Fernandez, F., McMahon, A., Johnson, L., & Dailey, C. R. (2021). Efficacy of a college and career readiness program: Bridge to employment. *The Career Development Quarterly*, 69(3), 231-247.

DuFour, R., Dufour, R., Eaker, R. Many, T. W., Mattos, M., & Muhammad, A. (2024). *Learning by doing. A handbook for Professional Learning Communities at Work* (4th ed.). SolutionTree.

Franco, M. S., Patel, N. H., & Lindsey, J. (2012). Are STEM High School Students Entering the STEM Pipeline? *NCSSSMST Journal*, *17*(1), 14-23.

Fullan, M. (2021). *The right drivers for whole system success* (CSE Leading Education Series 01).

Grant, L. E. (2023). *STEM Elementary Schools: Teacher and Administrator Perceptions and Concerns*. Washington State University.

House, A., Peters-Burton, E. E., Hinton, V. P., Remold, J., & Levin-Güracar, E. (2020). Critical Components of STEM-Focused Elementary Schools. *Journal of Higher Education Theory & Practice*, *20*(8), 20-45.

Jackson, C., Mohr-Schroeder, M. J., Bush, S. B., Maiorca, C., Roberts, T., Yost, C., & Fowler, A. (2021). Equity-oriented conceptual framework for K-12 STEM literacy. *International Journal of STEM education*, *8*, 1-16.

Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM education*, *3*, 1-11.

Lesseig, K., Firestone, J., Morrison, J., Slavit, D., & Holmlund, T. (2019). An analysis of cultural influences on STEM schools: Similarities and differences across K-12 contexts. *International Journal of Science and Mathematics Education, 17*, 449-466.

National Academies of Sciences, Engineering, and Medicine. (2024). *Scaling and Sustaining Pre-K-12 STEM Education Innovations: Systemic Challenges, Systemic Responses.* Washington, DC: The National Academies Press. https://doi.org/10.17226/27950

National Research Council. (2011). *Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics.* The National Academies Press.

Peters-Burton, E. E., House, A., Peters, V., & Remold, J. (2019). Understanding STEM-focused elementary schools: Case study of Walter Bracken STEAM Academy. *School Science and Mathematics*, *119*(8), 446-456.

Roehrig, G. H., Dare, E. A., Ellis, J. A., & Ring-Whalen, E. (2021). Beyond the basics: A detailed conceptual framework of integrated STEM. *Disciplinary and Interdisciplinary Science Education Research, 3*, 1-18.

Ruchti, W., Bennett, C. A., & Dunstan, M. (2018). Understanding quality work in mathematics: Supporting teachers in leading professional development. *Journal of Interdisciplinary Teacher Leadership, 2*(1), 19-28.

Slavit, D., Nelson, T. H., & Lesseig, K. (2016). The teachers' role in developing, opening, and nurturing an inclusive STEM-focused school. *International Journal of STEM Education*, *3*, 1-17.

Wieselmann, J. R., Roehrig, G. H., Ring-Whalen, E. A., & Meagher, T. (2021). Becoming a STEM-focused school district: Administrators' roles and experiences. *Education Sciences, 11*(12), 805.

NAVIGATING CONTRADICTORY EXPECTATIONS: CHALLENGES IN PREPARING FOR THE GAMES, ANIMATION AND VFX INDUSTRIES

Silke Hassreiter, A. Treshi-Marie Perera, Tuki Clavero, Lindsey Bouwels, & Mata Haggis-Burridge
The Academy for Games and Media, Breda University of Applied Sciences (The Netherlands)

Abstract

The European games, animation, and VFX industries, along with related educational institutions, are shifting towards sustainable practices due to growing awareness of workforce well-being, however, layoffs and increased interest in these fields has intensified competition in an already saturated job market. This has created contradictory expectations for prospective employees: the ideal *employee*, an adaptable team player, team-fit, with strong interpersonal skills; but also the ideal *applicant*, characterised as standout, highly skilled, competitive, and self-promoting. Using Study Demands-Resource Theory, this study examined how educational institutions and emerging talents navigate these contradicting demands. Thematic analyses highlighted the extreme nature of the overall industry, job market and academic demands placed on students, as well as how peer support, messages of reassurance, and well-meant advice can be both resources and stressors. Educational experts and students face critical decisions with significant implications for well-being and career prospects.

Keywords: *Games, animation and VFX industry, student well-being, burnout, study demands, study resources.*

---

1. Introduction

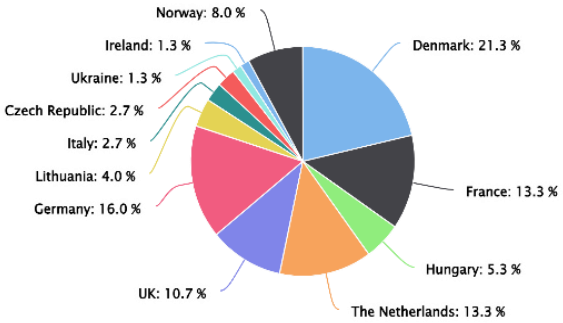
The video games, animation and VFX (visual effects) sectors are rapidly expanding industries; however, this expansion has been associated with systemic issues perpetuating a crunch-culture for many employees with demands for high-quality outputs under tight deadlines and high-pressure work environments (Edholm et al., 2017). This has contributed to toxic and unsustainable work environments that marginalise communities (e.g., women; Peticca-Harris et al., 2015) and are detrimental to staff wellbeing, with reports of increased stress, burnout, and staff turnover (Cote & Harris, 2021). Awareness and open discourse concerning this toxicity has promoted initiatives prioritising collaboration, diversity, and wellbeing in these sectors (Hassreiter et al., 2024). Our recent findings demonstrate an industry drive towards favouring 'adaptable team-players' as ideal employees where soft skills are valued over technical skills (Hassreiter et al., 2024).

There are challenges to becoming the 'ideal' workplace, education, or (future) employee despite efforts and aspirations towards achieving an ideal characterised by balanced, collaborative work cultures. Challenges underscored by the games, animation, and VFX industries, the competitive job market, and educational institutions related to these industries continue to foster high-pressure work environments (Hassreiter et al., 2024). While these industries value team-oriented and adaptable individuals, they continue to pursue highly skilled, compliant, and hardworking talents during hiring. This duality creates tension between embracing sustainable workplace ideals and meeting the competitive demands of such fast-paced, results-driven industries. The over-saturated job market exacerbates this challenge, placing added pressure on talents to stand out, favouring competitive self-promotion and exceptional portfolios over softer, team-oriented skills. For emerging professionals in these fields, such pressures sit over typical study activities that are part of higher education, including attending lectures, group work, and assignments. This places additional demands on students aiming to join these industries compared to other skilled sectors. Simultaneously, the rise in educational offerings in games, animation, and VFX, has intensified competition among universities, resulting in them emphasising outcomes that showcase graduates' technical capabilities using standout student portfolios as marketing tools (Hassreiter et al., 2024). These dynamic places pressure on both educational institutions and students to reconcile these conflicting expectations, and navigate a complex landscape where collaboration is publicly championed, but individual technical expertise and self-promotion remain intrinsically paramount.

The Study Demands-Resource Theory (SD-R; Bakker & Mostert, 2024) proposes student life to be characterised by *demands* costing physical, mental, and emotional distress, and *resources* that buffer these demands and motivate students, leading to better outcomes. Educational institutions must therefore pay close attention to the balance of demands and resources placed on students as they are prepared for these competitive and rapidly evolving games, animation, and VFX industries which exist in a saturated job market. They should be proactive in adapting curricula and support mechanisms aimed at reducing stressors and supporting students as needed. This may prevent performance decline, stress, and burnout, while fostering greater workforce sustainability in these industries (Salanova et al., 2010). Based on the SD-R theory, this study examined how higher educational staff and students navigate conflicting industry demands and the resources available to them. Despite its demanding nature, to our knowledge there is no evidence considering the applicability of SD-R theory to higher education sectors in games, animation, and VFX. By exploring student and staff experiences and coping strategies in this sector, this study aimed to provide in depth and nuanced insights into the demands, resources, and potential stressors for educational institutions to consider when promoting productivity of their staff, employability of their students, and the well-being of both.

2. Methodology

Figure 1. Percentage of participants by country of residence.



As part of the Paneurama project (www.paneurama.eu), a qualitative study was performed, comprising both unstructured and semi-structured interviews, focus groups, expert panels, and informal discussions. These were conducted at FMX (Film & Media Exchange Conference) 2024 in Germany, the International Animation Film Festival in Annecy, France, and the Viborg Animation Festival in Denmark. The study recruited 75 participants, comprising industry experts (connected to educational institutions as guest lecturers, industry panellists, examiners), educational experts (from academic and vocational institutions), and final-year students across 12 European countries (see Figure 1) between January and September 2024, via snowball sampling and leveraging initial contacts to expand the participant pool. All participants provided written informed consent and the students were part of Bachelor's and Master's programs in games, animation, and VFX. Recruitment efforts ensured a balanced sample in terms of gender, work experience, academic year, and levels of experience of industry professionals (less than / greater than two years of work experience). Data was analysed using thematic analysis, allowing us to identify key patterns across responses. Participants were primarily based in Northern and Central Europe; however, the analyses represented all participant voices, and this diversity is reflected in the findings, offering a nuanced and comprehensive understanding of the complex issues faced by educational experts and students in the field. The findings of this study aim to inform policy discussions and to contribute to future large-scale research and quantification.

3. Findings

A detailed analysis of the data revealed several key themes, which are outlined below. These themes emerged as interconnected and compounding factors, creating a chain of escalating circumstances.

3.1. Educational experts balancing conflicting demands amid a fragmented approach

In response to changes in the industry and to align with the growing demand for adaptable team players as ideal employees, educational institutions are shifting from modular learning approaches, which honed individual technical skills, to blended approaches including collaborative and project-based learning. However, the reality of conflicting industry demands and the competitive job market has led to educational experts adopting divergent teaching approaches that prioritise either technical skills or a balance of both

soft and technical skills. This has resulted in a lack of unified messaging for students. As one participant explained: *"The tricky thing is that even within our degree programs, we don't have consensus on this [teaching approach], because there are still industry veterans that say no, this is how the industry works [they need rockstars]. […] More people are talking about healthy, sane working practices. But that's not a universal message yet, and I don't think we can get away with a universal message yet."*

For instance, some educational experts, especially senior professionals socialised in older workplace conventions, continue to perpetuate outdated standards such as the 'Rockstar' mentality, and emphasise the importance of mastering hard skills and building exceptional portfolios over developing soft skills. They advise students to focus on technical expertise and individual achievement while treating scheduled project work as secondary. They justify this by referencing the job market's competitive nature, and the industry's ongoing call for highly skilled, compliant workers. As explained by a participant: *"We have a hierarchy problem. Most teachers that come from the industry and teach are seniors, but they rather talk about past experiences in the industry and perpetuate. The ones that talk new practices are the ones that are juniors. That makes it difficult to change overall approaches in Universities due to hierarchy issues."*

Conversely, other educational experts expressed a desire to focus on the ideal vision of the industry while acknowledging the need to be realistic about the conflicting demands of both industry and the job market. They encourage students to leverage group projects to develop soft skills, maintain healthy work-life balances, and gain creative input through activities outside of their workplaces. Simultaneously, they also encourage the development of competitive hard skills to build standout portfolios. One expert highlighted this tension, stating: *"I think our industry partners would rip us apart in the feedback [if we would only concentrate on group work and soft skills]: Hey, they lack technical skill, they lack to follow orders. […]. So, that leaves us as an education in an incredibly tricky situation. Do we teach right now for the skills they need to get a job today, or do we teach what the industry should be according to a little more liberal interpretation of what a healthy workforce is? And there is a direct conflict with that".* Educational experts are therefore faced with an ethical dilemma concerning the potential production of exceptionally skilled and compliant graduates who may have a competitive edge in the job market but are primed for exploitation rather than sustainability – which they describe as *"cannon fodder for the industry"*, or the production of students meeting the new industry ideal, but potentially struggling to break into the industry due to the competitive job market.

In summary, the varying teaching approaches of educational experts add to the already complex set of expectations of graduates. They distort curricula and push students in opposing directions, sometimes transforming educational experts from supportive resources to stressors. Navigating the complex and contradictory expectations of the industry, the job market, and educators can therefore be cognitively and emotionally taxing for students and potentially compromise student well-being and professional growth.

3.2. Students navigating complex and contradictory expectations: Emerging approaches

Upon entering higher education, students are confronted with a *"reality check"* as a result of complex and conflicting pressures from their academic environment, industry expectations, and the job market. This is amplified by the context of peers who are equally the best in their fields: *"I think that there's also a big shock for them, when they enter educational institutions. Because, I am not the best at it anymore. I used to be the best one at drawing […]. That was my super strength and now I'm struggling to keep up with all of these other people who are the best at what I used to think I was the best in."* This compels many students to exceed the standard 40-hour study week to upskill themselves and stand out among their peers. At the same time, faculty and industry speakers increasingly advise students to avoid overworking and embrace industry trends toward a healthier work-life balance. Students perceive this as additional stress, as they now feel pressured to meet new industry trends while coping with the overwhelming workload and high expectations. As such, this work-life balance advice is often perceived by students as a demand, rather than well-meaning advice. As described by one participant: *"Every time a lecturer comes into the room, I have the feeling I need to strike a yoga pose."*

Against this backdrop, this study found students to develop diverse coping mechanisms and work ethics, which impact their academic and career paths. These include, the 'Rockstar Mindset', the 'Self-Preservation Mindset', and the 'Competitive Improvement Mindset'.

- **The 'Rockstar Mindset':** Rockstar students prioritise standing out and dedicate significant time to mastering hard skills and building exceptional portfolios. This clashes with present curricula emphasising collaboration, and creates tension between personal goals and the team-oriented structure of projects. *"In uni I think my standard week was like 80 hours and then it would jump up to 110 at times. So eventually I also took a break for a year like between my 3rd and 4th year [. Then] I felt I lost time. I worked hard again and made up for putting a gap year in."* According to educational experts, these students run the risk of overworking to create exceptional portfolios

and gain visibility, fostering toxic work habits at university. Despite their potential to gain a competitive edge in the job market, they might struggle with transitioning towards collaborative production teams when they secure a job in the industry.

- **The Self-Preservation Mindset:** Self-Preservation students prioritise personal well-being while pursuing the new industry ideal by developing a solid foundation in both hard and soft skills. The curriculum's emphasis on group work aligns well with their approach, because it allows them to develop collaborative skills and share responsibilities in a way that supports their balanced lifestyle. *"If I think about it too much, then it gets stressful. Then I'm like, oh sh*t. Maybe I also need to do that [work as hard as them], but I know for myself, I'm not even able to do that kind of stuff, like work so many afterhours and stuff. So for me, I'm kind of accepting it. Like we'll see where I land and I'm not trying to worry about other people."* Some students following this approach face difficulties securing employment despite having a strong portfolio. As a result, they either consider working in other industries or adopt a 'competitive improvement mindset' during Master's studies, using this time next to a full-time study to create a stronger portfolio without creating a gap in their CV. However, participants are concerned about this trend, fearing this focus on work-life balance in educational institutions might lead students to self-limit and choose different career paths too early, potentially missing opportunities to reach their full career potential.

- **The Competitive Improvement Mindset:** Competitive Improvement students focus on individual excellence and creating exceptional portfolios while developing soft skills, actively engaging in peer networking and extracurricular activities for experience and new insights, all while fulfilling educational tasks that require participation in group work. This mindset is outlined in the following quote, *"Game education is something that you have to sacrifice things for. It takes time, not just a regular nine to five. […] You will do more outside of it because you will want to learn different things. You'll want to make a portfolio, so you gotta put in those hours. You gotta do your research for that in order to get to where you want to go. […] Talk to those people, make connections right away. […]. Be friendly, be flexible. […]. You just need to work hard and be nice to get in."* As a result, these students often exceed a 40-hour study week and sacrifice leisure time to meet their goals. Participants expressed concern about the potential negative impact of this approach on student well-being. One young professional, who adopted this approach, compared their study time to working in the highly demanding games, animation, and VFX industry: *"Compared to the stress levels during my studies, a job in the industry feels like a walk in the park."*

3.3. Peer networks: The greatest resource for support?

Despite recognising that peers will be future sources of competition, participants identified peers as their greatest resource during their studies. They value peer networks for motivating each other as they complete educational tasks, sharing resources relating to the industry landscape, keeping each other updated on sought-after skills, and potential employment opportunities. Even students with a 'Rockstar Mindset', though selective, support and collaborate with peers of similar skill levels. *"For sure, you kind of still want to be the best. But you also want your friends to succeed as well, right? So we are really pushing each other. We motivate each other. I would not have managed to get where I am right now without my friends and that is really important to me personally. They helped me continue. I helped them push. We all push each other and make sure that we did our best."*

While peers seem to be a strong resource for many students, in the academic context and later in the work context, an overly deep sense of belonging to these peers can also turn into a stressor. Participants reported the students in these fields often experienced some form of exclusion in previous educational settings for being different. When entering university, they frequently meet like-minded peers for the first time and experience a feeling of deep friendship, which can lead students to push themselves to stay within their peer group and environment, even though they lack the skill level or mental and emotional capacity to remain in education and later in the industry. *"They [peers at educational institution] were my people and it was the first time I felt like I was part of a collective. I've never had that before. […]. I think it's the people that were a bit ostracised by society because they are nerds, gamers. This even goes with the artists. They were probably doodling in their sketchbooks in high school, and then other people were like: 'Oh, look at that nerd just drawing'. Then you come all of a sudden to this place [university], where everyone has been ostracised at some point and you're like: 'Oh, we've all been going through the same for being different." "Often, these students have dealt with loneliness and exclusion, perhaps as loners in school. They weren't on the sports team, they weren't the centre of attention—they've been more in the background. Now, with this education, it is their chance to be seen, heard, and admired. And it's very dangerous [that*

they push themselves too hard]." This intense drive to prove themselves and belong can lead to an unhealthy work-life balance, as the desire for validation from peers becomes a significant source of pressure.

4. Conclusion

The games, animation, and VFX industries are known for their high-pressure work environments, characterised by long hours and tight deadlines. This study found that students training for these fields face similar, if not more complex, demands, putting them at risk of burnout. Specifically, students are placed in the challenging position of navigating conflicting industry ideals, job market realities, and a non-unified voice from educational experts within often contradictory curricula. While many students respond to these demands by working well beyond the typical 40-hour study week, well-intentioned messages to avoid overworking and burning out are often perceived as an additional pressure. Despite the competitive job market, peer networks are seen as strong resources for motivation, staying updated on industry needs, and fostering a sense of belonging. However, these networks can also turn into stressors when the desire to remain within this peer group becomes overwhelming, and the fear of falling behind academically leads to overworking. Overall, the research highlights how these student experiences can normalise unsustainable working conditions during education, creating a paradox where students perceive working in the high-pressure industry as less stressful than studying. This misalignment risks undermining well-being-focused interventions, fostering a performative culture of balance and resilience rather than genuine experiences of these qualities.

5. Recommendations

- **Facilitate Open Discourse:** Encourage transparent discussions about the conflicting demands students face, including those stemming from educational institutions. While industry and job market demands may be challenging to influence directly, universities can help by acknowledging these contradictions and critically reviewing and aligning internal practices to assist students in preparing for these demands without adding more stress. Additionally, allowing students to personalise parts of their academic paths to align with their specific career and self-promotion goals, such as allocating scheduled time to focus on self-directed growth and career-specific skills, can ensure individual development within group-centric learning environments.
- **Position Well-Being as a Core Professional Competency**: Recognise well-being as an essential professional skill and integrate it into the curriculum. This can be achieved through dedicated training in areas like stress management, work-life balance, and resilience building. By framing well-being as integral to professional success, institutions equip students with tools to navigate high-pressure environments while fostering long-term career sustainability.
- **Collaborate with Industry Leaders for Systematic Change**: Use empirical insights to engage industry leaders, raising awareness of the demands placed on students and advocating for more sustainable work practices. This approach can provide both immediate support for students and a framework for systemic change, aligning education with the goal of creating a healthier and more sustainable future for the games, animation, and VFX industries.

References

Bakker, A. B., & Mostert, K. (2024). Study Demands–Resources Theory: Understanding Student Well-Being in Higher Education. *Educational Psychology Review, 36*(3), 92. https://doi.org/10.1007/s10648-024-09940-8

Cote, A. C., & Harris, B. C. (2021). 'Weekends became something other people did': Understanding and intervening in the habitus of video game crunch. Convergence: *The International Journal of Research into New Media Technologies, 27*(1), 161-176. https://doi.org/10.1177/1354856520913865

Edholm, H., Lidstrom, M., Steghofer, J.-P., & Burden, H. (2017). Crunch Time: The Reasons and Effects of Unpaid Overtime in the Games Industry. *2017 IEEE/ACM 39th International Conference on Software Engineering: Software Engineering in Practice Track (ICSE-SEIP)*, pp. 43-52. https://doi.org/10.1109/ICSE-SEIP.2017.18

Hassreiter, S., Haggis-Burridge, M., Clavero, T., & Bouwels, L. (2024). *Work Environment Dynamics and Soft Skills in Animation, Games, and VFX industries*. Retrieved from: http://www.paneurama.eu

Peticca-Harris, A., Weststar, J., & McKenna, S. (2015). The perils of project-based work: Attempting resistance to extreme work practices in video game development. *Organization, 22*(4), 570-587. https://doi.org/10.1177/1350508415572509

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

IMPLEMENTATION OF THE TALE-BOT ROBOT FOR DEVELOPING EXECUTIVE FUNCTION IN PLANNING AND ORGANISATION: PILOT TEST

Elena Pérez-Vázquez, & Alba Gilabert-Cerdá
Department of Developmental Psychology and Didactics/University of Alicante (Spain)

Abstract

Executive functions (EF) are a set of essential skills involved in all daily activities, allowing individuals to adapt to their surroundings. These skills, which are fundamental for behaviour control and regulation, require specific attention within the educational field. Among these EF skills, planning and organisation stand out, referring to the ability to anticipate and structure future events and goals. Learning through robotics could represent an effective methodology for fostering planning and organisation skills in primary school students. Currently, among the available floor robots for this purpose is the Tale-Bot robot. This robot contains directional symbols that allow users to programme its routes, provides instant voice feedback, and has the capability to record narrations. For activity development, 10 x 10 cm grid playmats are used. In this context, the present research aims to evaluate improvements in the executive skill of planning and organisation in a primary school pupil following the implementation of a protocol based on the use of the Tale-Bot floor robot. To achieve this general objective, a methodology based on a quantitative approach with a single-case quasi-experimental design, using pretest and posttest, will be implemented. For this design, the sample was intentionally selected in a non-probabilistic manner, comprising a 7-year-old female pupil. Specifically, the BRIEF®-2 (Behaviour Rating Inventory of Executive Function-2) was used as the instrument to measure planning and organisation skills. The intervention was conducted in a state-subsidised school in Alicante, Spain. As for the procedure, it consisted of five individual sessions of 30 minutes each, where activities based on challenges were carried out using the "Let's go to the zoo" playmat. During the sessions, the pupil was required to programme the robot's route according to the previously provided challenge. The results showed an increase in scores on the clinical scale of planning and organisation. In conclusion, these findings suggest that the Tale-Bot robot activity protocol could be a potentially beneficial educational approach for developing this executive function.

Keywords: *Tale-Bot, executive functions, planning and organization, primary education.*

1. Introduction

Executive functions (EFs) are high-level cognitive processes essential for mentally playing with ideas, taking time to think before acting, and staying focused (Diamond, 2013). Recent research (Pascual et al., 2019; Spiegel et al., 2021) has shown a significant relationship between executive functions and academic development during the Primary Education stage. Specifically, school-based interventions targeting EF can improve academic achievement, as demonstrated by studies such as the one conducted by Jacob & Parkinson (2015). Among the different executive functions, the ability to plan and organise is a central component of the cognitive control system. It enables individuals to set goals, design strategies to achieve them, prioritise tasks, and manage resources and time effectively (Maldonado Belmonte et al., n.d.). This executive function is involved in initiating and maintaining social interactions, managing emotions and behaviours, and adapting to the dynamic demands of the school environment (Freeman et al., 2017). Primarily, the use of robots like Tale-Bot in Primary Education supports the development of executive functions by promoting key cognitive skills in an engaging and interactive manner. With this robot, students must set goals, sequence steps, and anticipate outcomes. This involves planning and organising skills, as they need to determine the correct order of actions for the robot to accomplish a specific task, such as reaching a destination on an interactive mat. Various studies (Di Lieto et al., 2017; Urlings et al., 2019) suggest that educational robotics enhances executive functions in Primary Education children. By integrating programming and interactive games, complex cognitive processes are stimulated, contributing to the student's holistic development (Marras et al., 2024). For these reasons, using robots like

Tale-Bot not only introduces students to computational thinking and programming but also strengthens their executive functions, better preparing them to face academic and social challenges more effectively.

2. Objectives

The aim of this research is to apply the Tale-Bot robot to develop the executive component of planning and organisation in a 7-year-old neurotypical student. From this general objective, the following specific objectives arise, which will guide our research:

- SO1. To describe the executive functioning in terms of planning and organisation of the participant, both before and after the intervention.
- SO2. To evaluate any significant differences in the planning and organisation of the participant following the intervention.

3. Methodology

This section details the various components that constitute the research methodology.

3.1. Research approach and design

This investigation employed a quantitative research methodology, which is primarily characterized by numerical data analysis to ensure objectivity, reproducibility, and the ability to generalize findings (Zawawi, 2007). This approach enables the systematic measurement of the studied phenomena and facilitates the identification of relationships among multiple variables (Stockemer et al., 2019). Moreover, a quasi-experimental pretest-posttest design was utilized. This particular methodological framework allows for the evaluation of intervention effects by comparing data collected before and after its implementation (Rogers & Revesz, 2019).

3.2. Participants

A non-probability purposive sampling method was used to select the participant. This sampling technique involves choosing an individual who meets specific criteria relevant to the research objectives. In this case, the participant was a 7-year-old neurotypical female student enrolled in primary education. The selection criteria included: (1) typical neurodevelopment without any clinical diagnoses, (2) enrolment in a regular classroom, and (3) parental consent along with a signed participant assent form.

3.3. Measurement instrument

The study focused on assessing executive functions, specifically planning and organization skills, through selected items from the Behaviour Rating Inventory of Executive Function – Second Edition (BRIEF-2). Consistent with the primary research objective, this instrument was used for both pretest and posttest evaluations to assess these skills in the participant. The teacher completed a questionnaire containing 53 items rated on a three-point Likert scale: never (0), sometimes (1), and frequently (2). To facilitate the process, the researcher read each item aloud, allowing the teacher to select the most appropriate response, which was subsequently recorded. The assessment was conducted online, with responses documented using the *TEAcorrige platform.*

For this study, items 4, 9, 14, 19, 29, 39, 44, and 49 from the BRIEF-2 were utilized to evaluate planning and organizational abilities. These items assess the student's capacity to structure information, establish objectives, and sequence necessary steps to achieve them. Unlike its predecessor, the BRIEF-2 conceptualizes planning and organization as a single domain, supported by empirical evidence indicating their strong interconnection (Maldonado Belmonte, n.d).

3.4. Research procedure

The study was conducted in several sequential phases, as described below:

- Phase 1: Institutional Approval and Consent Collection. Initial contact was made with the educational institution, followed by an introductory meeting where comprehensive details regarding the study were shared. During this meeting, informed consent was obtained from the parents of the participating students. Once all necessary permissions were secured, a schedule was established to conduct the intervention.
- Phase 2: Pretest Administration of the BRIEF-2. Prior to the intervention, participants were assessed using the BRIEF-2 inventory [21]. The evaluation took place in collaboration with the regular teacher. The researcher verbally presented each item, while the teacher responded using

the Likert scale (never, sometimes, frequently), and a second researcher recorded the responses in the TEAcorrige system. This process was identical for both participants.

- Phase 3: Implementation of the Tale-Bot Pro Robot Intervention. The intervention comprised five individual sessions, each lasting approximately 30 minutes. These sessions were conducted over a three-week period, from November 25th to December 13th. Throughout the sessions, participants engaged in progressively complex programming challenges aimed at enhancing planning and organizational skills. The "Let's Go to the Zoo" interactive mat (Figure 1) was used to support these activities.

Figure 1. Carpet of Tale-Bot Pro.

- Phase 4: Posttest Administration of the BRIEF-2. Following the intervention, the BRIEF-2 inventory was re-administered to assess any changes in executive function skills. The procedure mirrored that of Phase 2 to ensure consistency in data collection.
- Phase 5: Data Processing and Conclusion Formulation. The final phase involved analyzing the collected data, interpreting the results, and drawing conclusions based on the findings.

3.5. Data analysis

To process and analyze the collected data, the SPSS 28 statistical software package was utilized. Initially, descriptive statistical analyses were conducted to determine measures such as mean, standard deviation, and median for the pretest and posttest results. Subsequently, a non-parametric statistical test, the Wilcoxon signed-rank test, was applied to examine potential significant differences between pretest and posttest scores for both participants.

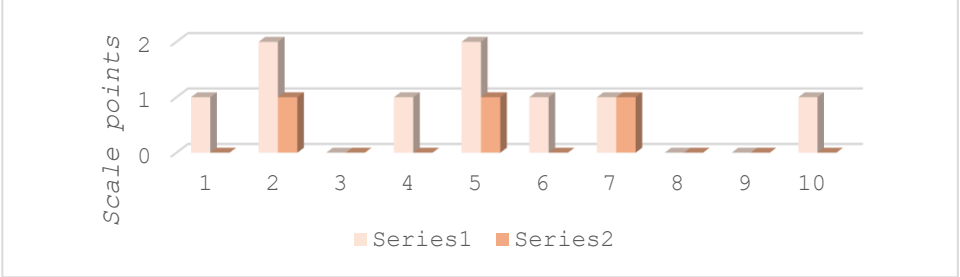
4. Results

The following presents the results of the research, which respond to the specific objectives of the study.

4.1. Descriptive results of executive functioning regarding planning and organisation for the participant, before and after the intervention

Figure 2 displays the scores obtained by Participant on the items related to executive functioning in terms of planning and organization from the BRIEF-2. Specifically, the scores for both the pretest and posttest are shown.

Figure 2. Results of participant.



As shown in Figure 2, on the one hand, the scores decreased in 60% of the items (items 4, 9, 19, 24, 29, and 49). Specifically, in items related to organizing objects in an orderly manner when instructed (item 4), difficulty finding personal belongings despite receiving clear instructions (item 19), struggling to consider alternative solutions when encountering difficulties in problem-solving (item 29), and leaving tasks incomplete even after receiving guidance on how to complete them (item 49), the participant's responses shifted from "sometimes" (point 1 on the Likert scale) to "never" (point 0 on the Likert scale). Additionally, in items concerning the need for external prompting to initiate a task despite being willing to do so (item 9) and difficulty adhering to established routines for sleeping, eating, or playing (item 24), the participant's responses changed from "frequently" (point 2 on the Likert scale) to "sometimes" (point 1 on the Likert scale). It is important to note that, according to the BRIEF-2, higher scores indicate greater difficulties in executive functioning. On the other hand, in the remaining 40% of the items, including difficulties remembering what to retrieve when sent to fetch something (item 14), becoming overly focused on minor details rather than the main objective of a task (item 39), and struggling to locate personal items in familiar environments despite receiving explicit instructions (item 44), the participant obtained the same scores in both the pretest and posttest, indicating no observed change in these areas.

Secondly, Table 1 presents the descriptive results.

Table 1. Descriptive statistics of the first participant.

	Number of items	***Mean (M)***	***Standard Deviation (SD)***	***Median***
Pretest	10	0.9	0.738	1
Postest	10	0.3	0.483	0

4.2. Evaluation of potential significant differences in planning and organisation for the participant after the intervention.

After analysing the data using the non-parametric Wilcoxon signed-rank test for related samples, the results obtained are presented in Table 2.

Table 2. Wilconox signed-rank test results for subject 1.

	Ranks	***N***	***Average Rank***	***Sum of Ranks***
Postest - Pretest	Negative Ranks	6[a]	3.5	21
	Positive Ranks	0[b]	0	0
	Ties	4[c]		
	Total	10		

Note: (a) Post < Pre; (b) Post > Pre; (c) Post = Pre

Next, the statistics of the Wilcoxon Signed-Rank Test are presented.

Table 3. Wilconox signed-rank test statistics for subject 1.

Z	***Sig. asin. (bilateral)***
-2.449	0.014

As can be seen in Table 3, the results for participant number 1 show a significance level of $p < .05$.

5. Discussion

In pursuit of the general objective, the research has addressed several specific research objectives. Specifically, on the one hand, the results of specific objective number one, concerning the participant, show a decrease in the mean and standard deviation from the pretest (M = 0.9, SD = 0.738) to the posttest (M = 0.3, SD = 0.483). According to Maldonado Belmonte et al. (n.d), demonstrate an improved performance in the planning and organisation skill. According to the interpretation criteria of the BRIEF-2, a lower score indicates fewer difficulties. These results are consistent with those presented by Urlings et al. (2019) where students of Primary Education showed improvements in executive function after the implementation of a floor robot with features similar to the Tale-Bot Pro robot. Regarding the second specific objective, the results show significant differences after the intervention with the robot. These results are consistent with Urlings et al. (2019) research.

6. Conclusions

The following conclusions were drawn based on the specific objectives outlined:

- The participant achieved a lower score in 60% of the items in the posttest, relating to the executive skill of planning and organisation. As a result, the mean and standard deviation were higher in the pretest than in the posttest. According to the interpretation criteria of the BRIEF-2, the student demonstrated improved executive function following the intervention with the Tale-Bot Pro robot.
- Significant differences were observed with $p = 0.014$ in the executive function of the participant following the intervention with the Tale-Bot Pro robot.

References

Diamond, A. (2013). Executive functions. *Annual Review of Psychology, 64,* 135-168. https://doi.org/10.1146/annurev-psych-113011-143750

Di Lieto, M. C., Inguaggiato, E., Castro, E., Cecchi, F., Cioni, G., Dell'Omo, M., ... & Dario, P. (2017). Educational Robotics intervention on Executive Functions in preschool children: A pilot study. *Computers in Human Behavior, 71,* 16-23.

Freeman, L., Locke, J., Rotheram-Fuller, E., & Mandell, D. (2017). Brief Report: Examining Executive and Social Functioning in Elementary-Aged Children with Autism. *Journal of Autism and Developmental Disorders, 47,* 1890-1895. https://doi.org/10.1007/s10803-017-3079-3

Jacob, R., & Parkinson, J. (2015). The Potential for School-Based Interventions That Target Executive Function to Improve Academic Achievement. *Review of Educational Research, 85,* 512-552. https://doi.org/10.3102/0034654314561338

Maldonado Belmonte, M. J., Fournier del Castillo, M. C., Martínez Arias, R., González, J., Espejo-Saavedra Roca, J. M., & Santamaría, P. (n.d.). *Evaluación conductual de la Función Ejecutiva - Segunda versión (BRIEF-2)* (Versión española).

Marras, A., Negrini, L., & Pasqualotto, A. (2024). Educational Robotics in Schools: Exploring the Potential for Training Attentional Control and Executive Functions. *Technology, Knowledge and Learning,* 1-22. https://doi.org/10.1007/s10758-024-09602-7

Pascual, A., Muñoz, N., & Robres, A. (2019). The Relationship Between Executive Functions and Academic Performance in Primary Education: Review and Meta-Analysis. *Frontiers in Psychology, 10.* https://doi.org/10.3389/fpsyg.2019.01582

Rogers, J., & Revesz, A. (2019). Experimental and Quasi-Experimental Designs. In J. McKinley & H. Rose (Eds.), *The Routledge Handbook of Research Methods in Applied Linguistics* (pp. 133-143). Routledge.

Spiegel, J., Goodrich, J., Morris, B., Osborne, C., & Lonigan, C. (2021). Relations between executive functions and academic outcomes in elementary school children: A meta-analysis. *Psychological Bulletin, 147*(4), 329-351. https://doi.org/10.1037/bul0000322

Stockemer, D., Stockemer, G., & Glaeser, J. (2019). *Quantitative Methods for the Social Sciences.* Cham, Switzerland: Springer International Publishing.

Urlings, C. C., Coppens, K. M., & Borghans, L. (2019). Measurement of executive functioning using a playful robot in kindergarten. *Computers in the Schools, 36*(4), 255-273.

Zawawi, D. (2007). Quantitative versus Qualitative Methods in Social Sciences: Bridging the Gap. *Integration & Dissemination, 1.*

ENHANCING ACTIVE LEARNING IN ADVANCED DATABASE COURSES THROUGH AN EDUCATIONAL ESCAPE ROOM APPROACH

Vicente R. Tomás, Sandra Catalán, María I. Castillo, Rocio Carratalá, & Iván Monzón
Department of Computer Science and Engineering, Universitat Jaume I (Spain)

Abstract

The increasing need for active methodologies in higher education has given rise to a set of innovative techniques such as flipped classroom and project-based learning, among others. This active approach facilitates and encourages the acquisition of specific competences and soft skills. In this paper, we present the work conducted as part of the educational innovation project "Fostering Active Learning through Computational Sustainability Projects in Advanced Database Courses". The project aims to develop active learning tools for the course Database Design and Implementation, part of the curricula of the Computer Science degree at Jaume I University. More concretely, in this work we describe how we designed and put into practice an escape room whose games were solved by applying the course contents. The escape room was structured as a sequence of puzzles based on core topics of the course, including logic and physical design, normalization, SQL optimization, and triggers. Students worked in teams to "escape" by solving a series of interconnected tasks that required a deep understanding of database practical skills. Each task was aligned with the course's learning objectives, ensuring that participants not only engaged with the content, but also applied critical thinking and analytical skills in real-time. To assess the effectiveness of the escape room activity as a learning strategy, feedback was collected from the students through a questionnaire. This survey explored their perceptions from two points of view: the escape room experience itself, and its usefulness as a learning tool for the subject. The results are very positive, showing that students experienced a substantial increase in motivation and engagement, as well as reinforced the course contents comprehension.

Keywords: *Active learning, escape room, advanced databases, higher education, collaborative learning.*

1. Introduction

The demand for professionals with technical expertise is undeniable, particularly in technology-driven fields such as Computer Science. However, possessing only technical and specialized skills is no longer sufficient. Nowadays, employers increasingly seek professionals with soft skills and teamwork abilities, considering them essential for performing any job.

In this new scenario, universities have a responsibility to incorporate these types of skills into their daily teaching. The Organization for Economic Cooperation and Development (OECD), in Learning Compass 2030 (OECD, 2019) defines core foundations as the fundamental conditions, essential skills, knowledge, attitudes, and values that serve as prerequisites for continuous learning across the entire curriculum. OECD divided skills into three groups: 1) cognitive and meta-cognitive skills (critical thinking, learning-to-learn…), 2) social and emotional skills (self-efficacy, responsibility, collaboration…), and 3) practical and physical skills (communication, technology…).

Higher education is evolving to transform traditional teaching methods by incorporating active learning strategies. Active learning encompasses various innovative approaches, such as flipped classrooms and project-based learning, among others. These techniques foster the development of students, enhancing their technical expertise, interpersonal skills, teamwork abilities, and leadership qualities. Additionally, active learning has been shown to positively influence the learning process (Rao et al., 2018).

This paper presents the work conducted in two courses from the Computer Science degree curriculum at Jaume I University, both centered on advanced database topics: Database System Design (EI1038) and Database System Design and Implementation (EI1052). Currently, the learning methodology for these courses is based on Project-Based Learning (PBL). This approach has been developed as part of the educational innovation project entitled "Fostering Active Learning through Computational Sustainability Projects in Advanced Database Courses". In particular, we describe and analyze a specific

active session in the form of an escape room that was formulated to review the advanced database concepts taught during the.

The rest of the paper is organized as follows: Section 2 reviews the state of the art on the use of escape rooms in higher education. Section 3 describes our approach to implement escape rooms as a learning activity for database courses. Section 4 analyzes the assessment of the activity and its outcomes. Finally, Section 5 presents the conclusion and potential directions for future work.

2. Escape rooms for higher education

Educational escape rooms are an innovative pedagogical approach that integrates game-based learning principles to enhance student engagement and foster collaborative problem-solving skills. Originating from recreational escape rooms, this methodology has been adapted for educational purposes to create immersive, challenge-based learning experiences. In these activities, students work in teams to solve puzzles, decode clues, and complete tasks within a set timeframe, all while engaging with course content in a dynamic and interactive environment (Clarke et al., 2017). An educational escape room is a scenario-based learning activity where students must solve interconnected puzzles to achieve a specific goal, such as “escaping” a virtual or physical room. The challenges are designed to align with learning objectives, ensuring that the activity reinforces key concepts and skills. This approach not only stimulates critical thinking and creativity but also promotes teamwork and effective communication among participants (Hermanns et al., 2017).

In recent years, educational escape rooms have gained traction in higher education across various disciplines. For instance, Borrego et al. (2017) implemented an escape room in a chemical engineering course, where students tackled puzzles related to process engineering concepts. Similarly, López-Pernas et al. (2019) reported on the use of escape rooms in a programming course, highlighting their potential to motivate students and make abstract concepts more tangible. These studies consistently demonstrate that escape rooms are effective in creating an engaging learning environment that encourages active participation and improves the course contents comprehension.

The primary advantage of educational escape rooms is their ability to foster active learning and improve soft skills such as collaboration, leadership, and time management. They also provide a novel way to contextualize theoretical knowledge, making learning more meaningful and memorable (Veldkamp et al., 2020). However, challenges such as the significant time investment required for design and setup, as well as the need for careful alignment with learning objectives, must be addressed to maximize their educational value.

3. Escape room for a databases course

Following this trend, we designed and implemented an educational escape room to enhance students' learning process in advanced databases and improve their soft skills. The students of both courses developed the activity together in the same classroom. The activity took place during the 12th week of the semester, when the students had already received all the theoretical and practical aspects of the subject. It was a voluntary activity for the students and lasted two and a half hours of a regular theoretical session.

Students were divided into the same groups they used for the PBL projects, ensuring they are familiar with each other and their teamwork dynamics. Out of the 50 students enrolled in both courses, 38 participated in the activity. Most groups consisted of four members, except for two of them, which had three members each.

The game combined database exercises with traditional escape room elements, such as locks. The storyline revolved around a thief who had stolen a chemical component and placed a bomb to destroy the laboratory. Students had to work with two different databases: one containing information about users, data connections, and logs, and another related to chemical components, risks, storage, and transport. Both databases were populated with a large volume of data. Additionally, two scripts were developed to dynamically feed the databases with new relevant data during the escape room activity, as if the thief was maliciously accessing them.

Students had to connect to a specific database server and develop a specific audit to retrieve a key number that unlocked a cryptex. Inside the cryptex, they found a set of clues directing them to another classroom, where hidden hints were revealed using an ultraviolet flashlight. This information led them back to the original room, where they had to solve a three-digit combination to open the lock securing a box. The box contained additional clues to access another database server and uncover critical information about the thief and a four-letter code. This code unlocked a final box that provided instructions for stopping the thief's activities. In the final stage, after successfully thwarting the thief, the students obtained a new code to unlock a final box containing an “explosive”. They had to deactivate it to complete the mission.

4. Results

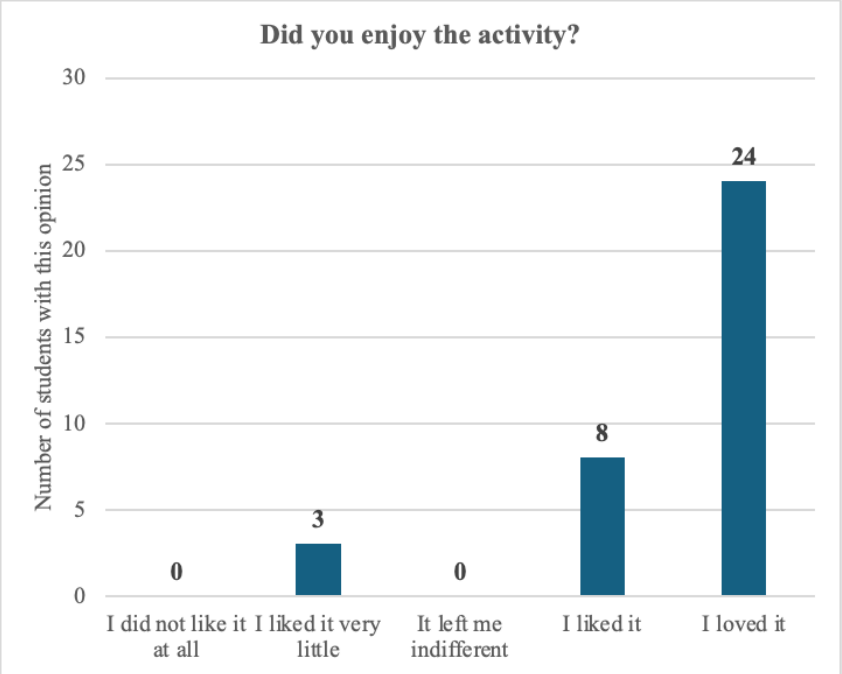
Once the activity was completed, the students were asked to complete an anonymous survey designed to assess their level of satisfaction with the escape room experience. By gathering feedback on their perceptions and experiences, we aimed to determine the effectiveness of the escape room as an educational tool and its potential to enhance engagement and comprehension in the context of database-related concepts.

There were three main aspects asked in the survey with respect to the engagement and comprehension impact of the activity, with several fixed answers offered (following a Likert scale) for each of them:

- Question: "Did you enjoy the activity?" Possible answers: "I did not like it at all" (1), "I liked it very little" (2), "It left me indifferent" (3), "I liked it" (4), and "I loved it" (5).
- Question: "Would you like to have more activities like today's in this or the other courses?" Possible answers: "No, I don't want to do anything like this again" (1), "I'd prefer not to have more activities like this" (2), "I don't mind" (3), "I'd like it" (4), and "I'd love it" (5).
- Question: "Do you think the game has helped you better understand the concepts of the course?" Possible answers: "No, I was focused on the game" (1), "Yes, but only in very few aspects" (2), and "Yes, in all the aspects covered in the game" (3).

In total, 35 students answered the survey. Figures 1-3 summarize the survey answers to each of the mentioned questions. Regarding the first question (see Figure 1), it is evident that most of the students enjoyed the activity. In fact, 69% of them loved the activity, 23% liked it and only 9% liked it very little, which means that more than 90% of them had fun solving the proposed exercises.

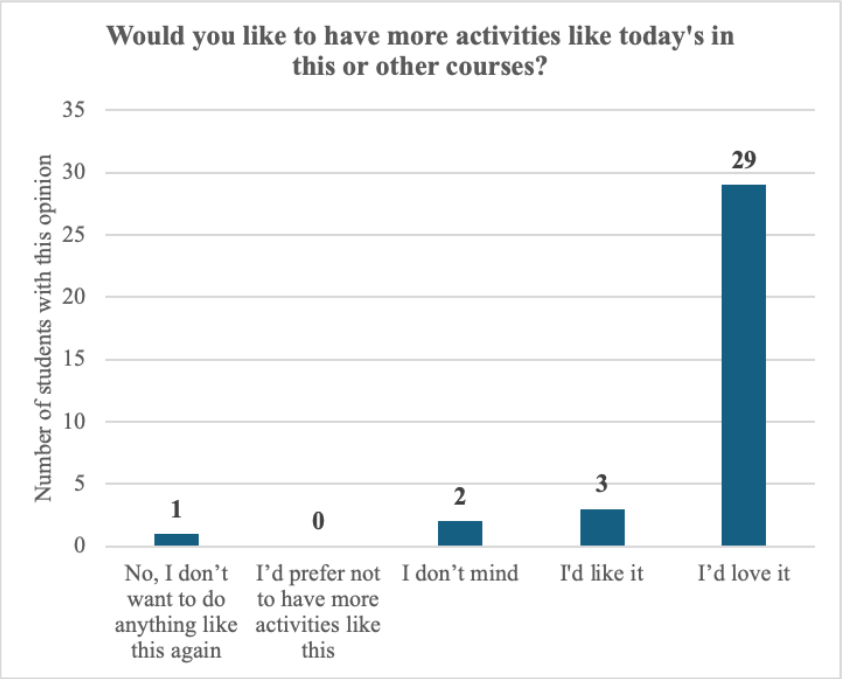
Figure 1. Students and enjoyment opinion about the escape room.



With respect to the second question (Figure 2), 91% of the students are in favor of solving similar activities in the future (actually, 83% of them would love to), just 6% do not mind about it, and only one student (3%) would not like to do anything similar again.

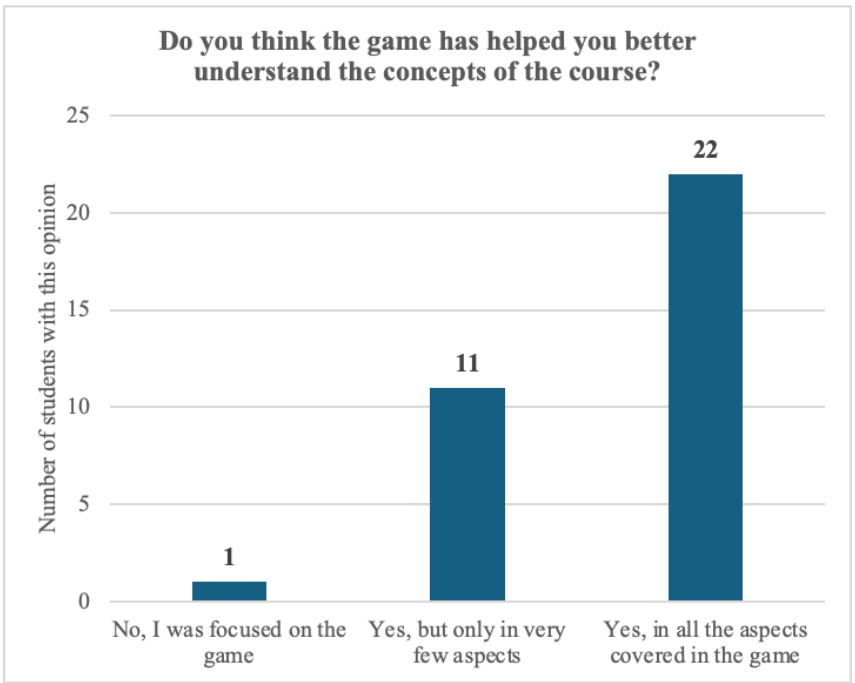
p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

Figure 2. Students' interest in using escape rooms to learn.



Finally, considering the third question, 65% of the students stated that the activity helped them better understanding all the concepts covered, 32% improved their knowledge regarding part of the concepts, and just one student (3%) felt too focused playing that did not gain any better understanding. This means that all except one student felt that the activity helped them assimilate the course contents, which was the main purpose of the exercise. Note that this question was left blank in one of the surveys and that is the reason why only 34 answers were gathered.

Figure 3. Escape room as a tool to understand and reinforce database concepts.



Considering the Likert scale, out of a maximum of 5, the average was 4.5 for the first question, and 4.7 for the second; and, out of a maximum of 3, the average was 2.6 for the third question. In our humble opinion, the results were extremely positive, and the students clearly stated that their engagement and enjoyment of the game was high, and that their course knowledge improved. All in all, this means that the activity was useful to consolidate the contents comprehension while having fun during the process.

5. Conclusions and future work

Active learning is an effective approach to enhance students' learning experiences. Implementing methods such as PBL and active group sessions, as demonstrated in this paper, fosters not only technical expertise but also essential soft skills, including teamwork, critical thinking, and leadership.

Escape rooms in the learning process are highly effective tools that integrate recreational and educational elements into a single and engaging activity. By encouraging teamwork, critical thinking, and problem-solving skills, these activities create an immersive and interactive learning environment that fosters active participation and enhances knowledge retention. Furthermore, escape rooms can be tailored to suit a wide range of educational objectives, making them versatile and adaptable to different subject areas and age groups.

In our example, we designed and implemented an educational escape room to enhance students' learning process in advanced databases. Students must apply their database knowledge to solve a set of puzzles and advance in the story line to reach the final problem solution.

The surveys conducted showed that most students valued positively the activity, highlighting that they did not only enjoy it, but felt their knowledge reinforced. The teamwork element further reinforced collaborative problem-solving skills, which are essential in real-world database management scenarios.

This positive reception and evident learning gains have encouraged other teachers involved in the innovative project to adapt the escape room as a learning tool in hardware-related subjects. As part of the future work, we plan to conduct similar activities on other courses, and extended versions of this experience in future years for the same courses, covering more concepts.

Acknowledgements

This work has been developed under projects "*Fostering Active Learning through Computational Sustainability Projects in Advanced Database Courses" and "Building Knowledge Together: Fostering Collaborative Learning in the Classroom"* funded by University Jaume I in the frame of the "call for grants for educational innovation projects" for year 2024.

References

Borrego, C., Fernández, C., Blanes, I., & Robles, S. (2017). Room escape at class: Escape games activities to facilitate the motivation and learning in computer science. *JOTSE, 7*(2), 162-171.

Clarke, S., Peel, D., Arnab, S., Morini, L., & Wood, O. (2017). EscapED: A framework for creating educational escape rooms and interactive games to for higher/further education. *International Journal of Serious Games*, *4*(3), 73-86.

Hermanns, M., Deal, B., Hillhouse, S., Opella, J. B., Faigle, C., & Campbell IV, R. H. (2017). Using an "escape room" toolbox approach to enhance Pharmacology Education. *Journal of Nursing Education and Practice*, *8*(4), 89-95.

López-Pernas, S., Gordillo, A., Barra, E., & Quemada, J. (2019). Examining the use of an educational escape room for teaching programming in a higher education setting. *IEEE Access*, *7*, 31723-31737.

OECD. (2019). *Future of education and skills 2030: OECD learning compass 2030*.

Rao, P. R. M., Chugh, K. L., Prasad, K. S., & Shekar, K. (2018). Impact of Active Learning in Engineering Education. *2018 IEEE 6th International Conference on MOOCs, Innovation and Technology in Education (MITE)*, Hyderabad, India. doi: 10.1109/MITE.2018.8747038.

Veldkamp, A., Daemen, J., Teekens, S., Koelewijn, S., Knippels, M. C. P., & van Joolingen, W. R. (2020). Escape boxes: Bringing escape room experience into the classroom. *British Journal of Educational Technology*, *51*(4), 1220-1239.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

MODEL OF FUNCTIONAL LITERACY FOR TEACHERS CONCERNING THE APPLICATION OF 3D PRINTING IN SECONDARY SCHOOLS

Tetjana Tomášková, Jan Krotký, & Jarmila Honzíková
Department of Mathematics, Physics and Technology, Faculty of Education, University of West Bohemia (Czech Republic)

Abstract

The article discusses a model of functional literacy for teachers in the context of integrating 3D printing into secondary school education. Functional literacy for teachers includes basic reading and writing skills and the ability to use modern technologies effectively. Concerning 3D printing, this means that teachers must be able to understand the technical aspects of 3D printing, such as working with 3D modeling software, understanding the printing process, and troubleshooting technical issues. 3D printing represents an innovative tool that allows students to visualize and manipulate complex concepts, fostering creativity and the development of practical skills. This technology supports creativity, critical thinking, and practical skills, key competencies for the 21st century. A key aspect is the preparation of teachers, which includes technical training and pedagogical strategies for the effective use of this technology. This can include workshops, online courses, or collaboration with 3D printing experts. It is important that teachers not only understand the technical aspects but also know how to incorporate this technology into their lesson plans and use it to achieve educational goals. However, the implementation of 3D printing in schools faces challenges such as high costs for purchasing and maintaining printers, the need for technical support, and the necessity to update curricula. Teachers may also face resistance to change or a lack of time to acquire new skills. It is important to identify these obstacles and find ways to overcome them, such as through grants, partnerships with companies, or resource sharing among schools. The article also provides examples of good practices where 3D printing has been successfully integrated into teaching. It is important to emphasize that functional literacy for teachers includes the ability to adapt to new technologies and effectively integrate them into teaching. This includes not only technical skills but also pedagogical approaches that support active learning and student engagement. The document also states that the successful integration of technologies such as 3D printing requires the support of school leadership and the availability of resources for the continuous professional development of teachers. These examples show how 3D printing can enrich teaching and provide practical experiences that are very beneficial for students. The result of the article is a model of functional literacy for teachers, which is available to all interested parties and can be widely applied in pedagogical practice.

Keywords: *Functional literacy, 3D printing, teacher training, pedagogical strategies, educational technology.*

1. Introduction

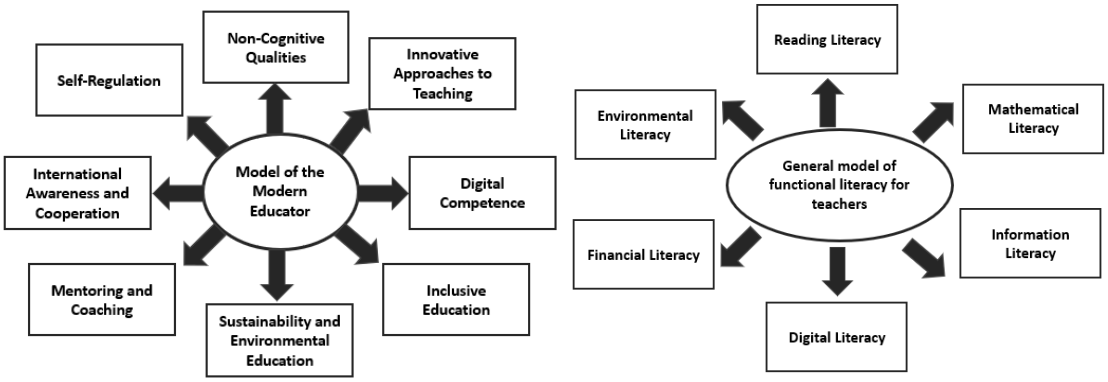
Functional literacy of teachers is a key element for effective and innovative teaching in the 21st century. This concept includes not only basic reading and writing skills, but also the ability to effectively use modern technologies in the educational process. In the context of secondary schools, functional literacy of teachers becomes essential for the integration of advanced technologies, such as 3D printing, into teaching (Schelly, Anzalone, Wijnen, & Pearce, 2015; Fernandes & Simoes, 2016; Song, 2018, Ford & Minshall, 2019; Holzmann, Schwarz, & Audretsch, 2020; Cheng et al., 2020; Anđić et al., 2023. The integration of 3D printing into teaching in secondary schools represents a significant step towards the modernization of the educational process. This technology allows students to visualize and manipulate complex concepts, which supports their creativity and the development of practical skills (Lavicza et al., 2022; Wu, Liu & Huang, 2022; Kuo, 2024. 3D printing also provides students with the opportunity to actively learn and engage in projects that have a real impact on their education (Anđić, 2022; Pearson & Dubé, 2022; Kalman, Nazim, Pavlenko, & Ivanov, 2024. Through a study of the application of 3D printing six categories of uses were identified and described: teaching students about 3D printing; teaching

educators about 3D printing; 3D printing as an assistive technology in teaching; creating didactic aids that aid learning; creating technologies; supporting outreach activities (Ford & Minshall, 2019). The aim of this article is to present a model of teacher functional literacy that includes the technical and pedagogical skills needed to effectively use 3D printing in teaching. The article focuses on the importance of teacher technical preparation, pedagogical strategies for integrating 3D printing into curricula, and overcoming the challenges associated with implementing this technology in schools. The contribution of this article to pedagogical practice is to provide a comprehensive model that can be widely applied and contribute to the development of key student competency.

2. Model of functional literacy of teachers

The general model of functional literacy can be considered a specific application of the broader model of the modern educator, see Figure 1 (a). While the model of the modern educator includes a wide range of competencies and skills that reflect current trends and needs in education, the functional literacy model focuses on specific skills needed to support the functional literacy of students. The model of the modern educator includes innovative approaches to teaching, digital competences, inclusive education, sustainability, mentoring, international cooperation, self-regulation and non-cognitive qualities that are not explicitly included in the functional literacy model.

Figure 1. Model of the modern educator (a) & General model of functional literacy for teachers (b).



a) Model of the modern educator **b) Model of functional literacy for teachers**

The model of a modern educator encompasses a wide range of competencies and skills that reflect current trends and needs in education. This model includes innovative teaching approaches, digital competencies, inclusive education, sustainability, mentoring, international collaboration, self-regulation and non-cognitive skills. Innovative teaching approaches include project-based learning and gamification, which support active student engagement and the development of critical thinking. Digital competencies include cybersecurity and online learning, which enable teachers to provide a safe online environment and effectively use digital tools for distance learning. Inclusive education focuses on working with diverse groups and promoting inclusion, creating an environment where every student has the opportunity to fully participate and develop. Sustainability and environmental education include ecological literacy and green projects, which educate students about environmental issues and sustainable practices. Mentoring and coaching are important for supporting colleagues and students' personal development, while international awareness and collaboration include engaging in international projects and promoting multicultural awareness. Self-regulation includes planning and organization, impulse control, stress management, self-assessment, goal setting, and perseverance, which are key skills for effective teachers. Non-cognitive qualities such as emotional intelligence, motivation, resilience, and social skills are also essential for successful education. Communication is a key part of the modern educator model and includes effective communication with students, parents, colleagues, digital communication, cross-cultural communication, and communication in crisis situations. Overall, the modern educator model provides a comprehensive framework for teacher development that encompasses all aspects necessary for successful and modern education (Banasiak & Karczmarzyk, 2018; Gorycheva, Ignateva, & Dautova, 2020; Peng, 2023; Mirzayeva & Mengboyeva, 2024).

2.1. Definition and basic skills

Functional literacy is a key element of modern education that enables individuals to navigate effectively in different areas of life. This general model includes reading, mathematics, information, digital, financial and environmental literacy, which together form the basis for successful and sustainable functioning in society, see Figure 1 (b). **Reading literacy** is the ability to understand and interpret texts. This skill is the basis for critical thinking and lifelong learning, encompassing not only the ability to read, but also to analyze and evaluate information from various sources (Xiong, 2020; Otsuka, 2021; Priyatni, As'ari, Suharyadi, Ahmad, & Azizah, 2021). **Mathematical literacy** is the ability to apply mathematical skills in real-world situations, which is key to solving practical problems and developing logical thinking (Priyatni, As'ari, Suharyadi, Ahmad, & Azizah, 2021). **Information literacy** is the ability to search for, evaluate and use information effectively, which is essential in the digital age (Luthfia, Handayani, Gasa, Ramadanty, & Ridzuan, 2023; Pan, Li, Chen, & Chen, 2023). **Digital literacy** is the ability to use digital technologies and tools, which is key to success in the modern world (Tiede, Treacy, Grafe, & Mangina, 2022). **Financial literacy** is the ability to understand and manage finances, which is important for personal and professional life (Pillai, Singh, Bhosale, & Doifode, 2023). **Environmental literacy** is the ability to understand and respond to environmental issues, which is key to sustainability and environmental protection (Pillai, Singh, Bhosale, & Doifode, 2023).

2.2. Specific requirements for functional literacy in the context of 3D printing

The functional literacy model for secondary school 3D printing teachers includes the following skills: technical literacy, design literacy, material literacy, safety literacy, project literacy, innovation literacy, and quality literacy, see Table 1. The functional literacy of the educator for the field of 3D Printing is closely related to the Educator's competency matrix for the presentation of the product life cycle (Tomášková, Duda, Krotký, & Honzíková, 2024).

Table 1. Specific requirements for functional literacy in the context of 3D printing.

3D Printing Literacy	Characteristics
Technical Literacy	The ability to understand and use 3D printers, including their maintenance and troubleshooting.
Design Literacy	The ability to create and modify 3D models using CAD (Computer-Aided Design) software.
Material Literacy	Knowledge of the different materials used in 3D printing and their suitability for different applications.
Safety Literacy	The ability to follow safety procedures when working with 3D printers and materials.
Project Literacy	The ability to plan and implement projects involving 3D printing, including time and resource management.
Innovation Literacy	The ability to use 3D printing to solve problems innovatively and support student creativity.
Qualitative Literacy	The ability to ensure high quality outputs from 3D printing, including quality control, optimization of printing parameters, and evaluation of results.

3. Integrating 3D printing into education

Pedagogical approaches and teacher preparation include technical training and pedagogical strategies that are key to effective teaching. Workshops, online courses, and collaborations with external partners and 3D printing experts help teachers integrate this technology into lesson plans and achieve educational goals. However, implementing 3D printing in schools faces challenges such as financial costs, technical support, curriculum updates, and resistance to change, as well as time constraints and the need for continuous professional development. Examples of good practice show successful integration of 3D printing into teaching, pedagogical approaches that support active learning and student engagement, and concrete projects that have a positive impact on the educational process (for example: analysis and study of the quality of the printing process and materials (Krotký, Honzíková, & Moc, 2016); demonstration of Taylor-Couette flow (Duda, Klimko, Skach, Uher, & Uruba, 2018); realization of experiments such as demonstration of Bernoulli equation, Taylor-Couette flow, effect of viscosity to scales and decay of turbulence and Galilean transformation inside an axial compressor (Duda, Yanovych, & Uruba, 2022); demonstration of time-symmetry breaking in a jet flow (Duda, Tomášková, Yanovych, Krotký, & Uruba, 2024); Support from school leadership and teacher professional development are essential, with school leadership playing a key role in supporting technology integration, ensuring the availability of resources for continuous professional development, and seeking funding opportunities and collaboration with external partners.

4. Conclusions

In today's rapidly evolving technological era, it is important that teachers are equipped with the skills and knowledge to effectively integrate modern technologies into their teaching. One such technology is 3D printing, which offers a wide range of opportunities for innovative and hands-on learning. The model presented in this article focuses on the specific skills needed to support the functional literacy of students, especially in the area of 3D printing applications in secondary schools.

References

Anđić, B., Lavicza, Z., Ulbrich, E., Cvjetićanin, S., Petrović, F., & Maričić, M. (2022). Contribution of 3D modelling and printing to learning in primary schools: A case study with visually impaired students from an inclusive biology classroom. *Journal of Biological Education, 58*(4), 795-811. https://doi.org/10.1080/00219266.2022.2118352

Anđić, B., Ulbrich, E., Dana-Picard, T., et al. (2023). A Phenomenography Study of STEM Teachers' Conceptions of Using Three-Dimensional Modeling and Printing (3DMP) in Teaching. *Journal of Science Education and Technology, 32*, 45-60. https://doi.org/10.1007/s10956-022-10005-0

Banasiak, M. A., & Karczmarzyk, M. A. (2018). Teacher as Leader and Teacher as Manager: Competences of Modern Educator. *Psycho-Educational Research Reviews, 7*(3), 32-37. Retrieved from: https://www.perrjournal.com/index.php/perrjournal/article/view/228

Cheng, L., Antonenko, P. D., Ritzhaupt, A. D., Dawson, K., Miller, D., MacFadden, B. J., Grant, C., Sheppard, T. D., & Ziegler, M. (2020). Exploring the influence of teachers' beliefs and 3D printing integrated STEM instruction on students' STEM motivation. *Computers & Education, 158*, 103983. https://doi.org/10.1016/j.compedu.2020.103983

Duda, D., Klimko, M., Skach, R., Uher, J., & Uruba, V. (2018). *Experimental Fluid Mechanics 2018 (EFM18)*. Vol. 213, Article 02014. Paper presented at the 13th International Conference on Experimental Fluid Mechanics, November 13-16, 2018, Planetarium & Stefanik's Observatory, Prague, Czech Republic. DOI: 10.1051/epjconf/201921302014

Duda, D., Tomášková, T., Yanovych, V., Krotký, J. & Uruba, V. (2024). Demonstration of time-symmetry breaking in a jet flow. In *Education and New Developments 2024*. Porto: inScience Press, pp. 313-315. ISBN 978-989-35-7280-1, ISSN 2184-044X.

Duda, D., Yanovych, V., & Uruba, V. (2022). *Topical Problems of Fluid Mechanics*. Prague: Czech Academy of Sciences, Institute of Thermomechanics. Paper presented at the Conference on Topical Problems of Fluid Mechanics, February 16-18, 2022, pp. 37-43. DOI: 10.14311/TPFM.2022.006

Fernandes, S. C. F., & Simoes, R. (2016). Collaborative use of different learning styles through 3D printing. In *2nd International Conference of the Portuguese Society for Engineering Education (CISPEE)* (pp. 1-8). Vila Real, Portugal. https://doi.org/10.1109/CISPEE.2016.7777742

Ford, S., & Minshall, T. (2019). Invited review article: Where and how 3D printing is used in teaching and education. *Additive Manufacturing, 25*, 131-150. https://doi.org/10.1016/j.addma.2018.10.028

Gorycheva, S. N., Ignateva, E. Y., & Dautova, O. B. (2020). Structural and Content Characteristic of Didactic Competency of a Modern Educator. In S. Alexander Glebovich (Ed.), *Pedagogical Education - History, Present Time, Perspectives, vol 87. European Proceedings of Social and Behavioural Sciences* (pp. 658-666). European Publisher. https://doi.org/10.15405/epsbs.2020.08.02.86

Holzmann, P., Schwarz, E. J., & Audretsch, D. B. (2020). Understanding the determinants of novel technology adoption among teachers: the case of 3D printing. *Journal of Technology Transfer, 45*, 259-275. https://doi.org/10.1007/s10961-018-9693-1

Kalman, O., Nazim, A., Pavlenko, I., & Ivanov, V. (2024). Advantages of 3D printing in the education process. In M. Balog, A. Iakovets, S. Hrehová, & K. Berladir (Eds.), *The 2nd EAI International Conference on Automation and Control in Theory and Practice*. EAI ARTEP 2024. EAI/Springer Innovations in Communication and Computing. Springer, Cham. https://doi.org/10.1007/978-3-031-59238-6_1

Krotký, J., Honzíková, J., & Moc, P. (2016). Deformation of Print PLA Material Depending on the Temperature of Reheating Printing Pad. *Manufacturing Technology. Ústí nad Labem: UJEP, FVTM. 16*(1), 140-144.

Kuo, H. C. (2024). Transforming tomorrow: A practical synthesis of STEAM and PBL for empowering students' creative thinking. *International Journal of Science and Mathematics Education*. https://doi.org/10.1007/s10763-024-10511-0

Lavicza, Z., Weinhandl, R., Prodromou, T., Anđić, B., Lieban, D., Hohenwarter, M., Fenyvesi, K., Brownell, C., & Diego-Mantecón, J. M. (2022). Developing and evaluating educational innovations for STEAM education in rapidly changing digital technology environments. *Sustainability, 14*(12), 7237. https://doi.org/10.3390/su14127237

Luthfia, A., Handayani, F., Gasa, F. M., Ramadanty, S., & Ridzuan, A. R. (2023). Navigating the Cyber Frontier: Youth Capabilities to Confront Dis/Misinformation with Digital Literacy and Digital Security. In *2023 17th International Conference on Telecommunications (ConTEL)*, Graz, Austria, pp. 1-8. DOI: 10.1109/ConTEL58387.2023.10198919

Mirzayeva G., E. & Mengboyeva S., O. (2024). How a Modern Educator Should Be Today. *Excellencia: International Multi-Disciplinary Journal of Education (2994-9521), 2*(6), 428-429. https://doi.org/10.5281/

Pearson, H. A., & Dubé, A. K. (2022). 3D printing as an educational technology: Theoretical perspectives, learning outcomes, and recommendations for practice. *Education and Information Technologies, 27*, 3037-3064. https://doi.org/10.1007/s10639-021-10733-7

Peng, Z. (2023). The Role of the Teacher in Modern Education. *International Journal of Education and Humanities, 8*(2), 117-118. https://doi.org/10.54097/ijeh.v8i2.7758

Schelly, C., Anzalone, G., Wijnen, B., & Pearce, J. M. (2015). Open-source 3-D printing technologies for education: Bringing additive manufacturing to the classroom. *Journal of Visual Languages & Computing, 28*, 226-237. https://doi.org/10.1016/j.jvlc.2015.01.004

Song, M. J. (2018). Learning to teach 3D printing in schools: how do teachers in Korea prepare to integrate 3D printing technology into classrooms? *Educational Media International, 55*(3), 183-198. https://doi.org/10.1080/09523987.2018.1512448

Wu, C. H., Liu, C. H., & Huang, Y. M. (2022). The exploration of continuous learning intention in STEAM education through attitude, motivation, and cognitive load. *International Journal of STEM Education, 9*, 35. https://doi.org/10.1186/s40594-022-00346-y

Xiong, X. (2020) Research on Chinese Individualized Reading Teaching Based on "Big Data" Education Platform. In *2020 2nd International Conference on Information Technology and Computer Application (ITCA)*, Guangzhou, China, pp. 668-671. DOI: 10.1109/ITCA52113.2020.00145

Otsuka, Y. (2021). Evaluation of the effect of ICT in education on the academic literacy of high school students. In *2021 Ninth International Symposium on Computing and Networking Workshops (CANDARW)*, Matsue, Japan, pp. 305-308. DOI: 10.1109/CANDARW53999.2021.00058

Priyatni, E. T., As'ari, A. R., Suharyadi, Ahmad, & Azizah (2021). The Development of an Online Teacher Training Model for Reading Literacy and Numeracy Improvement. In *2021 7th International Conference on Education and Technology (ICET)*, Malang, Indonesia, pp. 161-166. DOI: 10.1109/ICET53279.2021.9575078

Pan, Y.-Y., Li, M.-C., Chen, C.-M., & Chen, Y.-T. (2023). The Effects of Web-based Inquiry Learning Mode with the Support of Collaborative Digital Reading Annotation System on Information Literacy Learning Effectiveness and Technology Acceptance. In *2023 14th IIAI International Congress on Advanced Applied Informatics (IIAI-AAI)*, Koriyama, Japan, pp. 247-252. DOI: 10.1109/IIAI-AAI59060.2023.00057

Pillai, D., Singh, A. S., Bhosale, T., & Doifode, A. (2023). A Perspective on the Application of Fintech as a Gateway for Financial Literacy. In *2023 International Conference on Information Technology (ICIT)*, Amman, Jordan, pp. 811-814. DOI: 10.1109/ICIT58056.2023.10225810

Tiede, J., Treacy, R., Grafe, S., & Mangina, E. (2022). Fostering Learning Motivation of Students with Reading and Spelling Difficulties by an AR-Enhanced Gamified Educational App for Literacy Learning. In *2022 IEEE Games, Entertainment, Media Conference (GEM)*, St. Michael, Barbados, pp. 1-6. DOI: 10.1109/GEM56474.2022.10017825

Tomášková, T., Duda, D., Krotký, J., & Honzíková, J. (2024). Ecodesign as a new possibility in teaching technical subjects in secondary schools. In *Education and New Developments*. Lisbon, Portugal: inScience Press, pp. 199-203. ISBN 978-989-35-7280-1, ISSN 2184-044X

HYBRID ACTION-ORIENTED LEARNING AND TEACHING: A TRANSFORMATIVE APPROACH TO VOCATIONAL EDUCATION

Thomas N. Jambor
Didactics of Electrical Engineering and Computer Science, Leibniz University Hannover (Germany)

Abstract

In the domain of vocational education, experiential learning constitutes a pivotal component of instructional design, encompassing the execution of experiments and the engagement with (model) systems. These practices are embedded within the didactic concept of action orientation, a mandatory component in Germany's curricular standards. The implementation of learning and teaching activities as hybrid teaching thus presents challenges for teachers, since on the one hand hybrid teaching is required by both learners and companies, and on the other hand the action-oriented approach is to be followed. In the following paper, the possible implementation is discussed and the question of a meaningful combination of online and face-to-face teaching is answered on the basis of the determinants that describe action-oriented learning-teaching arrangements. This response is intended to serve as a foundation for the implementation of hybrid, action-oriented learning-teaching arrangements and to inspire further discussion on the subject.

Keywords: *Blended Learning, fundamentals of electrical engineering, constructivist didactics, determinants.*

---

1. Introduction

The shift towards hybrid teaching, a combination of face-to-face and online learning, has emerged as a significant approach to making teaching in general and vocational schools as well as at universities learner-oriented, particularly in the context of the ongoing pandemic. The necessity for hybrid or purely online teaching during the pandemic was driven by the imperative to ensure the continuity of teaching activities. Consequently, the focus was often on rapid implementation, which hindered the development and evaluation of appropriate didactic concepts. A particular challenge exists in the area of vocational education, given its emphasis on the practical design of learning-teaching arrangements. In Germany, action orientation is an obligatory concept for the design of lessons at vocational schools, which at first glance requires direct interaction between students and the use of real artefacts. The following research question is the focus of this paper:

"How should face-to-face and online teaching be combined and configured to facilitate action-oriented learning and teaching arrangements that are conducive to learning?"

In order to provide a response to the research questions, it is first necessary to explain the theoretical context. In particular, Chapter 2.3 clarifies the special requirements of vocational education, since the determinants of such a (obligatory) teaching concept are explained here. Subsequently, possibilities are shown for designing hybrid teaching that takes these framework conditions into account, in order to be able to carry out action-oriented learning-teaching arrangements in a hybrid way. The individual considerations are always undertaken from an angle derived from constructivist learning theory, which is the reason why the paper refers to the term "learning-teaching" and not "teaching-learning" arrangements. In constructivism, learning processes are considered to be superficial and teaching processes to be supportive.

2. Theoretical framework

In order to provide a meaningful framework for understanding the individual proposals that facilitate hybrid, activity-based teaching, the term "hybrid teaching" is first defined below. This is followed by the subject-didactic positioning of the activities of the author of this paper and the definition of activity-based learning-teaching arrangements according to ten determinants.

2.1. Hybrid teaching

The term 'hybrid teaching' is generally used to describe the combination of face-to-face and online teaching (Olapiriyakul & Scher, 2006). However, the specific combination of these two options can vary depending on the target group, the available resources and other framework conditions (Graham, 2006). In the context of differentiating between face-to-face and online teaching, GRAHAM identifies several dimensions that allow for a more detailed distinction than the comparison of the two basic concepts. In his differentiation of teaching and learning forms, GRAHAM considers four dimensions: space (live vs. virtual), time (live synchronous vs. asynchronous), fidelity (high (rich all senses) vs. medium (e.g. audio only) vs. low (text only)) and humanness (high human vs. high machine) (Graham, 2006). A refinement of the distinction between face-to-face and online teaching is provided by ALLEN, SEAMAN and GARRET, who introduce distinct boundaries between the individual formats. According to this classification, traditional teaching (face-to-face teaching) is characterized by a complete absence of online elements, web-facilitated teaching by a proportion of 1-29% online elements, blended or hybrid teaching by a proportion of 30-79% online elements, and online teaching by a proportion of 80% or more online elements. In this context, a differentiation is made based on the content of the respective degree program (Allen, Seaman & Garrett, 2007), although this can also be applied to individual learning scenarios.

STAKER and HORN identify four fundamental models within the domain of hybrid teaching. In the rotation model (1), learners transition between learning modalities in accordance with a predetermined plan or based on the instructor's specifications, with an online component constituting a minimum of 30% of the total to align with the definition proposed by ALLEN et al. The flex model (2) offers learners enhanced flexibility by primarily delivering content online and enabling them to follow an individualized, customizable schedule. This flexibility allows learners to switch between learning modalities at their own preference. Another approach is the self-blend model (3), in which complete learning units or modules are available online. Learners have the option to combine these with other learning units, thus ensuring a high degree of customization of their learning activities. Finally, the enriched-virtual model (4) represents a combination of online and classroom teaching, whereby the overall school experience is maintained. This implies that learners usually commence their learning in the classroom, with the teaching enriched by online content. (Staker & Horn, 2012)

According to STAKER and HORN, the first model is particularly suitable for vocational schools, as it accounts for the legal requirement for compulsory schooling and the curricular guidelines. However, it is imperative to acknowledge that a proportion of 15% to 30% of online teaching in vocational schools is currently being discussed, thereby falling short of the criterion established by ALLEN et al. Consequently, the current situation merely permits the designation as web-supported teaching within the rotation model. Nevertheless, the present paper concentrates on the proportion of online teaching that falls within the range of 30% to 79%.

2.2. Constructivist didactics of electrical engineering

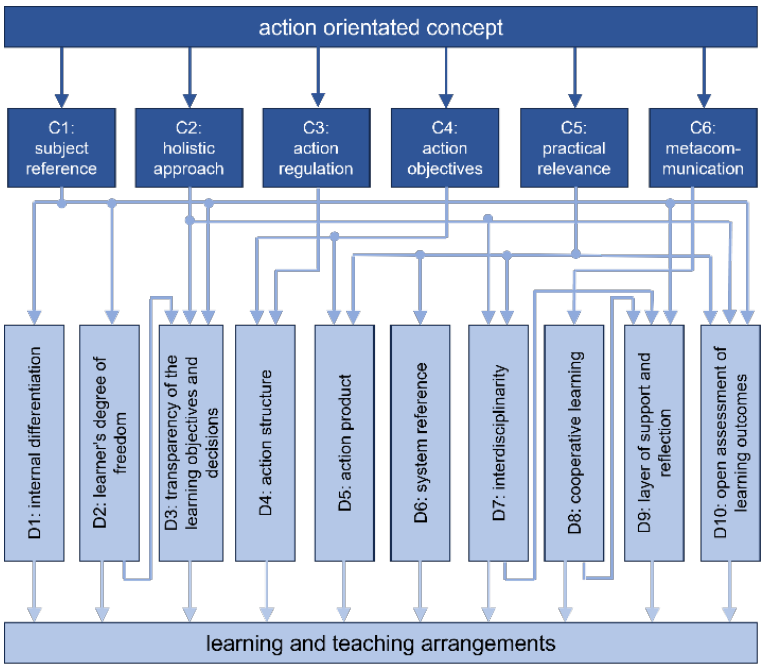
The constructivist Didactics of Electrical Engineering (cDoEE) (Jambor, 2022) serves as the foundational framework for the author's teaching and research activities. The cDoEE didactics emphasizes the fundamental principles of electrical engineering, which are distinguished by their abstract nature and frequent mathematical representation. This characteristic of electrical engineering presents a significant challenge for learners due to the complexity of the subject matter. The theoretical basis for these didactics is constructivism, a learning theory that emphasizes the active construction of knowledge by individuals. The cDoEE conceptualization of the human being is rooted in the Transactional Analysis of STEWART and JOINES, which rejects the notion of a fundamental hierarchical distinction between individuals and posits their capacity for deliberate decision-making and self-correction (Stewart, Joines, 1987). The application of these learning theories to learning-teaching arrangements implies a shift in responsibility for one's own learning processes to the learners, as well as a shift in the teachers' tasks to the area of support. The development of helpful and unhelpful preconceptions can be seen as a possible side effect of the learning processes, which is identified as one of the main aspects in cDoEE (Jambor, 2024).

The overarching objective of the cDoEE is to create a tool for selecting content and competencies for learning-teaching arrangements, as well as for planning these arrangements, taking into account both vocational training and the introductory phase of university degree programs. From this overarching objective, four intentions of the cDoEE are derived. The motivation of learners (1) for the often-abstract fundamentals of electrical engineering is a central success factor in the learning-teaching processes to be designed and should be encouraged. Furthermore, preconceptions (2) related to the fundamentals of electrical engineering should be counteracted, and the significance of subject knowledge (3) should be reinforced, given its particular importance in the field as a foundation for more advanced content. Finally, the development of inert knowledge (4) should be avoided, so that competence-oriented teaching is emphasized.

2.3. Action orientation

Action orientation is a fundamental concept in cDoEE, which is particularly salient in terms of its first and last intentions. This concept can be delineated in terms of characteristics (C1 - C6) and determinants (D1 - D10), as illustrated in Figure 1. These characteristics represent the comprehensive approach of action orientation and are derived from constructivist learning theory. However, the inherent abstractness of these characteristics renders them only marginally suitable for delineating an action-oriented learning-teaching arrangement. To address this limitation, the characteristics are thus substantiated and described in the form of determinants. These determinants can be utilized not only as a reference framework for planning but also for evaluation, thereby facilitating reflection on the implementation of the learning-teaching arrangement. A comprehensive presentation of the characteristics and determinants can be found in JAMBOR (2024), so that only the determinants are outlined here for reasons of scope and relevance.

Figure 1. Characteristics and Determinants of Action Orientation.



The determinant "inner differentiation" (D1) prioritizes the consideration of individual learners and their prior knowledge, with a focus on addressing learner needs, individualizing the structural coupling between learners and teachers or the subject (Meturana, Varela, 1980), and, when necessary, practicing reframing to eliminate potential learning hurdles (Clark, 1998). The support provided to learners is not limited to the elimination of difficulties; it also encompasses the fostering of individual development, thereby creating additional scope for both learners as a group and as individuals. Consequently, this fosters further degrees of freedom for learners (D2) in the sense of self-control. To promote the feeling of being able to use these degrees of freedom and to enhance learners' motivation, it is crucial to establish transparency (D3) regarding the learning objectives and didactic decisions made by the teacher.

The learning process is predicated on the workflow of a skilled worker or expert. Skilled workers or experts begin by identifying a problem (phase 0). Then, they inform themselves (phase 1), plan their process (phase 2), make necessary decisions (phase 3), carry out the action (phase 4), check the result (phase 5), and reflect on their work (phase 6). This results in an action structure (D4) with six phases (phase 1-6), which is frequently cited in the didactic literature and has been expanded by the author of this paper to include the zeroth phase. The individual phases are inherently linked to an action product (D5), which can be a device requiring repair or a circuit requiring modification. The action product should be sufficiently complex to promote system reference (D6) and to enable interdisciplinary links to other disciplines (D7), such as economic or ecological considerations. System reference promotes the problem-related structuring of knowledge within the learning process and counteracts the accumulation of inert knowledge (chapter 2.2.; 4th intention of cDoEE). Furthermore, the complexity of the action product necessitates cooperative learning (D8), thereby facilitating the alignment of cognitive structures among learners. During these activities, educators must establish a layer of support and reflection (D9). The three main components of the teacher's activity within this layer of support are as follows: classroom management (e.g., designing the

learning environment by setting rules; establishing routines that promote learning), cultivating a positive error culture in which errors are recognized as learning opportunities, and methodological support. The creation of process-related opportunities for reflection is subsumed under the layer of reflection and can be implemented, for example, through learning diaries and selective reflection discussions. Finally, the establishment of open assessment (D10) options emerges as the pivotal element in ensuring that action-oriented learning-teaching arrangements transcend the confines of mere selective knowledge queries and that learners are evaluated beyond the confines of their mere knowledge. Instead, the objective is to implement outcome- and process-related performance assessments and to engage learners in the evaluation process.

3. Action-oriented realization of hybrid learning and teaching

The individual determinants have been defined with a focus on implementation as face-to-face teaching; therefore, it is important to consider how hybrid implementation can be carried out without having to dispense with the individual determinants or to define them differently for hybrid teaching. With regard to the first determinant (D1), hybrid teaching opens up the possibility of providing learners with enhanced individual support, since learners can access individually adapted learning materials at their own pace online. Moreover, the temporal decoupling of learning and teaching processes enables the addressing of any difficulties that arise and the preparation of additional sources of information, thereby expanding the spectrum of learning opportunities for learners and increasing their individual degrees of freedom within learning processes (D2). Consequently, both media and methodological options can be utilized more comprehensively, thus allowing for the consideration of learners' individual learning preferences. In this context, the third determinant (D3) assumes even greater significance, as the selective decoupling of learning and teaching processes necessitates the assurance of transparency in learning objectives and teachers' decisions regarding learning modalities. This implies the continuous availability of both the learning objectives and the rationale for individual content-related and methodological decisions.

The phases of online and face-to-face learning can be arranged on the basis of the action structure (D4), which ensures a systematic and comprehensible transition between these phases. It is also possible to conduct individual phases of the learning process both online and face-to-face. For example, the first part of the implementation phase can be completed online with the aid of a simulation, and the second part of the phase can be conducted in face-to-face sessions using models and experiments. In either scenario, a deliberate transition between learning modalities is crucial. Ideally, this transition would occur within structured sequences, such as those that synchronize learners' learning statuses, address emerging questions, and define subsequent tasks. However, it is important to note that these transitions do not constitute actual phases in the sense of action orientation. Instead, they are intentionally designed to facilitate a seamless and structured transition between learning modalities.

The combination of the two learning modalities initially poses a challenge for the following two determinants, especially when the action product (D5) is used as a model in face-to-face learning phases. The possibility of establishing a system reference (D6) is to be assessed as positive with this real type of implementation, since learners do not focus exclusively on individual elements and contents, but grasp these in the context of entire devices and systems. The extension of models to encompass digital twins facilitates the utilization of devices and systems within both learning modalities, facilitating a transition from the device to the system level, and subsequently to the individual content. An audio amplifier, available in both model and virtual twin forms, can serve as a demonstrative example. Learners have the opportunity to work virtually from the amplifier as a whole, dividing it into individual assemblies (e.g., control unit, power supply) and then into the basic circuits used (e.g., voltage divider in the power supply). This enables them to consciously perceive the significance of the basic voltage divider, which may be considered abstract, in the context of system reference (D6). Subsequently, the voltage divider is examined through measurements in the amplifier and simulations in virtual space. The digital twin can also be utilized to consider ecological and economic aspects, fostering interdisciplinary work (D7). The spatial and, in some cases, temporal decoupling of learning activities necessitates the promotion of communication and collaboration through cooperative learning (D8). The integration of learning platforms and other digital tools, even in face-to-face settings, is crucial to ensure a seamless transition between learning modalities and to avoid overloading transition sequences with content that is more effectively viewed within individual modalities.

In the implementation of the omnipresent layer of support and reflection (B9), which is introduced in cDoEE to supplement the action structure, it should be noted that the temporal and spatial distance between the learner and the teacher also plays a role. With regard to the layer of support, the establishment of routines should be mentioned first, as they are considered an important part of designing the learning environment. These routines encompass, for instance, the discussion of questions, the articulation of

learning objectives, and the summarization of the most pivotal learning outcomes. The establishment of these routines must be meticulously trained and practiced in both face-to-face and online settings. Moreover, a positive error culture assumes even greater significance in online contexts, where individual errors and unhelpful preconceptions can be systematically logged and assigned to specific learners. This can lead to learners being reluctant to participate, so a stronger focus on mistakes as potential learning opportunities and their communication are required. The interpersonal relationship on which the interaction between learners and teachers takes place is becoming increasingly important because it has a decisive influence on learning success. In the context of hybrid teaching, where learners are entrusted with a greater responsibility for their own learning processes compared to conventional learning-teaching arrangements, systematic support becomes crucial. This is particularly pertinent in navigating challenges during online phases. Incorporating methods that promote and encourage prompt, continuous, and deliberate reflection is imperative within the framework of this layer of reflection. Learning diaries, portfolios, and one-minute papers are particularly suitable for reflection during learning. Finally, open assessment of learning outcomes (B10) can and should also be used to reflect on one's own learning activities, which proves to be particularly useful when it is used as a further opportunity for reflection in the sense of a positive error culture.

4. Summary and outlook

In addressing the research question, the preceding chapter delineates the potential for designing hybrid teaching methods in an action-oriented manner within the context of vocational education. It is demonstrated that the determinants and corresponding characteristics can be realized in hybrid settings. However, given that this is a conceptual framework and a basis for future discourse, subsequent research endeavors will undertake a more profound theoretical substantiation, along with the methodological implementation and evaluation in the context of studies involving learners.

References

Allen, I. E., Seaman, J., & Garrett, R. (2007). *Blending in - The extent and promise of blended education in the United States*. Needham, MA: The Sloan Consortium.

Clark, A. J. (1998). *Reframing: A therapeutic technique in group counseling*. *Journal for Specialists in Group Work, 23*(1), 66-73.

Graham, C. R. (2006). Blended learning systems: Definition, current trends, and future directions. In C. Bonk, C. Graham, & J. Cross (Eds.), *The handbook of blended learning: Global perspectives, local designs* (pp. 3-21). Pfeiffer.

Jambor, T. N. (2022). *Konstruktivistische Fachdidaktik der Elektrotechnik* (Postdoctoral Thesis, Munich, Germany).

Jambor, T. N. (2024). The Use of Simulation Tools to Reduce Unhelpful Preconceptions in Electrical Engineering Education. In *EDULearn 2024 Proceedings of the 16th International Conference on Education and New Learning Technologies* (pp. 2997-3007). doi: 10.21125/edulearn.2024.0798

Meturana, H. R., & Varela, F. J. (1980). *Autopoiesis and Cognition – The Realization of the Living*. London.

Olapiriyakul, K., & Scher, M. J. (2006). A guide to establishing hybrid learning courses: Employing information technology to create a new learning experience, and a case study. *The Internet and Higher Education, 9*(4), 287-301.

Staker, H., & Horn, M. B. (2012). *Classifying K-12 blended learning*. Innosight institute.

Stewart, I., & Joines, V. (1987). *TA today: A new introduction to transactional analysis*. Nottingham: Lifespace Pub.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

CONDITIONS AFFECTING LEARNING ON THE COLLECTIVE LEARNING PLATFORM - A STUDY WITH SECONDARY SCHOOL STUDENTS

Santos Orejudo, Raquel Lozano, & Carmen Elboj
Department of Psychology and Sociology, University of Zaragoza (Spain)

Abstract

Technological development is creating new learning environments that take place in the digital space. An example of this is Collective Learning, a digital platform based on a model of collective intelligence that generates a problem-solving context by allowing participants to develop their activity through different phases of interaction within it (Bautista and Valero-Tapia, 2024). Developed by the University Institute of Biocomputing and Physics of Complex Systems (BIFI) of the University of Zaragoza (Spain) in collaboration with Kampal Data Solutions, Collective Learning is designed so that large groups can generate collaborative solutions to the tasks or problems posed in it, also incorporating a consensus mechanism based on the analysis of participants' activity in real time. This collaborative environment can therefore be a learning environment with some conditions that increase the motivation of the participants, such as having learning partners outside the classroom, being able to learn in an environment where many of their daily interactions take place, having activities that have a certain challenging component, or being able to improve critical thinking. However, it is necessary to identify the conditions of these new environments that influence participants' motivation and learning. Therefore, we present data from 234 secondary school students (mean age 14.17 years - SD 1.58) who participated in different work sessions within the Collective Learning platform and who answered a 26-question questionnaire collecting aspects related to satisfaction with the activity and learning, as well as with the conditions that the platform contains to facilitate learning and the behaviours they generated during their interaction. The data were analysed by means of path analysis, in which learning on the platform is mediated by satisfaction with the activity. The results show that the variables included explain 49% of satisfaction and 45% of learning. The facilitating conditions of the platform are the most relevant variable in the model (β=.66 for satisfaction and β=.22 for learning), but equally important are students' behaviour towards the task, orientation towards change as an important factor in learning (β=.20). Finally, satisfaction has a direct effect on learning (β=.38). We conclude by pointing out that an environment such as Collective Learning makes it possible to generate learning experiences and to identify the elements that contribute to learning.

Keywords: *Collective learning, collective intelligence, learning experience, learner behaviour, platform conditions.*

1. Introduction

The construct of collective intelligence (CI) has become popular in recent years due to the possibilities offered by the Internet to create collaborative spaces for large groups. This construct is based on the assumption that groups of people are capable of generating more complex and higher quality solutions to proposed problems than each of them individually. A fundamental idea in this context is that by working together on a task, participants may also be learning (Navajas et al., 2018). In this sense, collaboration in small groups is a common condition in active methodologies such as cooperative learning or project-based learning. However, the possibilities offered by the Internet to move interactions into this space and to create new working conditions for large groups create an environment with new potential to be explored. Specifically, this work is based on an interaction platform based on collective intelligence models used as a learning tool, called Collective Learning.

This platform allows groups of people to work together to solve a proposed task. To this end, it has a system for disseminating information in successive phases, compatible with the gradual creation of more complex answers in a collaborative environment, to finally narrow down the solutions approved by the group by means of a consensus mechanism. It is designed to allow a very large number of people to carry out the same task. Previous work has demonstrated its effectiveness with groups of up to 800 people (Bautista et al., 2022; Cebollero et al., 2024; Orejudo et al., 2022, 2024).

1.1. The collective learning platform as a learning environment

Collective Learning is a digital tool that allows users to respond to activities at different stages (https://www.kampal.com/collective-learning/). In this way, users have the possibility to elaborate their answers successively, to see the answers of the other participants and, with this new information, to modify the answers already elaborated, to copy them directly or simply to ignore them. Participants are not obliged to generate new answers at each stage, but the activity is stimulated by successively receiving new information and encouraging the evaluation of this information, which provides an incentive to generate new answers (Bautista and Valero Tapia, 2024; Orejudo et al., 2022).

As mentioned above, participants go through different phases of activity. Thus, initially (phase 1), the work is carried out individually. Then, in phases 2, 3, 4 and 5, the work is carried out in small groups of 5 participants, with the aim of optimising this learning environment (Navajas et al., 2018), but also to ensure that the answers generated by the participants are disseminated throughout the network by successively exchanging the members of the group. Finally, phases 6 and 7 are aimed at reaching a consensus.

The activity designers or project managers within the platform are responsible for introducing the tasks to be carried out. The format of the activity is extremely flexible, as it can include text format, audio/video, external links, etc., and questions can be posed with different answer options, both open and closed (Orejudo et al., 2022; Orejudo and Denoni, 2024). The type of content to be included is very diverse, but it is well suited to tasks that are close to the format of problem solving, case studies, exercises and concrete tasks.

2. Design

The work presented is based on three elements. The first is the Collective Learning Platform, a virtual environment for collaborative learning that allows large groups of people to interact to complete learning tasks. Its characteristics have already been presented in the previous section. It is also relevant to mention the type of task that is introduced in the platform and that the participants in the platform have to analyse and that has to be designed for learning. In this case, the learning objectives are related to the development of socio-emotional e-skills for acting in digital contexts (Cebollero-Salinas, 2022; 2024). To achieve this objective, and following the methodology of cases in learning contexts (Orejudo et al., 2008), situations related to cyberbullying, hate speech on the Internet, social comparison, viral jokes or phubbing are included in the platform. For this purpose, different learning situations of between 45 and 50 minutes are planned and offered to all schools in the region through the Department of Education of the Government of Aragon (Spain). In this way, between 40 and 50 schools take part in these activities each school year, with each school being responsible for deciding how many students take part in each activity.

Finally, since the aim of this study is to analyse how the participants in the activities value the elements of the Collective Learning platform as a learning environment, the study has a component of evaluation of the activity through a survey format. In turn, the data analysis is based on a theoretical model of the relationship between the variables, in which both the conditions of the platform and the behaviour of the participants during the activity are directly related to the learning achieved and to the general satisfaction with the activity, and a relationship of mediation of these variables through general satisfaction and learning is also proposed. The AMOS 28 software was used for statistical analysis.

3. Objectives

Therefore, the aim of this paper is to present the assessment that students in compulsory and post-compulsory education make of the activities they do on the Collective Learning platform, to describe their own performance on the platform, and to verify that the conditions of the platform and the behaviour of the participants are related to satisfaction and learning.

4. Methods

4.1. Participants

A total of 234 secondary school students from Aragón (Spain) participated in this study (mean 14.17 years - SD 1.58). All of them completed at least one learning activity within the Collective Learning platform during the school year 2023/24. Of them, 49.1% are girls, 48.7% are boys and 2.1% identify with another identity. Most of them are in compulsory secondary education (88%), where they are aged between 12 and 16. The remaining 12% are students in the first year of high school or vocational training, aged between 16 and 22. As a condition for completing the activity evaluation survey, all of them had to have participated in at least one learning situation within the platform.

4.2. Activity evaluation questionnaire

As we have already mentioned, after the last activity of each group and after about one week, the participants had to fill in, in the presence of the teacher who had accompanied them during the activities, an activity evaluation questionnaire via Google Forms with 26 items specifically designed to evaluate the learning environment of Collective Learning. The items were specifically designed for this work and covered the following dimensions:

- Learning (6 items, α=.801). Example of items: "The situation(s) we analysed allowed me to really put myself in the place of the characters presented".
- Strategies followed during the activity aimed at change (5 items, α=.753). Example: 'Throughout the phases of the projects, I changed my initial response to others that seemed to me to be better ideas'.
- Strategies followed during the activity that are not change-oriented (3 items, α=.443). Example: "Throughout the project phases, I did not change my initial answer because I was too lazy to read or because there were too many answers".
- Platform conditions conducive to the activity (4 items, α=.783). Example "I felt comfortable on the platform because I could see what other people were saying".
- Platform conditions inhibiting activity (3 items, α=.635). Example: "I didn't like that the platform could delete responses".
- Platform conditions related to anonymity (2 items, α=.818). Example: "The fact that no one knew who you were allowed me to say what I really thought".
- Satisfaction with the activity (3 items, α.717). Example: "I liked the activity with the collective learning platform".

All items of the scales have a Likert scale format with values from 1 to 6. In order to facilitate the comparison between the scales, the mean for each of them is presented according to the number of items, so that the scores presented have theoretical ranges between 1 and 6.

5. Results

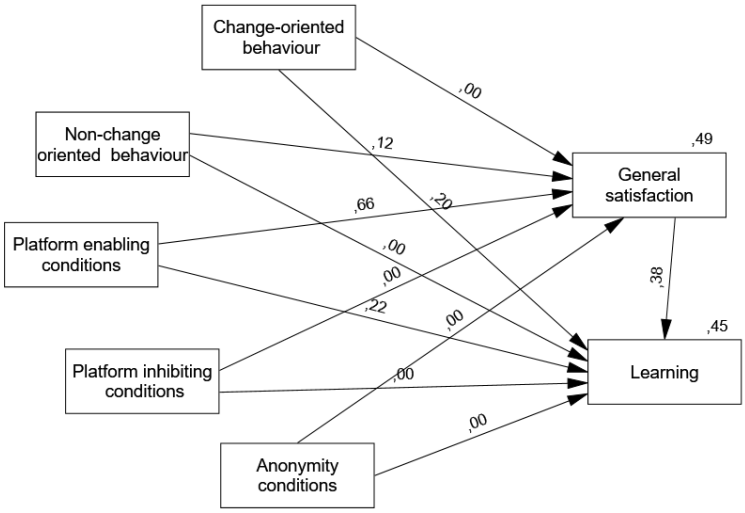
As can be seen in Table 1, students in secondary education give a medium-high rating to the activities carried out on the platform. It is worth noting that the highest scores are given to the general satisfaction and the facilitating conditions of the platform (3.97 and 3.89). Similarly, the assessment of learning is above the theoretical average of the scale (3.5). The condition of anonymity stands out as the least relevant.

Table 1. Descriptive statistics of the evaluation of the activity.

	N	Mean	S.D.
Learning	234	3.77	1.13
Change-oriented behaviours	234	3.39	1.18
Non-change oriented behaviour	234	3.49	1.09
Platform enabling conditions	234	3.89	1.19
Platform inhibiting conditions	234	3.43	1.07
Anonymity conditions	*234*	2.89	1.24
General satisfaction	*234*	3.97	1.21

In terms of the relationships between the variables, the results are shown in Figure 1. The model fit data reflect quite adequate values of the model (χ^2=8.302, df=6, p< .217, CFI=.997, TLI=.991, RMSEA=.041). This figure shows that all variables included in the model have some effect on the endogenous variables. In particular, Overall satisfaction (49%) and Learning (47%) are adequately explained by the exogenous variables and are closely related (β=.38), proving that Overall satisfaction with the activity is a condition for learning. Following this mediation relationship, Platform conditions that facilitate interaction are found to be particularly relevant for predicting satisfaction (β=.66) and direct learning (β=.22), accumulating total effects of β=.469. In turn, the participants' own behaviour is relevant, as their change-oriented behaviour is the main predictor of learning (β=.20). Finally, the relevance of non-change behaviour as a relevant condition for overall satisfaction is noteworthy (β=.12).

Figure 1. Path model.



6. Discussion and conclusions

The aim of this study was to analyse which elements of the learning environment created in the collective learning platform and the students' behaviour that emerges in it have an impact on the learning that takes place in it. To this end, a group of secondary school students in Spain evaluated the most relevant elements of this platform using an ad hoc questionnaire. This platform generates a new learning scenario with different characteristics, as it allows the dynamic interaction of large groups of people, it is based on small group work (Navajas et al., 2018), it encourages the dispersion of information among all participants in the activity and incorporates mechanisms to increase interaction between participants, and finally it generates a consensus mechanism that helps to generate a collective solution.

The results obtained show that the participants in the activity perceive the most relevant conditions of the activity and that they point out that their own action, oriented towards change and learning in this social context, is a key condition for learning and for showing satisfaction with the activity. Furthermore, it emerges as a key factor that the platform's own actions are significantly the most important elements in explaining both satisfaction and learning. These elements highlight the importance of the facilitation of interaction and the activity of participants as fundamental aspects in collaborative learning contexts mediated by technological support (Castellanos et al., 2017; Cesarini et al., 2016; Liu & Lan, 2016; Orejudo et al., 2024).

Likewise, it should be taken into account that these results are not independent of the learning content, the emotional e-competences (Cebollero et al., 2022; 2024), which are essential for adapting to virtual environments, and the way the content is presented within the platform, in which the case methodology (Orejudo et al., 2008) is essential, as it tries to facilitate the participants' involvement in the learning situation and, therefore, their motivation. Finally, it should be noted that the participants are secondary school students and that they have some different characteristics from other groups, such as university students, who give higher ratings to the activities (Valero-Tapia et al., 2023). However, it should be noted that in this group of students, a relevant value is found for non-change behaviour as a basic aspect of satisfaction with the activity, a relationship that could well be explained by the characteristics of this adolescent stage.

Acknowledgments

This study was funded by Department of Science, University and Knowledge Society, Government of Aragon (Ref. PROY_S14_24. CONVIVEN-CI-IA. Aprendizaje de competencias socioemocionales para la ciberconvivencia a través de la integración de herramientas de Inteligencia Artificial (IA) + Inteligencia colectiva (IC) en centros educativos). Project financed by: FEDER Aragón Operational Program 2014-2020. Building Europe from Aragon.

References

Bautista, P., & Valero-Tapia, S. (2024). Collective intelligence: A new way of e-learning. In *INTED2024 Proceedings* (pp. 6708-6714). https://library.iated.org/view/BAUTISTA2024COL

Castellanos, J, Haya, P. A., & Urquiza-Fuentes, J. (2017). A Novel Group Engagement Score for Virtual Learning Environments. *IEEE Transactions on Learning Technologies, 10*(3), 306-317.

Cesareni, D., Cacciamani, S., & Fujita, N. (2016). Role taking and knowledge building in a blended university course. *International Journal of Computer-Supported Collaborative Learning, 11*(1), 9-39. DOI: 10.1007/s11412-015-9224-0

Cebollero-Salinas, A., Elboj-Saso, C., Íñiguez-Berrozpe, T., & Bautista-Alcaine, P. (2024). Confronting Fake News Through Collective Intelligence in Adolescents, *International Journal of Human–Computer Interaction*, 1-14. DOI:10.1080/10447318.2024.2405567

Liu, S. H. J., & Lan, Y. J. (2016). Social Constructivist Approach to Web-Based EFL Learning: Collaboration, Motivation, and Perception on the Use of Google Docs. *Journal of Educational Technology & Society, 19*(1), 171-186.

Navajas, J., Niella, T., Garbulsky, G., & Sigman, M. (2018). Aggregated knowledge from a small number of debates outperforms the wisdom of large crowds. *Nature Human Behaviour, 2,* 126-132. https://doi.org/10.1038/s41562-017-0273-4

Orejudo, S., Cano-Escoriaza, J., Cebollero-Salinas, A. B., Bautista, P., Clemente-Gallardo, J., Rivero, A., Rivero, P., & Tarancón, A. (2022). Evolutionary emergence of collective intelligence in large groups of students. *Frontiers in Psychology, 13*, 848048. DOI: 10.3389/fpsyg.2022.848048

Orejudo, S., & Denoni, M. (2024). How question type affects student production in a digital collaborative learning space. In *INTED2024 Proceedings* (pp. 6783-6789).

Orejudo, S., Fernández Turrado, T., & Garrido Laparte, M. Á. (2008). Elaboración y trabajo con casos y otras metodologías activas: cuatro experiencias de un grupo de profesores de la Facultad de Educación de Zaragoza. *Revista Interuniversitaria de Formación del Profesorado, 63*, 21-46.

Orejudo, S., Lozano-Blasco, R., Bautista, P., Aiger, M. (2024). Interaction among participants in a collective intelligence experiment: an emotional approach. *Frontiers In Psychology, 15*. DOI: 10.3389/fpsyg.2024.1383134

Valero-Tapia, S., Sanvicen Torné, F., & Orejudo, S. (2023). Nuevos entornos digitales de aprendizaje: valoración de actividades de aprendizaje realizadas en la plataforma *collective learning*. In M. E. Illescas Estévez, J. C. De La Cruz Campos, J. M. Fernández Campoy, & J. A. Martínez Domingo (Eds.), *Innovando para las competencias docentes: Perspectivas desde la investigació*n (pp. 167-179). Dykinson, S.L.

NARRATION TO PROMOTE RESTORATIVE ATTITUDES IN ADOLESCENTS

Paola Nicolini[1], Lina Caraceni[2], Alessandro Maranesi[1], & Veronica Guardabassi[1]
[1]*Department of Humanities, University of Macerata (Italy)*
[2]*Department of Law, University of Macerata (Italy)*

Abstract

According to recent studies (Lodi et al., 2021), using a restorative approach in educational contexts is useful to efficiently solve problematic situations at school as well as to promote prosocial behaviours among young people. However, developing restorative attitudes is a slow and complex process that requires to develop the ability to adopt a probabilistic and multicausal representation (Nicolini, 2023) of the reality. In fact, according to the balanced model of restorative justice (Chapman, 2012), the damage that is the result of a crime involves not only the person victim, but also the responsible of the situation as well as the overall community in which the situation has been developed. Consistently with this assumption, the present study has the aim to develop a complex and a restorative attitude into adolescents. Specifically, it was hypothesized that the involvement in a narrative activity in which they assume in turn the prospective of a person victim, of a person author of a crime and/or of the community, can be useful to improve their restorative attitudes. Participants were 44 adolescents (24 girls and 20 boys) attending high school (M_{age} = 17.58; *SD* = .53). They took part to an event at the University lasting one morning. First, they were told a story about a car accident. Then they completed a questionnaire (T0) about anagraphic information and their restorative attitudes (Taylor & Bailey, 2022), a multicomponent tool with subscales about empathic understanding**,** harm and needs, restoration processes, accountability, community engagement. Soon after they were divided into groups to discuss about the episode based on the point of view of people victims or responsible of the car accident, familiars, friends, media. Each participant takes part to two different groups, adopting two different roles. At the end, they completed again the same questionnaire (T1) used at the beginning of the activity, collecting data about the empathic understanding, harm and needs, restoration processes, accountability, and community engagement. Descriptive and t-test analyses were performed. Statistical analyses showed that participants indicate an improvement of their restorative attitudes in term of empathic understanding, $t(43) = -3.81$; $p = .000$, harm and needs, $t(43) = -4.09$; $p = .000$, restoration processes, $t(43) = -4.01$; $p = .000$, accountability, $t(43) = 2.31$; $p = .026$, but not community engagement, $t(43) = -1.66$; $p = .103$. In conclusion, the results suggested that is possible to promote a restorative attitude among adolescents, despite more actions are needed to promote also a community engagement approach. Strengths, limits and future directions of the study will be discussed.

Keywords: *Restorative attitudes, adolescence, justice, narration, restorative justice*.

1. Introduction

Schools play an important role in the development of children and adolescents. They are not only places of instruction, but also places of education. Indeed, students develop their emotional and social skills at school and can have the opportunity to learn how to manage conflicts. In this sense, the restorative justice approach can provide valuable support. Restorative justice is a new paradigm that runs alongside traditional justice and involves the whole community in managing a crime, focusing on the harm caused by the crime (Zehr, 2015). It is based on the awareness that the consequences of a crime affect not only the victim, but also those responsible for the situation, as well as the wider community in which the situation occurred, following the balanced model of restorative justice (Chapman, 2012). All people directly and indirectly involved in a crime suffer as a result of it, and their needs must be recognised and addressed (Patrizi & De Gregorio, 2009; Patrizi 2024).

Recent studies have shown that this approach is effective when adopted in an educational context (Nicolini et al., 2024; Guardabassi & Nicolini, 2023). Schools that use a restorative approach in cases of conflict have also achieved positive results in terms of reducing deviant behaviours, fostering positive

relationships, and promoting pro-social behaviours, social and emotional skills, and student well-being (Church et al., 2021; Lodi et al., 2021)

Thus, promoting a restorative attitude can be a very important educational practice that can have a positive impact on students' lives. Based on this evidence, the aim of this study was to encourage restorative attitudes in adolescents. According to the study's hypothesis, participating in a narrative activity (Bruner 1956, 1986, 1990, 1996, 2002) in which they take on the perspective of a victim, an offender and/or the community can be useful in improving their restorative attitudes. Narrative thinking is useful to reconstruct and represent what is possible within a given framework, avoiding the intention of demonstrating what is true and what is false. It is a social way of thinking because narrative is a way of exchanging ideas and opinions, it is a vehicle of relationship.

2. Method

2.1. Participants and procedure

A group of high school students took part in a one-morning event at the university. First, they were presented with a story about a car accident. Then, they completed a questionnaire (T0) providing demographic information and their attitudes towards restorative justice. They were then divided into groups to discuss the episode from the perspective of different stakeholders, such as victims, those responsible for the accident, friends and family members, and the media. Each participant took part in two different groups. Finally, they completed the same initial questionnaire again (T1).

2.2. Measures

The following information was collected using a questionnaire at T0 and T1.

2.2.1. Demographic information. Some general information about the participants was requested, such as gender and year of birth. The latter variable was used to calculate participants' ages.

2.2.2. Restorative attitudes. The Restorative Justice Attitudes Scale (RJAS) by Taylor and Bailey (2022) was adopted to measure restorative attitudes. This 20-item multi-component tool comprises five subscales related to empathic understanding (α_{t0} = .896; α_{t1} = .927)**,** harm and needs (α_{t0} = .827; α_{t1} = .863), restoration processes (α_{t0} = .772; α_{t1} = .840), accountability (α_{t0} = .872; α_{t1} = .919), community engagement (α_{t0} = .803; α_{t1} = .879).

2.3. Statistical analyses

A descriptive analysis and a T-test were performed.

3. Results

3.1. Descriptive information

The participants were 44 adolescents (24 girls and 20 boys) who were attending high school (M_{age} = 17.58; *SD* = .53).

Table 1. Means and standard deviations.

	Pre (T0)		Post (T1)	
	M	*SD*	*M*	*SD*
Empathic understanding	3.54	.84	3.88	.97
Harm and needs	3.36	.88	3.77	.91
Restoration processes	3.42	.79	3.85	.83
Accountability	4.71	.44	4.42	.11
Community engagement	3.39	.74	3.62	.96

3.2. T-test analysis

The results showed that participants improved their restorative attitudes in terms of empathic understanding, $t(43) = -3.81$; $p = .000$, harm and needs, $t(43) = -4.09$; $p = .000$, restoration processes, $t(43) = -4.01$; $p = .000$, accountability, $t(43) = 2.31$; $p = .026$. However, there was no improvement in community engagement, $t(43) = -1.66$; $p = .103$.

4. Discussion

This study was conducted with the aim to develop restorative attitudes in adolescents, i.e., develop a multi-component and multi-probabilistic vision of the reality and an awareness about the complexity of events (Nicolini, 2023).

The activities conducted in this study with adolescents lead to significant changes in their restorative attitudes in term of empathic understanding, harm and needs and restoration processes. It can be said that to have embodied different roles was an efficient tool to allow the participants to take the point of view of persons directly involved in a conflict. Consistently with Galinsky and Moskowitz (2000), taking on the role and perspective of the other person, putting oneself in their shoes, seeing the world from their point of view, can reduce distance and prejudice because the other person is seen as less threatening and less different from oneself than one might think. This kind of cognitive and emotional intervention can activate the idea that we share the same destiny as human beings, that we are all interdependent. Thus, it can lead to an other-centred perspective, imagining how the other person experiences a given situation. Both are effective in increasing empathic feelings, although the self-centred perspective involves a higher level of commitment. Cognitive empathy often acts as a precursor to emotional empathy.

The results present also some unexpected outcomes. There has been a significant reduction in accountability, i.e., the author of the accident has not taken responsibility. However, this value is one of the highest on the restorative scale, and these changes can represent a reduction in the attribution of blame to the author of a crime. In addition, there is an absence of an improvement in term of community involvement. This can be due to the fact that the community is not directly involved in the situation, neither as an author nor as a target, which makes it more difficult to understand its role and involvement. Because a community is not a real person, but rather an abstract concept, it is probably more difficult to take the perspective of a community.

5. Conclusions

According to the initial hypothesis, to develop restorative attitudes into adolescents is possible, involving them in a narrative activity in which they are asked to assume in turn the prospective of a person victim, of a person author of a crime and/or of the community. However, as it was stated, developing full restorative attitudes is a slow and complex process that requires the ability to adopt a probabilistic and multicausal representation of the reality. In fact, the results of the current study show that while restorative attitudes improved in terms of empathic understanding, harm and needs, restoration processes, and accountability, no improvement resulted in the dimension of the community engagement.

As a point of strength, the research addressed a new topic by using workshop activities that directly involved adolescents, making them the main actors in their own development process as well as in the research. However, it also presents some limits: the sample size is small; there is no a control group; and no personal experiences of car accidents or similar negative events were explored.

Future studies should overcome these limitations and pursue this line of research, detecting new strategies to develop restorative attitudes among adolescents. This can foster a climate of greater democracy and tolerance, promoting the well-being of future generations in our society.

Acknowledgements

This work has been funded by the European Union - NextGenerationEU under the Italian Ministry of University and Research (MUR) National Innovation Ecosystem grant ECS00000041 - VITALITY - CUP D83C22000710005. Tiziana Montecchiari (Macerata University – Department of Law), Michele Feliziani (Macerata University – Department of Humanities), Benedetta Smargiassi (Macerata University – Department of Humanities) and Alessandra Pierini (freelance journalist) participated to the research team.

References

Bruner J. (1956). *A Study of Thinking*. New York: John Wiley & sons.
Bruner J. (1986). *Actual minds, possible words*. Cambridge: Harvard University Press.
Bruner J. (1990). *Acts of Meaning*. Cambridge: Harvard University Press.
Bruner J. (1996). *The Culture of Education*. Cambridge: Harvard University Press.
Bruner J. (2002). *Making Stories. Law, Literature, Life*. Farrar, Straus and Giroux.
Chapman, T. (2012). Facilitating Restorative Conferences in Northern Ireland. In E. Zinsstag, & I. Vanfraechem (Eds.), *Conferencing and Restorative Justice: Challenges, Developments and Debates*. Oxford: Oxford University Press.
Church, S., Marcus, D. K., & Hamilton, Z. K. (2021). Community Service Outcomes in Justice-Involved Youth: Comparing Restorative Community Service to Standard Community Service. *Criminal Justice and Behavior*, *48*(9), 1243-1260.
Galinsky, A. D., & Moskowitz, G. B. (2000). Perspective-taking: decreasing stereotype expression, stereotype accessibility, and in-group favoritism. *Journal of Personality and Social Psychology*, *78*(4), 708-724.
Guardabassi, V., & Nicolini, P. (2023). Adolescenza, cyberbullismo e approcci riparativi. In *Esperienze di giustizia riparativa. La mediazione penale minorile. Best practices e prospettive* (pp. 79-91). Napoli: Editoriale Scientifica srl.
Lodi, E., Perrella, L., Lepri, G. L., Scarpa, M. L., & Patrizi, P. (2021). Use of restorative justice and restorative practices at school: A systematic literature review. *International Journal of Environmental Research and Public Health*, *19*(1), 96.
Nicolini P. (2023), Per una mente riparativa. In L. Caraceni (Ed.,) *Esperienze di giustizia riparativa, la mediazione penale minorile. Best practices e prospettive* (pp. 65-77). Napoli: Editoriale Scientifica.
Nicolini, P., Mancini, G., Manoni, E., Maranesi, A., Smargiassi, B., & Guardabassi, V. (2024). Cyberbullying. How to Deal with this Phenomenon using the Restorative Justice Paradigm. *Bulletin of the Transilvania University of Brasov. Series vii social sciences. Law*, *17*, 15-24.
Patrizi P. (2024), *La giustizia riparativa. Psicologia e diritto per il benessere di persone e comunità*. Roma: Carocci.
Patrizi, P. & De Gregorio E. (2019). *Fondamenti di psicologia giuridica*. Bologna: Il Mulino
Taylor, T. O., & Bailey, T. K. M. (2022). The restorative justice attitudes scale: Development and initial psychometric evaluation. *The Counseling Psychologist*, *50*, 6-39.
Zehr, H. (2015). *Changing lenses: Restorative justice for our times*. Herald Press.

THE ETHNOGRAPHIC AI: EXPLORING THE FUTURE OF ACADEMIC WRITING WITH ARTIFICIAL INTELLIGENCE

Patricia Arnold
Department of Applied Social Sciences, Hochschule München University of Applied Sciences (Germany)

Abstract

As artificial intelligence (AI) tools continue to advance at an unprecedented pace, their impact on higher education and academic writing is becoming increasingly profound. This paper presents an auto-ethnographic exploration of the integration of AI tools in academic text production. Drawing inspiration from Carolyn Ellis's seminal work on autoethnography, the study employs a self-reflective approach to examine the author's experiences with a diverse array of AI tools for research and academic writing. The title alludes to the title of Ellis's key publication "The Ethnographic I" while also pointing to the new territory of future academic writing processes with strong assistance of AI tools. The investigation strives to unpack various aspects of AI as a transformative factor in academic text production. It explores the usage of AI tools in different phases of writing academic texts. In doing so, it highlights affordances and limitations of exemplary AI tools for academic writing. Furthermore, the investigation explores ethical implications of AI-assisted academic writing, including issues of authorship, academic integrity and responsible use of AI. It also discusses the key findings in terms of consequences for introducing students to academic writing.

Keywords: *Artificial intelligence, autoethnography, academic writing, higher education.*

1. Introduction

Given the rapid advancement and integration of artificial intelligence (AI) technologies, academic writing is undergoing a profound transformation. As AI tools become increasingly sophisticated and accessible, they are reshaping not only how we produce academic texts but also how we conceptualize the very nature of scholarly writing and knowledge production (Bozkurt, 2024; Limburg et al., 2023; Perkins, 2023; Simon et al., 2024; Stracke et al., 2024). In the context of higher education, the advent of AI tools “triggered dystopian panic, utopian-naïve glorification, and heated debates on written examination forms such as term papers and theses” (Gröpler et al., 2024, 408). While concerns about technology-enabled plagiarism and academic dishonesty predated AI tools, their sudden widespread accessibility and unprecedented capabilities started the debate about the boundaries between legitimate technological assistance and academic misconduct afresh.

The emergence of generative AI tools, particularly large language models like ChatGPT, has sparked "excitement, fear, and uncertainty" in academic writing (Bozkurt et al., 2024, 489). The rapid pace of technological advancement has outstripped higher education institutions' ability to provide timely guidance on academic integrity and research ethics. While guidelines and institutional policies are beginning to appear in German academia (e.g., PROFiL & Schreibzentrum der LMU, 2024; Simon et al., 2024; Gimpel et al., 2023), their relevance risks obsolescence by the time of publication.

From another perspective, the EU Artificial Intelligence Act (EU Artificial Intelligence Act, 2024) adds pressure to higher education institutions and their members. The regulation explicitly requires any organization providing or deploying AI for their processes to ensure AI literacy of all actors involved. AI literacy is, according to the regulation, a multidimensional construct that combines the capacity for informed implementation of AI tools with a critical awareness of their opportunities, risks, and potential adverse effects.

Against this backdrop, this study explores the future of academic writing with AI tools, with a special focus on authorship, academic integrity and responsible use of AI. The study aims to refine our understanding of how AI tools transform the lived experience of academic writing: How do scholars navigate this new terrain of academic text production with AI tools?

As all of this is mostly unchartered territory, the study addresses these questions through an auto-ethnographic lens, drawing methodological inspiration from Carolyn Ellis's seminal work on reflexive research practices (Ellis 2004). By positioning myself as both researcher and subject, I examine my own journey of integrating various AI tools into the writing process of this academic paper. Results will then be discussed in terms of consequences for introducing students to academic writing.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

2. Academic writing in transition

Generative AI tools that use large language models and natural language processing presently transform academic writing practice in great speed and towards unknown horizons. There is widespread agreement that this is not a transient trend but a long-lasting change that is only beginning (e.g. Bozkurt, 2024).

2.1. AI-assisted academic writing

AI tools can assist in practically every phase of an academic writing process, i.e. generating ideas and first drafts, doing literature reviews, analyzing data, structuring and presenting research results, or editing and shaping the text regarding language style and voice, usually with a high quality (e.g. Bozkurt 2024, Elstad & Eriksen 2024, Gröpler 2023, Limburg et al. 2023). Advantages of AI-assisted academic writing are usually seen in the potential of AI tools to enhance effectiveness and efficiency, especially for non-native speakers of English. In addition, AI tools can help to overcome writer's block. Moreover, AI tools potentially promote inclusivity as the AI tool can act as a personal tutor, giving personalized feedback and thus stimulate creativity and help to keep up motivation (Bozkurt, 2024, Limburg et al., 2023; Maphoto et al., 2024).

But the same authors also report tremendous risks in AI-assisted writing processes. They highlight the bias, discrimination and lack of diversity inherent in all large language models due to their biased training material. In addition, they point to the risk of misinformation including so called "hallucinations" (information bearing no relationship with reality) and to a potential increase in educational inequality due to commercial interests entering the field in form of premium versions of AI tools that incur license fees. A potential negative impact for thinking capabilities and for academic integrity could be yet another risk (for the risks in detail s. Simon et al., 2024).

In addition to the potential/risk assessment the discourse on AI's role in academic writing has centered on the 'tool versus agent' debate. While the tool perspective frames AI tools as advanced instruments under human direction – analogous to traditional writing aids but with enhanced capabilities – the agent perspective acknowledges AI's capacity for autonomous reasoning, suggestion-making, and even challenging human assumptions during the writing process. Researchers arguing from an agent perspective often talk about human-AI "cocreation" (Bozkurt, 2024) or "collaboration" (Maphoto et al., 2024). The tool perspective is dominant in the German discourse (PROFiL & Schreibzentrum der LMU, 2024; Simon et al., 2024; Stracke et al., 2024). The 'tool versus agent' debate often goes hand in hand with anthropomorphic attribution. Humans tend to ascribe humanlike qualities such as consciousness, understanding, and empathy to AI systems despite their fundamental limitations. This anthropomorphization tendency, documented from early experiments with Weizenbaum's (1966) ELIZA to contemporary interactions with generative AI tools, persists even when AI users know of the artificial nature of their interaction (Simon et al., 2024).

2.2. Authorship and academic integrity revisited

AI-generated texts presently cannot be detected reliably (Gröpel et al., 2024; Khalil & Er, 2023; Perkins, 2023). There seem to be certain expressions that happen to appear in high numbers since the advent of generative AI (e.g. "delves into") but such word analysis does not allow for valid use of AI detection (Kobak et al., 2024). Furthermore, AI-generated text is not copyright-protected. So if AI generated verbatim text is used in a research paper, it does not constitute plagiarism. However, such incorporation of AI-generated text without declaration of AI usage is considered academic misconduct, infringing on academic integrity. As AI tools have been adopted quickly for writing research papers in a competitive, 'publish or perish' university culture academic authorship and integrity must be reconceptualized (Bozkurt, 2024).

Some unusual publications with renowned publishers have highlighted the need for such a new discussion. On the one hand, research articles, without declaration of AI usage, contained accidentally typical AI conversation text such as "Certainly, here is a possible introduction for your topic" in the main body of the published article (Nikolic et al. 2024). On the other hand, with a clear intent to act with academic integrity in another published article, ChatGPT was stated as a co-author (O'Connor & Chat GPT, 2023)[1]. Revisiting criteria to claim authorship it became clear that AI-tools cannot fulfill the criteria of being fully accountable for all aspects of the work (e.g. Bozkurt, 2024). Major publishers thus currently rule out AI as an author (e.g. Nature, 2023).

However, the question remains how using AI can be declared transparently so as to comply with academic integrity standards such as "honesty, trust, fairness, respect and responsibility" (Nikolic et al., 2023). Some initial academic guidelines advocated for full documentation of all 'conversations' with AI tools that were part of the text production process. It soon became evident that such total transparency is not feasible, amongst others by sheer quantity. Publishers now provide declaration templates that

[1] Both examples are now changed by the publisher but the misconduct respectively misconception can still be traced back.

summarize AI use and - most importantly – include a statement of the author taking full responsibility for all aspects of the text. Other researchers suggest more nuanced statements depending on the AI use in each paper, e.g. the “Academic Integrity and Transparency in AI-assisted Research and Specification (aiTARAS) Framework for acknowledging and disclosing the use of generative AI in scholarly writing” (Bozkurt, 2024).

Another approach to foster academic integrity in times of AI-assisted academic writing and to provide orientation for the academic community is a framework of responsibility. Researchers, lecturers, and students each bear distinct responsibilities, with researchers being accountable for maintaining academic integrity and transparent authorship practices, while lecturers must develop their own AI literacy and create appropriate learning environments for AI integration. Students, meanwhile, are responsible for developing both AI literacy and academic writing competencies, maintaining accountability for their writing processes, and ensuring proper attribution and documentation when using AI tools. All groups need to actively and continuously engage in critical reflection about their use of AI tools (Brommer et al., 2023).

3. Autoethnography of a writing process using artificial intelligence

As a researcher confronted with the potential and the challenges of generative AI tools I chose an autoethnographic research approach, investigating my own process of writing this academic paper with AI tools. This approach allows for a nuanced exploration of many of the above-mentioned dimensions of AI-assisted academic writing and is part of the critical reflection on AI usage for research that is currently needed in higher education.

3.1. Autoethnography as research method

Autoethnography is a qualitative research method that combines elements of autobiography and ethnography, where researchers systematically analyze their personal experiences to understand broader cultural phenomena. As conceptualized by Ellis (2004), it represents a reflexive approach where the researcher's own experiences serve as primary data, connecting the personal to the cultural through detailed self-observation, including reflective thoughts, doubts and, generally, emotions. This autoethnographic research project is based on my personal experience during the different phases of writing this paper from Oct. 2024 to Feb 2025, using various AI tools. I document my experience in research notes and expand it in retrospect, with self-reflective exploration.

3.2. Autoethnography: Navigating the jagged technological frontier[2]

The autoethnographic data is presented through two vignettes, following established conventions in autoethnographic methodology.

3.2.1. “Cutting edge or failure?” – negotiating academic integrity. As I approach my final year at university before retirement, I find myself reflecting on the miraculous timing of AI's emergence in academia. Technological breakthroughs have shaped my entire career path – much like when the Internet led me toward pursuing a PhD after two decades of professional work. Now AI is advancing at an even more remarkable pace. I've been bouncing around ideas for my last conference paper, and suddenly it hits me – why not dive into AI tools for academic writing? Perfect timing since I'm mentoring BA students on their theses. Plus, I could circle back to autoethnography, a method I employed earlier in my academic life. But then the doubts creep in. Using AI for a published paper – am I crossing a line here? The university's ChatGPT guidelines are full of "don'ts," and conference rules are either extremely vague or basically threatening. Part of me thinks, "Why risk my reputation now?" Especially since autoethnography isn't exactly mainstream in German academia, and let's face it, I've never considered myself a particularly gifted writer. But wait – maybe AI could help with the writing part? And honestly, how can I guide my social work students through using AI if I haven't really dived in myself? The more I think about it, the more it makes sense. Besides, if someone at the end of their career won't push these boundaries, who will?

3.2.2. “Claude & I are nearly done” - Writing an article with more ease. I'm curious how this writing process with AI tools will differ from my previous experiences. While AI can help with brainstorming and research questions, I've deliberately chosen not to use it for those stages – I fear losing my academic stance, my ownership of the text. My first AI engagement was crafting conference abstracts. After having to decline one conference for personal reasons, I was amazed at how quickly I could rework my abstract elsewhere, maintaining my ideas while avoiding any double submission concerns. I explored tools like Hesse.ai and Scopos AI for the literature review, and I was initially captivated by how quickly I could grasp the research landscape. Yet I found myself lost in a seemingly endless sea of publications, many themselves AI-generated. I felt oddly relieved when I finally found a paper explicitly stating it was

[2] The title of my autoethnography is inspired by the title of Dell’Acqua et al. (2023)

written without AI assistance. Is writing more efficient with AI? Yes and no. It's brilliant for polishing rough sentences into precise academic English and helping with those perpetual writing challenges – like crafting that one opening sentence. However, the endless possibilities for iterations and revisions can become overwhelming, especially for a perfectionist like me. While I generally maintain a critical eye when reviewing Claude's suggestions, I've learned you can't let your guard down. My habit of last-minute writing once led me to overlook a classic ChatGPT exaggeration in the final sentence of an abstract (it got accepted nevertheless…). AI's greatest contribution? Reducing the solitude of writing and helping to fight doubts! Even if it risks anthropomorphizing, having 24/7 access to feedback, phrasing suggestions, or sentence starters is simply brilliant. The emotional valleys I still experience with every writing project, even after years of experience, feel less deep with Claude by my side.

4. Discussion

For critical reflection, I employ Brommer et al.'s (2023) responsibility framework for AI-assisted research, examining (1) AI's impact on academic integrity principles and (2) the selection, use, and control of AI tools.

(1) AI tools both support and challenge academic integrity principles. They foster deeper reflection on authorship and integrity practices, even for experienced academics. The advent of generative AI necessitates reconsidering established principles of good academic practice - future standards may shift from personal sentence drafting to author verification and endorsement. However, AI tools can compromise research transparency. Their internal mechanisms remain opaque, and comprehensively documenting all prompts, decisions, and refinements proves impractical, necessitating new metrics for adequate transparency.

(2) Selecting appropriate AI tools presents challenges amid rapidly evolving options and changing usage policies. For this study, Claude was chosen over ChatGPT due to data protection considerations and perceived superior text suggestions, though this preference warrants further investigation. For literature reviews, specialized tools like Hesse.ai, Consensus, and Scopus AI were preferred over general-purpose AI due to their access to verified academic sources. Quality control involved maintaining critical distance and verifying language usage independently. Time pressure emerged as a significant risk factor, potentially compromising the necessary critical oversight.

5. Conclusions

This study showed that generative AI tools are fundamentally transforming academic writing practices. The findings suggest that students need structured opportunities to explore AI-assisted writing across all academic writing courses, given the complexity of these tools and the ongoing transformation of academic practices. This approach not only reflects responsible academic teaching but also aligns with European higher education institutions' need to comply with the EU AI Act.

Acknowledgments

The author acknowledges the use of Claude 3.5 Sonnet Pro, Consensus, Hesse.ai, Scopus AI in facilitating various stages of writing and ideation for this paper. All contributions from the AI were reviewed, critically edited, and validated by me to ensure academic rigor and adherence to ethical standards. The author also assessed and addressed potential biases inherent in the AI-generated content. The final content, conclusions, and assertions in this paper are the sole responsibility of the author.

References

Bozkurt, A. (2024). GenAI et al.: Cocreation, Authorship, Ownership, Academic Ethics and Integrity in a Time of Generative AI. *OpenPraxis*, *16*(1), pp. 1–10. DOI: https://doi.org/10.55982/openpraxis.16.1.654

Bozkurt, A., Xiao, J., Farrow, R., Bai, J. Y., Nerantzi, C., Moore, S., Dron, J., Stracke, C. M., Singh, L., Crompton, H., Koutropoulos, A., Terentev, E., Pazurek, A., Nichols, M., Sidorkin, A. M., Costello, E., Watson, S., Mulligan, D., Honeychurch, S., … Asino, T. I. (2024). The manifesto for teaching and learning in a time of generative AI: A critical collective stance to better navigate the future. *Open Praxis*, *16*(4), 487-513. https://doi.org/10.55982/openpraxis.16.4.777

Brommer, S., Berendes, J., Bohle-Jurok, U., Buck, I., Girgensohn, K., Grieshammer, E., Gröner, C., Gürtl, F., Hollosi-Boiger, C., Klamm, C., Knorr, D., Limburg, A., Mundorf, M., Stahlberg, N., Unterpertinger, E. (2023). Wissenschaftliches Schreiben im Zeitalter von KI gemeinsam verantworten. Diskussionspapier Nr. 27. Berlin: Hochschulforum Digitalisierung

Dell'Acqua, F., McFowland III, E., Mollick, E. R., Lifshitz-Assaf, H., Kellogg, K., Rajendran, S., Krayer, L., Candelon, F., Lakhani, K. R., Navigating the Jagged Technological Frontier: Field Experimental Evidence of the Effects of AI on Knowledge Worker Productivity and Quality (September 15, 2023). Harvard Business School Technology & Operations Mgt. Unit Working Paper No. 24-013, The Wharton School Research Paper, http://dx.doi.org/10.2139/ssrn.4573321

Ellis, C. (2004) The ethnographic I: A methodological novel about autoethnography. New York: AltaMira Press.

Elstad, E.; Eriksen, H. (2024) Harnessing AI in Secondary Education to Enhance Writing Competence. arXiv:2412.12117v1. https://doi.org/10.48550/arXiv.2412.12117

EU Artificial Intelligence Act (2024) Regulation (EU) 2024/1689. https://eur-lex.europa.eu/eli/reg/2024/1689/oj/eng

Gimpel, H., Hall, K., Decker, S., Eymann, T., Lämmermann, L., Mädche, A., Röglinger, R., Ruiner, C., Schoch, M., Schoop, M., Urbach, N., Vandirk, S. (2023). Unlocking the Power of Generative AI Models and Systems such as GPT-4 and ChatGPT for Higher Education: A Guide for Students and Lecturers. University of Hohenheim, March 20, 2023.

Gröpler, J. (2023). Schreiben oder schreiben lassen? Forum Bibliothek und Information, 75(7), 366 – 368.

Gröpler, J., Mundorf, M., Wilder, N: AI supported Text Production in the University, in: Christopher A. Nunn and Frederike van Oorschot (eds.): Compendium of Computational Theology 1. Introducing Digital Humanities to Theology, Heidelberg: heiBOOKS, 2024, S. 407–427. DOI: https://doi.org/10.11588/heibooks.1521.c21962

Khalil, M., Er, E. (2023). Will ChatGPT Get You Caught? Rethinking of Plagiarism Detection. In: Zaphiris, P., Ioannou, A. (eds) Learning and Collaboration Technologies. HCII 2023. Lecture Notes in Computer Science, vol 14040. Springer, Cham. https://doi.org/10.1007/978-3-031-34411-4_32

Kobak, D., González-Márquez, R., Horvát, E.-Á., Lause, J. (2024) Delving into ChatGPT usage in academic writing through excess vocabulary. arXiv:2406.07016v2 [cs.CL] https://doi.org/10.48550/arXiv.2406.07016.

Limburg, A., Bohle-Jurok, U., Buck, I., Grieshammer, E., Gröpler, J., Knorr, D., Lira Lorca, A., Mundorf, M., Schindler, K., & Wilder, N. (2023). Zehn Thesen zur Zukunft des Schreibens in der Wissenschaft, Diskussionspapier, Berlin: Hochschulforum Digitalisierung https://hochschulforumdigitalisierung.de/sites/default/files/dateien/HFD_DP_23_Zukunft_Schreiben_Wissenschaft.pdf

Maphoto, K. B., Sevnarayan, K., Mohale, N. E., Suliman, Z., Ntsopi, T. J., & Mokoena, D. (2024). Advancing Students' Academic Excellence in Distance Education: Exploring the Potential of Generative AI Integration to Improve Academic Writing Skills. *Open Praxis*, *16*(2), pp. 142–159. DOI: https://doi.org/10.55982/ openpraxis.16.2.649

Nature. (2023). Tools such as ChatGPT threaten transparent science; here are our ground rules for their use. Nature, 613. DOI: https://doi.org/10.1038/d41586-023-00191-1 ,

Nikolic, S., Sandison, C., Haque, R., Daniel, S., Grundy, S., Belkina, M., Neal, P. (2024). ChatGPT, Copilot, Gemini, SciSpace and Wolfram versus higher education assessments: an updated multi-institutional study of the academic integrity impacts of Generative Artificial Intelligence (GenAI) on assessment, teaching and learning in engineering. Australasian Journal of Engineering Education, 29(2), 126–153. https://doi.org/10.1080/22054952.2024.2372154

O'Connor S, ChatGPT (2023). Open artificial intelligence platforms in nursing education: Tools for academic progress or abuse? Nurse Educ Pract. 2023; 66:103537

Perkins, M. (2023). Academic Integrity considerations of AI Large Language Models in the post-pandemic era: ChatGPT and beyond. Journal of University Teaching & Learning Practice, 20(2). https://doi.org/10.53761/1.20.02.07

PROFiL & Schreibzentrum der LMU (Eds.) (2024): Frag doch ChatGPT? Eine praxisorientierte Handreichung für den gekonnten Umgang mit Sprachmodellen in der Hochschulbildung. München: Ludwig-Maximilians-Universität München.

Simon, J., Spiecker gen. Döhmann, I. & von Luxburg, U. (2024): Generative KI – jenseits von Euphorie und einfachen Lösungen. Diskussion Nr. 34, Halle (Saale): Nationale Akademie der Wissenschaften Leopoldina

Stracke, C. M., Bohr, B., Gabriel, S., Galla, N., Hofmann, M., Karolyi, H., Mersmann-Hoffmann, H., Mönig, J. M., Mundorf, M., Opel, S., Rischke-Neß, J., Schröppel, M., Silvestri, A., & Stroot, G. (2024): Ethische Nutzung von Künstlicher Intelligenz (KI) in der Hochschule – eine Handreichung. Hrsg. v. Netzwerk „Ethische Nutzung von KI". https://doi.org/10.5281/zenodo.10793844

Weizenbaum, J. (1966). ELIZA. A computer program for the study of natural language communication between man and machine. *Communications of the Association for Computing Machinery*, *9*, 36–45. https://doi.org/10.1145/365153.365168

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

ENHANCING RURAL LIFE SCIENCES TEACHERS' PRACTICAL WORK COMPETENCIES THROUGH A COLLABORATIVE APPROACH TO TEACHER PROFESSIONAL DEVELOPMENT

Nomzamo Xaba, Mayaba Brian Nhlumayo, & Aviwe Sondlo
Mathematics, Science and Technology Education, University of Zululand (South Africa)

Abstract

This study explores how rural Life Sciences teachers' practical work competencies can be enhanced through a collaborative approach to teacher professional development. Practical work is central to the South African Life Sciences curriculum; however, many rural science teachers face challenges due to geographical isolation, resource constraints, and limited access to training. While the KwaZulu-Natal Department of Education offers workshops, these primarily target Grade 12 teachers and are aimed at addressing persistent matric underperformance. Diagnostic reports from 2020 to 2024 have consistently shown that most matric learners struggle with practical-based questions, reflecting a broader issue which may suggest that many Life Sciences teachers, particularly in rural areas, either do not conduct practical work or lack the necessary competencies. Also, existing workshops do not seem to adequately equip teachers with practical work skills suited to resource-limited contexts. Consequently, little is known about effective interventions for enhancing Life Sciences teachers' practical competencies, which are critical to improving learner outcomes. This participatory action research study explores whether a local university, in collaboration with education stakeholders, can contribute towards upskilling in-service Life Sciences teachers in rural schools, particularly those teaching Grades 10 and 11 by enhancing their practical work competencies. The results of the study showed that to support practical work competencies in rural contexts, professional development should (i) be collaboratively designed and responsive to local needs; (ii) include hands-on training with follow-up support; (iii) provide curriculum-aligned, low-cost resources; and (iv) foster peer networks for continued learning and reflection. The findings from the analysis reveals that long-term success depends on sustained partnerships between universities, schools, and education departments, with teachers actively contributing to shaping and improving professional development workshops.

Keywords: *Practical work, teacher professional development, improvisational teaching and learning strategies and collaborative partnerships.*

1. Introduction

In South Africa, practical investigations are an essential component of the Life Sciences curriculum, particularly in the Further Education and Training (FET) phase (Grades 10–12). According to the Curriculum and Assessment Policy Statement (CAPS) (Department of Basic education [DBE], 2011), these investigations are designed to cultivate learners' inquiry skills, scientific reasoning, and understanding of scientific processes. However, in many rural schools, practical work is not being implemented effectively due to lack of infrastructure and underlying teacher beliefs and attitudes (Xaba & Sondlo, 2022). The Life Sciences matric diagnostic reports of over the past five years (2019-2022) from the DBE, have consistently highlighted poor learner performance in questions requiring experimental design, data analysis, and scientific interpretation. This trend signals a deeper pedagogical issue: the underdevelopment of Life Sciences teachers' practical work competencies and the lack of systemic support for their professional growth especially in under-resourced settings. In provinces such as KwaZulu-Natal, rural teachers face significant contextual challenges including inadequate laboratory infrastructure, shortages of consumables and equipment, overcrowded classrooms, and limited access to subject-specific professional development due to their isolated geographical locations. While teacher workshops are widely recognised as a crucial mechanism for building teachers' content knowledge and pedagogical content knowledge (PCK), the current models of workshops delivery seem to be often superficial, exam-focused, and short-term. These workshops typically target Grade 12 content, neglecting foundational teaching in Grades 10 and 11, and fail to provide sustained, context-sensitive support that empowers teachers to adapt practical activities using

locally available materials. As such, the professional development landscape often reproduces inequality, leaving rural teachers isolated and underprepared to meet curriculum demands.

Research by Adebayo et al. (2020), Kibirige et al. (2021), and Chuene and Tiane (2024) highlights the importance of teacher PD programmes that are collaborative, situated, and continuous. Chuene and Tiane (2024) emphasise that science teachers in rural contexts require more than 'content updates', but rather need structured opportunities to share practices, co-develop teaching strategies, reflect on their own learning, and receive ongoing support that is tailored to their realities. Moreover, in-service teachers, particularly those who graduated more than a decade ago, frequently report insufficient training in conducting and assessing practical work, further reinforcing the need for responsive professional development initiatives. Thus, the key guiding research question of this paper was "How can rural Life Sciences teachers' practical work competencies be enhanced through a collaborative approach to teacher professional development?" The paper contributes to the growing body of literature on equitable, sustainable models of professional development for science educators in marginalised contexts. It also offers practical insights for policymakers and higher education institutions aiming to enhance the impact of teacher workshops and other forms of in-service training in rural schools.

2. Rural science teachers' competencies for integrating practical investigations

CAPS allows teachers a degree of flexibility to adapt practical investigations using locally available materials. However, this assumes that teachers possess the pedagogical content knowledge (PCK) required to design meaningful investigations, improvise effectively, and link theory with practice. Boateng and Maliwa (2024) assert that PCK plays a critical role in shaping learner achievement, and its absence is particularly pronounced in rural schools. Several studies point to significant gaps in Life Sciences teachers' ability to conduct scientific investigations due to limited training in inquiry-based methodologies (Chuene & Tiane, 2024; Furiwai & Singh-Pillay, 2020). Many teachers are unprepared to compensate for the lack of resources through innovative teaching strategies, and few have been exposed to digital laboratories or virtual simulations that could serve as alternatives. As a result, their teaching remains rooted in traditional content transmission, with limited learner engagement or application of investigative skills. Chuene and Tiane (2024) emphasises that strengthening teachers' capacity to improvise with available materials and integrate digital tools is essential. Similarly, Boateng and Maliwa (2024) advocate for equipping teachers with both theoretical knowledge and hands-on skills to foster inquiry-based learning. Teachers themselves have acknowledged a lack of sufficient training and support from subject advisors, reinforcing the need for targeted professional development (Chuene & Tiane, 2024). Communities of practice have been suggested as a promising model to improve instructional practices. By providing platforms for collaboration, knowledge-sharing, and mutual support, such communities can enhance teachers' confidence and competence in delivering practical lessons (Chuene & Tiane, 2024). However, for these interventions to be successful, they must be rooted in an understanding of the specific constraints faced by rural teachers.

3. Teacher professional development in the South African context

Given the competency gaps and resource constraints identified, teacher professional development (PD) emerges as a critical lever for change. Teacher PD refers to structured initiatives aimed at enhancing teachers' knowledge, instructional techniques, and professional growth (Ajani, 2020; Gumbo, 2020). When well-designed, teacher PD has the potential to improve PCK and support the implementation of inquiry-based learning in science classrooms (Xaba &Sondlo, 2022). However, research has highlighted serious shortcomings in existing teacher PD programmes for South African teachers. Ajani (2020) and Gumbo (2020) argue that many teacher PD workshops are often generic in design, fail to focus on subject-specific challenges, and are disconnected from the daily realities of rural classrooms. Teachers are often treated as passive recipients of knowledge, which limits the effectiveness of PD efforts. Mxenge and Bertram (2023) confirm that short-term workshops rarely translate into sustained improvements in classroom practice. Despite these challenges, context-sensitive PD models show promise. Sibisi and Sibisi (2024) report that subject-specific interventions targeting Life Sciences teachers in under-resourced schools led to measurable improvements in both conceptual understanding and classroom application. However, they caution that such gains are limited when resource provisioning is not addressed concurrently. Gumbo (2020) calls for ongoing evaluation to track the long-term effects of PD, while Akuma and Callaghan (2020) argue for the integration of inquiry-based methodologies. Furthermore, Furiwai and Singh-Pillay (2020) recommend aligning PD with CAPS goals and ensuring that participating schools receive appropriate teaching materials.

4. Method

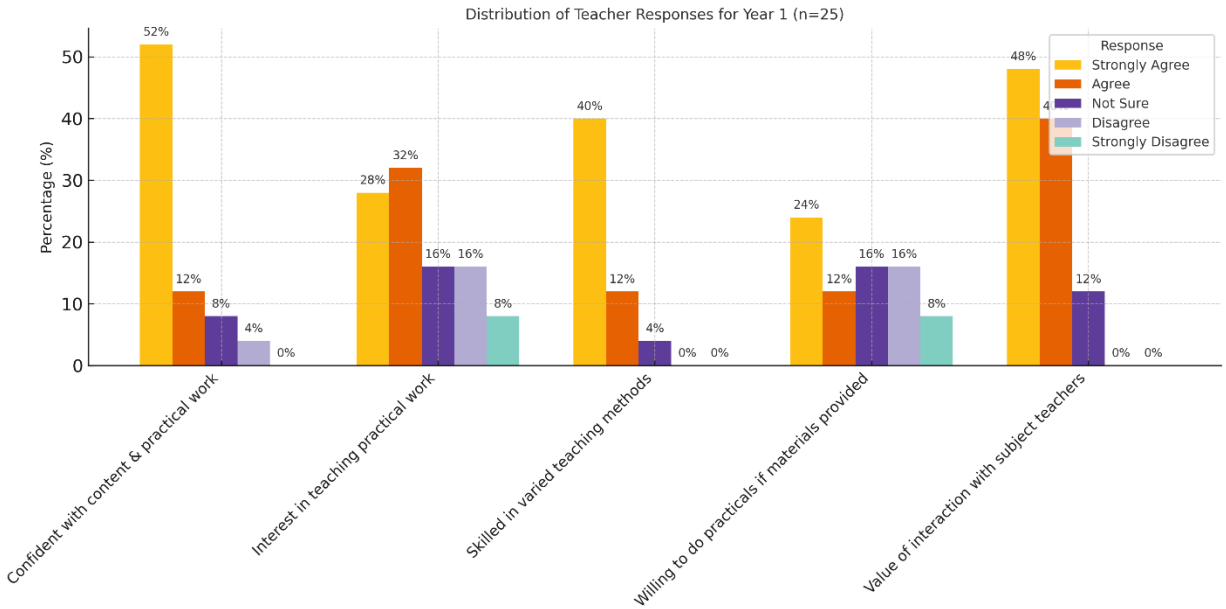
A mixed-methods approach (Creswell, 2014) was employed to capture both quantitative patterns and qualitative insights. Twenty-five Grade 10 and 11 Life Sciences teachers from secondary schools in Zululand, KwaZulu-Natal were purposively selected based on school contexts marked by limited resources, poor performance in school-based assessments (SBA) for practical work, and geographic isolation. Teaching experience among participants ranged from 1-25 years. The study adopted a participatory action research (PAR) design embedded within a bigger project of a teacher PD initiative which is in collaboration with the KwaZulu-Natal DBE and conducted over four workshop cycles yearly. PAR was selected for its emphasis on collaboration, context-sensitive problem-solving, and iterative reflection through cycles of planning, acting, observing, and reflecting (Cresswell,2014). This design was well suited to working alongside Life Sciences teachers to co-develop practical teaching strategies responsive to their realities. Prior to each session, subject advisors consulted with the participating teachers to determine the content and practical activities to be covered during the two-day PD workshops, which informed planning in collaboration with university-based science education specialists. At the end of each session, reflective discussions were held to review what worked, identify gaps, and plan improvements for the next PD workshop. This design allowed the project to remain responsive to the evolving needs and insights of the participating Life Sciences teachers.

Data collection involved a Likert-scale questionnaire with both open and closed-ended items, administered during the fourth teacher PD workshop cycle. Items focused on confidence in teaching content and practical work, skill development, collaboration, interest in integrating practical work and improvised teaching strategies. The questionnaire was kept brief to encourage authentic responses during the limited five-hour sessions held over two days of each term. Additionally, one-hour semi-structured interviews were conducted with teachers who volunteered, offering deeper insight into the motivations and contextual factors underlying their questionnaire responses. Interviews were audio-recorded, transcribed, and analysed thematically. Quantitative data were analysed descriptively using frequencies and percentages. Researcher triangulation was applied during the coding process to ensure rigour and consistency of the data and findings. Ethical clearance was obtained from the university and the DBE. All participants gave informed consent, and pseudonyms were used to protect confidentiality, with participation remaining voluntary throughout.

5. Data analysis and findings

The findings reflect teacher responses during Year 1 of the teacher PD workshops (n=25) and align with the study's aim to enhance practical teaching competencies in rural contexts, see Figure 1 below.

Figure 1. Descriptive data of the teachers' survey responses.



As depicted in Figure 1 above, over 64% of teachers reported increased confidence in managing content and practical work, with 52% strongly agreeing. This indicates that structured, hands-on training can indeed strengthen teacher self-efficacy which is an essential factor in effective Life Sciences instruction. While 60% expressed interest in conducting practical work, a significant 24% remained hesitant. One teacher noted, "*…some of us are old and we really want to gain more knowledge about practical work so we can help our learners perform better, especially since most of us teach in schools lacking resources... We often rely on textbooks to facilitate practical engagement, which is frustrating but what can we do that is all we know and are used to...*" The remarks reveal the critical tensions between capability and motivation as well as experiential and/or generational barriers. Thus, showing that motivation alone cannot overcome deeply rooted systemic and behavioural or attitude barriers. For teacher PD initiatives to be enhanced, they must focus beyond skill-building but rather aim to boost confidence, address deeply rooted traditional instructional habits, boost and provide sustained as well as resource-sensitive support that enables meaningful pedagogical transformation.

The data also reveals that only 36% indicated readiness to implement practicals even if materials were provided, suggesting that resources alone are insufficient without clear guidance, planning support, and time allocation. As one teacher shared "*...some of our schools do not even have electricity or any resources so it will be difficult for us to do some of the practical work or even use the simulations that you have shown us…*" This reinforces the importance of continuous and hands-on focused workshops, embedded in real teaching contexts. In response, the university procured and distributed practical science materials to participating schools in the following year (see Figure 2 below). This shift demonstrates the importance of educational partnerships in ensuring the sustainability and effectiveness of teacher PD programmes.

Figure 2. Resources procured by the university and distributed to the participating teachers at each school.

This practical support in the end of Year 1 likely contributed to improved teacher responses and enhanced classroom implementation.

Although 52% felt skilled in using varied teaching methods and technologies, 44% disagreed or felt unprepared. These results support Mxenge and Bertram (2023)'s findings that teacher PD need to be iterative, rather than one-off or short term. Encouragingly, 88% valued collaboration with peers, affirming the importance of professional learning communities. As one teacher shared, "*...even planning together helped us feel less alone.*" This confirms the value of structured, peer-based support in overcoming isolation and fostering sustained growth.

6. Discussion of results and conclusion

To respond to the research question that guided the study which is "How can rural Life Sciences teachers' practical work competencies be enhanced through a collaborative approach to teacher professional development?" The results of the study showed that to support practical work competencies in rural contexts, professional development should (i) be collaboratively designed and responsive to local needs; (ii) include hands-on training with follow-up support; (iii) provide curriculum-aligned, low-cost resources;

and (iv) foster peer networks for continued learning and reflection. The findings from the analysis reveals that long-term success depends on sustained partnerships between universities, schools, and education departments, with teachers actively contributing to shaping and improving PD workshops.

References

Adebayo, K. A., Ntokozo, N., & Grace, N. Z. (2020). Availability of educational resources and student academic performances in South Africa. *Universal Journal of Educational Research, 8*(8), 3768-3781. https://doi.org/10.13189/ujer.2020.080858

Ajani, O. A. (2020). Teachers' professional development in South African high schools: How well does it suit their professional needs? *African Journal of Development Studies, 10*(3), 59-78. https://doi.org/10.31920/2634-3649/2020/10n3a4

Akuma, F. V., & Callaghan, R. (2020, April). Gaps in teacher competencies linked to inquiry-based practical work in certain resource-constrained South African physical sciences classrooms. *In Journal of Physics: Conference Series*, *1512*(1), 012035.

Boateng, S., & Maliwa, B. (2024). In-depth analysis of contributing factors impacting Grade 12 learners' performance in Life Sciences "Investigation Questions": A South African case study. International *Journal of Learning, Teaching and Educational Research, 23*(2), 227-247. https://doi.org/10.26803/ijlter.23.2.11

Chuene, D., & Teane, F. (2024). Resource inadequacy as a barrier to effective curriculum implementation by Life Sciences teachers in South Africa. *South African Journal of Education, 44*(2), 1-10. https://doi.org/10.15700/saje.v44n2a2387

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approach* (4th ed.). Thousand Oaks, CA: Sage.

Department of Basic Education. (2011). *Curriculum and Assessment Policy Statement (CAPS): Life Sciences Grades 10–12*. Pretoria: Government Printing Works.

Department of Basic Education. (2020–2024). *Diagnostic Report: National Senior Certificate Examination – Life Sciences*. Pretoria: Department of Basic Education. Available at https://www.education.gov.za

Furiwai, S., & Singh-Pillay, A. (2020). The views and experiences of Grade 10 Life Sciences teachers on the compulsory practical examination. *Perspectives in Education*, *38*(1), 242-254. https://doi.org/10.18820/2519593X/pie.v38i1.17

Gumbo, M. T. (2020). Professional development of Technology teachers: Does their training meet their needs? *Perspectives in Education, 38*(1), 58-71. https://doi.org/10.18820/2519593X/pie.v38i1.5

Kibirige, I., Teffo, W. L., & Singh, S. (2022). Investigating teachers' perceptions of facilitating scientific investigations. *Eurasia Journal of Mathematics, Science and Technology Education*, *18*(2), 1-18. https://doi.org/10.29333/EJMSTE/11511

Mxenge, N., & Bertram, C. (2023). Teacher learning and collaboration in a Life Sciences cluster in South Africa. *South African Journal of Education, 43*(4), 1-9. https://doi.org/10.15700/saje.v43n4a2251

Sibisi, N. T., & Sibisi, N. N. (2024). Enriching professional development in disadvantaged schools through the Targeting Talent Programme (TPP) Educators Enrichment Programme: Insights from Math and Science educators. *International Journal of Learning, Teaching and Educational Research, 23*(3), 548-567. https://doi.org/10.26803/ijlter.23.3.27

Xaba, N., & Sondlo, A. (2022). Using a learner-based activity approach in developing science teachers' readiness in inquiry-based learning. In *Education and New Developments 2022 – Volume I* (pp. 340-343). Lisbon: inScience Press.

RISK OF MISINFORMATION IN THE USE OF LLM BY UNIVERSITY STUDENTS

Gibrán Aguilar Rangel*, Claudia Cintya Peña Estrada*,
Omar Bautista Hernández*, & Luis Ambrosio Velázquez García**
Accounting and Management Faculty, Universidad Autónoma de Querétaro (Mexico)
**PhD., **ISC.*

Abstract

In recent years there has been an exponential growth in the use of artificial intelligence (AI) by university students, specifically large language models (LLM) like ChatGPT, this has led to a discussion about the ethics of using these models, especially when it comes to solving assignments and school projects. One point that is often overlooked is the misinformation these models can generate if not used properly, since students can trust the results, they get without verifying it. For this research we aimed to understand how university students use LLM and how they interpret the results they get. We designed a short questionnaire that was sent online to students in the Universidad Autonoma de Queretaro, in Mexico, results were anonymous in order to encourage truthful responses. The responses show that a lot of students are using LLMs to search for information, many times over search engines, and that even though they might detect some mistakes, there´s a lack of awareness on the risk of misinformation.

Keywords: *AI, misinformation, LLM, ChatGPT.*

1. Introduction

Encyclopedias were one of the earliest attempts to concentrate lots of information from different topics in a single source, this was no easy task of course, and some encyclopedias could span several volumes and be quite expensive. The advent of the internet promised to achieve the task of concentrating human knowledge into an accessible source, however, a big drawback was soon revealed, since anyone could publish information online, the quality of that information could be questionable, unlike encyclopedias that were reviewed prior to publication, on the internet anyone could publish anything and it was up to the user to distinguish fact from fiction. With time, some measures were taken in order to create a more verifiable environment, academic search engines, digital encyclopedias, online peer reviewed articles, among others.

Around this time one source started gaining traction among students and general audiences while being criticized as unreliable by academics, an always updatable online encyclopedia called Wikipedia. Its popularity stemmed from an ever-growing database that could give information about almost any topic, and that it was up to date in the most important (or popular) subjects. The criticism (rightly) pointed out that in theory anyone could edit the site, so the information could be not very reliable, so it was advised students shouldn't rely on this source due to concerns of the information being wrong. While these concerns were valid, Wikipedia's way of working has its own safeguards to avoid wrong data or correct it as soon is detected, that is not to say the system is flawless, less visited topics can have wrong data undetected for a long time and since the editors are a relatively small group of volunteers, they may imprint their own biases into the editing of the information (Konieczny, 2021).

With the introduction of virtual assistants, the goal was to provide easy answers to questions an user may have, so instead of the user searching through results on a search engine, the virtual assistant would provide it with the most relevant result to their question, in theory scouting through a database or a search engine, initial results were mixed, from Siri by Apple in 2011, to Alexa by Amazon in 2014, not all answers were relevant or some were plain wrong, other than basic tasks or basic questions these assistants were not as revolutionary as they were initially presented to be. In 2017 however, there was a breakthrough in how natural language processing worked, a neural network model named Transformer (Vaswani et al., 2017). This technological breakthrough had the effect of accelerating the rate in which these models could analyze texts and create statistical predictions in order to generate answers, this resulted in the creation of

large language models (LLMs) that were capable of creating seemingly original texts, derived from the analysis of large datasets, the most famous being ChatGPT.

The main appeal of a LLM is that it´s capable of understanding natural language, that is a person can ask a question like it would do to another individual and the model will understand it and (ideally) answer with the same language the correct response. There's a couple of problems with this approach, the main being that the ideal of right answers all the time is not being achieved, LLMs depend on the data they´re trained on, and said data can contain wrong information, since these models don´t have the ability to distinguish correct data from incorrect one, they can present wrong answers as being right (Barman et al., 2024). The other risk has to do with malicious intent, individual can make use of LLMs to knowingly distribute misinformation, thus misleading people to believe wrong affirmations (Park et al., 2024).

2. Methodology

The main objective was to identify the level of understanding of university students about the accuracy of the responses they might get when using a large language model (like ChatGPT). Another objective was to determine how students are using the LLM and their awareness in the topic of hallucinations.

Since the topic of the use of LLM to assist in academic workload is still a sensitive topic, the survey was anonymous, it was distributed via a messaging app and the platform used was Google forms with no email collection, all of this so the students could really feel their answers couldn't be traced back and would answer honestly. We obtained a total of 308 answers, all of them students at the Autonomous University of Queretaro, Mexico. There were 10 closed questions, one semi-open question and one open question so students could give their personal opinion about LLM.

3. Results and discussion

In the following table (Table 1) we present the results of the survey.

Table 1. Results of the survey.

QUESTION	OPTIONS	
HOW FREQUENTLY DO YOU USE CHATGPT OR OTHER AI MODELS?	Several times a day	56
	At least once a day	48
	4-5 times per week	38
	A couple times a week	116
	Occasionally (a couple times a month	50
WHAT DO YOU USUALLY USE IT FOR?	Solving doubts	220
	Search for information	214
	Summarize articles	82
	Writing assignments	40
TO SEARCH INFORMATION, DO YOU CONSIDER CHATGPT THE SAME AS GOOGLE OR OTHER SEARCH ENGINE?	Yes, they´re similar	116
	No, ChatGPT is better	86
	No, Google is better	36
	Yes, but I prefer Google	20
	Yes, but I prefer ChatGPT	50
WHICH SOURCE IS MORE TRUSTWORTHY, WIKIPEDIA OR CHATGPT?	Wikipedia	28
	ChatGPT	214
	Neither	66
HOW DO YOU CONSIDER THE INFORMATION THAT CHATGPT GIVES?	Absolutely trustworthy	8
	Generally reliable	148
	Sometimes reliable, sometimes not	146
	Absolutely unreliable	6
	True	212

I'VE DETECTED WRONG INFORMATION IN THE RESULTS PRESENTED BY CHATGPT	False	96
HOW FREQUENTLY HAVE YOU DETECTED WRONG INFORMATION?	Each query	0
	Very regularly	24
	Regularly	34
	Occasionally	78
	Very occasionally	100
IF YOU DOUBT OF AN ANSWER PROVIDED BY CHATGPT DO YOU USE ANY OTHER SOURCE TO FACTCHECK?	Yes	284
	No	24
IF YOU DO, WHICH ONE DO YOU USE?	Google	232
	Another AI	24
	Wikipedia	6
	Other	26
HAVE YOU USED CHATGPT FOR MATH PROBLEMS?	Yes	170
	No	138
HOW WERE THE RESULTS FOR MATH PROBLEMS?	Satisfactory	30
	Somewhat satisfactory	84
	Mixed	54
	Unpredictable	16

While the goal of the survey was to make students feel at ease so they could answer as honestly as possible, there´s room for potential distrust since the survey comes from a teacher at their university and they could feel its kind of a trap. That said, the results are interesting since they confirm some theories about how students perceive the LLM. The first couple of questions were intended to know how frequently do students us it and what for, while the percentage of students that admitted using it for writing assignments was on the lower end, this was expected since, as mentioned earlier, there´s an element of distrust, this is not as relevant since it wasn´t the main focus of this research, there are other studies that prove that given the opportunity, students will use it to solve assignments unethically (Dakakni & Safa, 2023).

The next set of questions dealt with the main topic of interest in this research, information and how do they perceive it, most of the students admitted using a LLM to search for information. A worrying answer is that most students considered that the LLM was the same as a search engine with a not so low percentage considering it better in order to search information, and while it may be common knowledge to most researchers and academics who work with LLM that they present a serious hallucination problem, that is, presenting wrong or biased information as if it were true (Lavrinovics et al., 2025), the students surveyed seemed not aware of this. In another interesting result, most students considered LLMs more trustworthy than Wikipedia, which may be derived of many years of teachers calling Wikipedia untrustworthy even if there´s evidence that nowadays it has a high degree of factual information (Konieczny, 2021).

A considerable number of students stated detecting wrong information in the results presented by the LLM, this makes the question about search engine vs LLM more interesting, that is, even if they detect wrong information in the LLM they consider it equal or better than a search engine, this might have to do with convenience, since a LLM will present just the information requested, while the search engine presents several results that need to be browsed, however, it can be said that results by a LLM have to go through a similar process, since they have to be verified, there´s a need for teaching students how to deal with this inconsistency, and a branch called AI ethical principles might gain some traction in the near future (Kajiwara & Kawabata, 2024).

Finally there were some questions related to LLMs and their ability with solving math problems, if a student has been following a math course and tries to solve problems using a LLM, chances are there might be more than a few answers wrong, LLMs are notably unpredictable at solving math problems (López Espejel et al., 2023), it is worth noting that in this aspect, a considerable number of students don´t use LLMs to try and solve math problems, this might be due to the nature of the courses, in which practice is more important than just getting a right answer, and the few students that answered that the results were satisfactory, may be lagging behind on the math course and unable to distinguish small mistakes.

4. Conclusions

For the foreseeable future, LLMs are here to stay, and as such they should be treated with the same caution as other tools, in the introduction we mentioned the Wikipedia example, when it surpassed the encyclopedia a lot of people warned about the risks, possible unverified information, the possibility of being edited by anyone, etc., and while a lot of this concerns have been fixed, the stigma continues to some extent, this has not been the case with LLMs so far, most concerns have to do with academic dishonesty, ethical concerns, etc., and while there are undoubtedly some studies about the misinformation problem and the hallucinations, they have failed to reach the general population that regards LLMs as almost infallible answering machines.

There needs to be an approach on educating students and teachers about LLMs, how they work, what they can or cannot do, what are hallucinations and how do they happen, and specially the risks of misinformation that they represent. There are a lot of proposals on how to use LLMs that do not address these concerns, they center on how to write prompts, for example, while failing to address that the best written prompt can still give you a wrong answer.

References

Barman, D., Guo, Z., & Conlan, O. (2024). The Dark Side of Language Models: Exploring the Potential of LLMs in Multimedia Disinformation Generation and Dissemination. *Machine Learning with Applications*, *16*(March), 100545. https://doi.org/10.1016/j.mlwa.2024.100545

Dakakni, D., & Safa, N. (2023). Artificial intelligence in the L2 classroom: Implications and challenges on ethics and equity in higher education: A 21st century Pandora's box. *Computers and Education: Artificial Intelligence*, *5*(August), 100179. https://doi.org/10.1016/j.caeai.2023.100179

Kajiwara, Y., & Kawabata, K. (2024). AI literacy for ethical use of chatbot: Will students accept AI ethics? *Computers and Education: Artificial Intelligence*, *6*(March), 100251. https://doi.org/10.1016/j.caeai.2024.100251

Konieczny, P. (2021). From Adversaries to Allies? The Uneasy Relationship between Experts and the Wikipedia Community. *She Ji*, *7*(2), 151-170. https://doi.org/10.1016/j.sheji.2020.12.003

Lavrinovics, E., Biswas, R., Bjerva, J., & Hose, K. (2025). Knowledge Graphs, Large Language Models, and Hallucinations: An NLP Perspective. *Journal of Web Semantics*, *85*(December 2024), 100844. https://doi.org/10.1016/j.websem.2024.100844

López Espejel, J., Ettifouri, E. H., Yahaya Alassan, M. S., Chouham, E. M., & Dahhane, W. (2023). GPT-3.5, GPT-4, or BARD? Evaluating LLMs reasoning ability in zero-shot setting and performance boosting through prompts. *Natural Language Processing Journal*, *5*(August), 100032. https://doi.org/10.1016/j.nlp.2023.100032

Park, P. S., Goldstein, S., O'Gara, A., Chen, M., & Hendrycks, D. (2024). AI deception: A survey of examples, risks, and potential solutions. *Patterns*, *5*(5), 100988. https://doi.org/10.1016/j.patter.2024.100988

Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, Ł., & Polosukhin, I. (2017). Attention is all you need. *Advances in Neural Information Processing Systems*, *2017-Decem*(Nips), 5999-6009.

ARTIFICIAL INTELLIGENCE ASSESSING CONTENT-FOCUSED SHORT ANSWERS

Juuso Rytilahti, Erkki Kaila, & Erno Lokkila
Department of Computing, University of Turku (Finland)

Abstract

The capabilities of Artificial Intelligence (AI), and specifically large language models (LLMs) have changed the way teachers work. Using LLM or other AI-assisted tools to help review student submissions has quickly become common practice. These AI-driven automatic assessment tools still have a lot of open questions regarding their effectiveness, performance, and reliability. In this study, we observe the LLMs' capabilities to assess textual answers. The data set used consisted of 31 different computer science-related questions and 2981 answers written in English with detailed feedback and the correct answers. The LLM we used was GPT-4o from OpenAI. At first, the performance of the LLM was tested against a single question present in the data set producing scores for all of its answers (N=82) using multiple different variations of settings. The best-performing approach was then used to process the full data set. With the full set, the model got the exactly correct evaluation in 41,3% of the cases. With an accepted error margin of ±20%, the correctness was 74.7%. When observing the fully correct answers in the set (N=1802), the model was able to correctly identify 51.4% of them. The results can be used to guide future research endeavors in AI-driven automatic assessment research and to guide teachers on how to improve the performance of educational use of LLMs in different ways.

Keywords: *Large language models, automatic assessment, content-focused short answers.*

---

1. Introduction

Large language models (LLM) have gained popularity as teaching-assisting tools. Their performance across various tasks is quite impressive. This study utilizes OpenAI's GPT-4o, one of the most popular state-of-the-art models available to assess short-answer data. One of the problems in LLM-based evaluation of student answers on courses is the need to specifically fine-tune a model with a specific set of questions and answers. As there are numerous courses where the amount of student submissions is not enough for fully creating custom AI models, the eyes of the educators turn toward LLMs without any specific fine-tuning, utilizing instead their performance on tasks based only upon user input. This creates a need to understand the best practices for achieving the best possible results.

This article aims to answer the following research questions:

RQ1. How reliably can an LLM assess short answers related to computer science?

RQ2. Is there a difference in results if we only consider answers that had received full points?

2. Background and related work

The usage of LLMs is not without limitations. LLMs output can also contain non-accurate information. This phenomenon is known as hallucination. LLM is hallucinating when the output contains plausible but factually incorrect or nonsensical information (Xu, Jain, & Kankanhalli, 2024). Additionally, in multiple-choice questions, the placement of choices, as well as the used symbols have been shown to greatly affect the LLM's performance on different multiple-choice-question benchmarks (Alzahrani et al., 2024). Furthermore, the current models are not able to formally reason but instead seem to follow the patterns that they have seen in their training data, as suggested by research conducted by Mirzadeh et al. (2024) in evaluating current state-of-the-art performance in mathematical reasoning tasks. The different model parameters affect it as well. One of these parameters is temperature. Temperature affects the likelihood of which the next token (word or part of word) will be in the model's output. Lower temperature leads to more consistent outputs, while high temperature creates more diverse output. Often temperature is claimed to control the "creativity" of the LLMs output, but the effects of it are not that straightforward, as noted by Peeperkorn et al. (2024).

Gao et al. (2024) noted in their systematic review that short-answer questions are a common focus of automatic assessment systems. They also noted that most current systems for automatically assessing text-based responses focus on assigning numerical values or automatic classification based on, for example, labels to provide feedback.

The performance of LLMs in auto-assessment of written works has been previously studied. Bui et al. (2024) utilized GPT-3.5 through web-UI for evaluating 200 argumentative essays comprised of 200-300 words and found that GPT-3.5 seemed to lack consistency across two independent rounds of scoring and that the gradings did not align closely with an experienced human reviewer. It should be noted that they utilized UI-version (higher temperature), which was likely at least partly the culprit. Flodén (2024) did a similar study utilizing GPT-3.5, automatically assessing 463 student answers. They produced a review three times using a specific prompt, and then averaged the gained grades, noting that "70% of ChatGPT's gradings were within 10% of the teachers' gradings and 31% within 5%". Kortemeyer, G. (2024) examined GPT-4 performance on short answer grading (ASAG) utilizing datasets Beetle and SciEntsBank. They found that the GPT-4 performs similarly to hand-engineered models but is worse than the pre-trained LLMs that received specialized training.

3. Research setup

The data set utilized in this study was Short Answer Feedback (SAF) (Filighera et al., 2022). The data set consists of college-level answers from computer science, more specifically communication networks topic. The data set is anonymized, licensed with cc-by-4.0, and retrieved from Hugging Face (Short Answer Feedback Interest Group 5, n.d.). For a more detailed explanation of the annotation process of the used data set, please refer to the original paper.

While the original data set contains answers from both German and English, this study only utilizes the English version. In this study, the utilized dataset consisted of 31 college-level English questions with a total of 2981 answers. Maximum scores of the questions were parsed from the data set. To unify the scoring, and make worded scoring a feasible approach, the scores were normalized to the scale of 0…1, rounding to one decimal (e.g., 0.25 was transformed to 0.3) before they were run through the pipeline. We then defined our acceptable threshold value to be 20%, which corresponds to two categories. This means that the grade given by the AI tool is considered acceptable if it is within the defined threshold.

The tool used for automatic assessment is open-source and publicly available at https://gitlab.utu.fi/tech/soft/tools/edu-ai-tools/TekstiArv. The examples used were randomly picked. Alzahrani et al. (2024) presented in their study that in multiple-choice questions (MCQs) the performance of the models is affected by the order of the questions (also known as position bias). We tried to mitigate this by shuffling and randomly selecting the essays used in the examples. The model used for evaluation was GPT-4o (gpt-4o-2024-08-06) from OpenAI.

The input to the model consisted of the following things: a system-role-based message where the model was described to be a teacher and the task was to assess the given answer based on the criteria. The grading scale was also provided. It should be noted that the rubric used for evaluating the answers was not given in the input of the model, as it was not available in the used data set. Then the LLM was given a question, reference answer, and a list of examples, one for each grade (if any were available) in randomized order. In practice, this meant each prompt included on average 5 different examples which included the answer, grade, and feedback of the said answer. The example selection was made randomly. The input given to the LLM in the role of the user included only the student's answer to be evaluated.

4. Methodology

We selected one of the available questions to test with different parameter settings. The decision to exclude initial testing to the submissions of only one question was made due to time constraints. First, we inspected the distribution of different grades on the questions and selected one with a wide grade distribution. Its grading was between 0-1, original grades on one rounding decimal, and the distribution of the answers was positively skewed (right-skewed). The selected question was "WHAT is the purpose of Reverse Path Forwarding and Reverse Path Broadcast? HOW do they work?" with a total of 82 different answers.

Then we ran the pipeline first for numeric grades (0-1, with a step of .1). The experiment was then run again by replacing numerical values with worded evaluations ("*Exceptional*", "*Excellent*", "*Commendable*", "*Proficient*", "*Adequate*", "*Developing*", "*Limited*", "*Deficient*", "*Inadequate*", "*Poor*", "*Failed/Unsubmitted*"). We did this twice, once with the same used examples in the same order, and a second time utilizing randomly selected examples to display the performance difference caused by the selection of the examples. We also ran the pipeline without any additional examples provided to the model

in input (only the grading scale, question, and reference answer provided in the input) with both numeric and worded evaluations to highlight the difference adding examples makes to the performance. All of these were run with temperatures 0.2, 0.4, 0.6, 0.8, and 1. Additionally, we would like to point out that there is a possibility that the performance could differ with a different amount of examples.

We also did a small-scale test of hybrid temperatures of the best-performing temperature from each approach listed in Table 1 by removing the grade from the output. Then we provided the full previous chat history and asked the model to output the grade "again", with the parameter temperature set to 0. For the final testing with the full data set, we selected the best-performing approaches of the initial run. To further validate the results, we decided to run both numeric and worded evaluations with the full data set with the same examples in the same order (Table 2).

5. Results

As noted in Chapter 4, we tested all of the different parameters on the initial testing with temperatures varying between 0.2-1. To display the difference that different settings make, we show the performance of the used model in the 0.2 temperature setting in Table 1 but decided to exclude other temperatures from the table for brevity. The only difference in the same seed was that the grading values were replaced to be either numerical or worded, the number of examples and order of them being the same on the runs with the same seed. On the initial testing, the amount of exact grade matches was low regardless of the used temperature. Additionally, the vast majority of the grades the model had given and fell inside the defined threshold on the full run were less than the ones the human assessor had given (Figure 1). We hypothesize that providing an analytical (or any) rubric in the model's input would likely improve results.

Even with the temperature set as 0.2 (low), there is still quite a significant difference between the different approaches. Additionally, the numeric grading outperformed the worded grading performance when utilizing the same examples in the same order. Although the number of automatically assessed submissions was low on the initial run, this trend was visible across different approaches. We also point out that in some approaches, the most high-performing was of higher temperature than 0.2, but this might be because of the rather limited amount of assessed submissions. Still, the highest performing was the numeric with examples and 0.2 temperature. As noted in the methodology, we tested the best-performing approach by removing the grading and prompted the model to only include in its output the (now) missing grade. Unfortunately, this approach produced inconclusive and mixed results and would need to be done on a larger scale to get anything conclusive.

Figure 1. The normalized distribution of the grades of the full run, worded and numeric with examples in the same order, and the original score is visible to highlight the grade distribution difference.

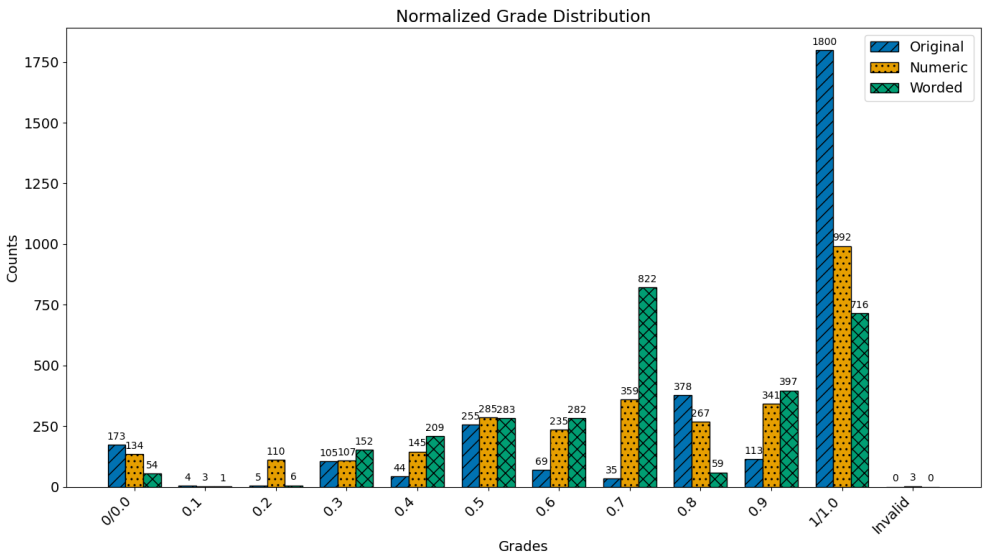


Table1. The values with different configurations in 0.2 temperature (temp.). The "Same order" column means that the examples used in the input were the same in the same order. A total of 82 submissions were used. The accuracy is reported as a percentage.

Type	Had examples	Same order	>=-20%	Equal	<=+20%	Within the threshold (%)
Num.	Yes	Yes	32.9	9.8	15.9	58.6
Num.	**Yes**	**No**	**32.9**	**12.2**	**14.6**	**59.7**
Num.	No	N/A	18.3	8.5	11	53.7
Worded	Yes	Yes	31.7	11	13.4	56.1
Worded	Yes	No	26.8	11	11	48.8
Worded	No	N/A	23.2	6.1	11	40.3

Table 2. The final run consisted of 2981 submissions of the 31 questions, with randomly selected examples (fixed seed). The fully correct (%) is the correctly evaluated full-point answers / actual full points gained submissions in the data.

Type	>=-20%	Equal	<=+20%	Within the threshold (%)	Invalid (%)	Fully correct (%)	Full points amount
Num.	24,1	41,3	9,3	74,7	0	51,4	1802
Worded	24.6	30	9.1	63.7	0,1	36.5%	1802

6. Limitations

The wording, order, selection of examples, and other factors present in the input may affect the results. Furthermore, the validation of the selected (best) approach was done with answers to only one question with 82 answers, which probably is not a sufficient amount to be generalizable. The grade distribution may also skew the results. Furthermore, more diverse prompting strategies could potentially improve the results.

It should also be noted that we looked only at the final produced scoring, ignoring the produced qualitative feedback from our analysis. Inspection of feedback could create a more holistic overview of the LLM capabilities across different reviewing tasks.

As the data set was publicly available on the internet, the data set may be leaked into the used model's (GPT-4o) training data. This may skew the results. As a future work, for validating the results it is strongly recommended to be tested with unforeseen data.

7. Discussion

The results indicate that the LLM-based assessment is not quite yet ready to be utilized as a sole method for grading. The model got a little over 40% of the answers fully correct, but with a threshold of 20 %, the correctness raised to 74.7%. As such, the answer to the first research question is that the LLM cannot do the assessment as reliably as needed in the real-life context. It seems that the fully correct answers are assessed a little bit better (51.4%), so the answer to the second research question is positive.

The absence of a well-designed rubric from the input should be noted, as the LLM could only rely on the input given (grading scale, question, reference answer, and examples). The presence of a rubric could likely improve the results further. A decision was made to not include a rubric, as it was absent from the data set, and producing one with LLM might have a caveat: Wu et al. (2024) noted that a gap exists between LLM and human-generated rubrics. The grading results using numeric evaluation outperformed worded grading. It should be noted that the input did not include the definition of the worded grades.

We also want to highlight that LLMs are already used for directly providing students with interactive feedback. Hong et al. (2024) introduced CAELF, an interactive agent to produces interactive feedback with grading automatically to students. These and previous results from other studies raise a question of how these systems should be used. As the only method for assessment, the models clearly are not sufficient. However, in the case of providing a student additional feedback, we feel that, at least with the current state-of-the-art, LLMs could be useful tools. Moreover, such tools can be valuable assets in direct student use as well, as long as the students are also encouraged to challenge the model's output and be reminded about the importance of critical thinking.

8. Conclusion and future work

The results of this study seem to suggest that GPT-4o seems to give lower grades compared to the human assessors, and regardless of set-up, the numeric grading seems to outperform worded grading. Although the initial run was done on a low number of 82 submissions, the results indicate that a lower temperature seems to provide better results. All in all, the results still indicate that as a sole assessment tool, the quality of LLM is not yet at a good enough level.

The presented study can be used to guide future research endeavors. The approaches used provide valuable insights for researching LLM's capabilities in the automated assessment of written works. Testing with different grading scales, as well as removing the final grade and injecting it again with a lower temperature setting should be examined at a larger scale at a later date. Moreover, testing different subjects and different kinds of questions can provide better results.

Acknowledgements

This work has been supported by FAST, the Finnish Software Engineering Doctoral Research Network, funded by the Ministry of Education and Culture, Finland.

References

Alzahrani, N., Alyahya, H. A., Alnumay, Y., Alrashed, S., Alsubaie, S., Almushaykeh, Y., ... & Khan, H. (2024). *When benchmarks are targets: Revealing the sensitivity of large language model leaderboards*. arXiv preprint arXiv:2402.01781

Bui, N. M., & Barrot, J. S. (2024). ChatGPT as an automated essay scoring tool in the writing classrooms: how it compares with human scoring. *Education and Information Technologies*, 1-18.

Filighera, A., Parihar, S., Steuer, T., Meuser, T., & Ochs, S. (2022). Your answer is incorrect… would you like to know why? introducing a bilingual short answer feedback dataset. In *Proceedings of the 60th Annual Meeting of the Association for Computational Linguistics* (Volume 1, pp. 8577-8591).

Flodén, J. (2024). Grading exams using large language models: A comparison between human and AI grading of exams in higher education using ChatGPT. *British Educational Research Journal*, *51*(1), 201-224.

Gao, R., Merzdorf, H. E., Anwar, S., Hipwell, M. C., & Srinivasa, A. R. (2024). Automatic assessment of text-based responses in post-secondary education: A systematic review. *Computers and Education: Artificial Intelligence*, *6*, 100206.

Hong, S., Cai, C., Du, S., Feng, H., Liu, S., & Fan, X. (2024). *"My Grade is Wrong!": A Contestable AI Framework for Interactive Feedback in Evaluating Student Essays*. arXiv preprint arXiv:2409.07453

Kortemeyer, G. (2024). Performance of the pre-trained large language model GPT-4 on automated short answer grading. *Discover Artificial Intelligence*, *4*(1), 47.

Mirzadeh, I., Alizadeh, K., Shahrokhi, H., Tuzel, O., Bengio, S., & Farajtabar, M. (2024). *Gsm-symbolic: Understanding the limitations of mathematical reasoning in large language models*. arXiv preprint arXiv:2410.05229

Peeperkorn, M., Kouwenhoven, T., Brown, D., & Jordanous, A. (2024). *Is temperature the creativity parameter of large language models?*. arXiv preprint arXiv:2405.00492

Short Answer Feedback Interest Group 5. (n.d.). *saf_communication_networks_english* [Dataset]. Hugging Face. Retrieved January 30, 2025, from https://huggingface.co/datasets/Short-Answer-Feedback/saf_communication_networks_english

Wu, X., Saraf, P. P., Lee, G. G., Latif, E., Liu, N., & Zhai, X. (2024). *Unveiling scoring processes: Dissecting the differences between llms and human graders in automatic scoring*. arXiv preprint arXiv:2407.18328

Xu, Z., Jain, S., & Kankanhalli, M. (2024). *Hallucination is inevitable: An innate limitation of large language models*. arXiv preprint arXiv:2401.11817

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

NATURAL HAZARDS AND ENVIRONMENTAL SUSTAINABILITY: USING ESCAPE ROOM AS A LEARNING TOOL

Giovanna Lucia Piangiamore[1], & Alessandra Maramai[2]
[1]Istituto Nazionale di Geofisica e Vulcanologia Sezione Roma 2 - Sede di Lerici (Italy)
[2]Istituto Nazionale di Geofisica e Vulcanologia Sezione Roma 1 (Italy)

Abstract

Keeping the attention of students is one of the most difficult challenges teachers have to face. The large experience with *distance learning (DAD)* during the Covid-19 pandemic underlined how game is a potent educational instrument able to engage students and maintain their focus, at the same time helping to implement knowledge and improve *critical thinking*. In particular, the use of educational digital games further enhances skills and competences adopting reality tasks in a challenging path according to storytelling. One of the main goals for our activities for schools is to spread good practices to be adopted in case of natural hazards. Two competitive Escape Rooms have been developed and tested to prepare future citizens to save themselves and others during natural disasters and to educate them to environmentally sustainable behavior. The first was an Escape to run away from natural risks (seismic, tsunami and hydrogeological risks), created in occasion of the 9th Planet Earth Week 2021, involving more than 900 students of Middle Schools (ISCDE 2) and Primary Schools from all over Italy in two different races. The second Escape room is the final product of a meaningful participatory *Project Based Learning (PBL)* experience on environmental topics between researchers, teachers and students of the second class of a Middle School. The students have learned through *real-life* tasks and they personally have promoted to their peers the sustainable behavior to mitigate the effects of climate change. In particular, deforestation, wildfires, sea rising and acidification have been discussed to solve enigmas. This Escape was played online during World Earth Day 2023, involving almost 800 students of Italian Middle Schools, and in presence as a peer education experience for about 100 students of Middle Schools during the Fosforo Science Festival (Senigallia) 2023. These games are also a multipurpose and useful tool for teachers for new ideas of teaching activities. In addition, they are examples of effective active learning in which the students' skills and cognitive development are enhanced. Experiencing escape rooms during special events highlighted that they are both learning and dissemination tools and can therefore be used for different purposes, both at school as a tool for innovative teaching and in research to promote projects or disseminate new scientific findings. They are to be considered bridging activities between School, Research and Society.

Keywords: *Knowledge, gamification in education, best practice dissemination, natural hazard, environmental sustainability.*

1. Introduction

The need to design engaging and educational activities in the occasion of special scientific events during the pandemic has led to experiment the online use of innovative digital teaching methods for science outreach educational activities for schools in *distance learning*.

Gaming is a powerful communication tool, an effective *active learning*, which allows the assessment of players' abilities, learning progress, and limits (Piangiamore *et al.*, 2021). It is also a tool that can help to explain natural phenomena and to communicate science. Good practices can be instilled to automatically promote safe behaviors to be implemented during natural events.

In our gaming practice, we have always used *serious games* which intrinsically have the idea of stimulating learning. Our serious games are *transformative learning* educational tools, useful to increase public awareness of risks related to natural events (Piangiamore *et al.*, 2024a).

The main purpose is to educate on natural risk reduction and environmental sustainability in Middle Schools (ISCDE 2) in an engaging way with new learning experiences, guided by researchers from the Istituto Nazionale di Geofisica and Vulcanologia (INGV). The activities are aimed at preparing students to cope with and reduce disasters *(DDR - Disaster Risk Reduction)* as well as acquiring different behaviours to be adopted in case of earthquakes, tsunamis, floods and landslides *(Life Save Skills)*.

Two Escape Rooms were designed and tested, featuring a fictional character in which students recognise themselves: the rescuer called Salvina. She is a young girl who faces several hazardous situations, from earthquake to flood and to environmental issues. Escape Rooms involve students in clues, logical puzzles and tasks that a team must solve to win (Manojlovic, 2022).

The didactic methodologies are based on the *PBL approach* and on *inquiry-based learning* aimed at promoting behavioral change (*service learning*) through *cooperative learning* (Griffin & Care, 2015).

2. Design and method

During the Covid19 Pandemic, traditional learning settings need to be replaced by more dynamic and engaging educational experiences. Gamification helped us to keep the attention high in Distance Learning, providing the educational community with tools to further enhance learning processes and, consequently, student success. At that time, to keep the School/Research relationship alive, our playing science activities were carried out creating the format *"Salvina's Choices"* to develop *critical thinking. Salvina's Adventures* are focused on natural risk reduction, in particular *"Salvina and the Earthquake: What Will She Do?"* and *"Salvina and the Flood: What Will She Do?".* These two adventures have been played during special scientific events (i.e., Science festivals and memorials of occurred events) with online challenges conducted by INGV researchers and involving schools throughout Italy (Piangiamore & Maramai, 2022). In the online races 350 classes competed, connected by interactive whiteboard, tablets and mobile phones for a total of 3800 students of Primary School and 4300 students of Middle School. Thereafter, two more games were developed for environmental education purposes, respectively "*Salvina and the Environment: What Will She Do?"* and *"Salvina and the 4Rs: What Will She Do?".* The first one promoted sustainable behaviour through the acquisition of good environmental practices, while the second one spread the four easy-to-follow stepping stones (Reduce, Reuse, Recycle and Repurpose) to be adopted in everyday life. In particular, "*Salvina and the Environment: What Will She Do?"* was played online during the European Researchers' Night 2021 by a total of more than 1800 students (about 770 students from Primary School and about 1050 students from Middle School all over Italy). During the European Researchers' Night 2022, the "*Salvina and the 4R"* was played in person in Rome by 150 children and their parents.

2.1. Educational escape rooms

Due to the enthusiastic responses from teachers and students after playing, we designed a first digital hypernarrative Escape Room, *"Let's free Salvina!",* to get away from natural hazards. From this experience *"4S Salvina and Samantha save species"* Escape Room was born in the participatory design of students, teachers and researchers as a new tool to protect the environment (Escribano, 2018).

Escape Rooms are collaborative logic games, accompanied by storytelling, that a group of people need to complete in a limited period of time. Intuition, logic and team building come into play. Competitors work together to find the way out of a thematic room thanks to a final key gained after a path of enigmas and solutions (Eukel & Morrell, 2021).

Used in teaching, Escape Rooms can motivate students, promoting the development of *collaborative problem-solving* competencies and communication skills (Awwal *et al.*, 2017). Soft skills achievement is becoming increasingly important in properly preparing students for *real-life* (Pan *et al.*, 2017).

Genially, a no-code platform for interactive visual communication was used to create the structure of the multi-hazard Escape Rooms rich in interactive contents, created by using several free learning apps, including *Quizziz, Flippity* and *Word Wall.*

As far as *"Let's free Salvina!"* is concerned, the storytelling led players to help Salvina who faces earthquake, tsunami, landslide, and flood, by making safe choices to solve enigmas as quickly as possible. For each risk scenario Salvina is the protagonist of educational quizzes designed with a level of complexity that fits the target it was intended for. To win, the students have to choose the right actions to survive (Care *et al.*, 2015).

The *"Let's free Salvina!"* challenge was enthusiastically played in online competition between classes during the Planet Earth Week 2021, simultaneously involving almost a thousand students from Latium, Liguria, Lombardia, Marche and Sicily. In particular, more than 300 students of 14 classes from Primary School and more than 600 students from 29 classes of Middle Schools were involved.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

Figure 1. Some games and settings on natural risk reduction used in "Let's free Salvina!" Escape Room, played online on the occasion of Planet Earth Week 2021.

This experience impressed the 2A class of the «S. De Magistris» Middle School of Caldarola (MC) that wished to try out the creation of a new Escape Room on climate change and sustainable behaviour, the *"4S Salvina and Samantha save species"*. Starting from the pre-existing Salvina's games on environmental issues, for the realization of the new Escape Room 15 weekly online meetings were carried out between students, teacher and INGV researchers. During these meetings, the students became familiar with both *"Salvina and the Environment: What Will She Do?"* and *"Salvina and the 4Rs: What Will She Do?"* games, playing them to learn eco-friendly behaviors. Students demonstrated their creativity, autonomously personalising the Escape Room paths on deforestation, planting, glacier melting and the consequent sea level rising, ocean acidification, and other topics to face climate change. In order to move on in the virtual game from one setting to another it's necessary to reflect on the right choices to save ourselves and planet Earth. The final product was played online during World Earth Day 2023 by 14 Middle Schools from Latium, Sicily and Liguria, for a total of 35 classrooms and 800 students, simultaneously challenging each other. In addition, at Fosforo Science Festival 2023, the student involved in the realisation of the *"4S Salvina and Samantha save species"* led in presence the learning activity in a successful experiment of *peer education* for a total of 100 students.

At the end of each scientific special venue, we collected data through individual satisfaction questionnaires, differentiated for teachers and students.

Figure 2. Some examples of feedback received to the questionnaires distributed after the "Let's free Salvina!" race online on the occasion of Planet Earth Week 2021.

How would you judge the activity carried out with the escape room *"Let's free Salvina"* ?

Interesting!
Very engaging and instructive
Very interesting
Totally positive experience!
Very positive
Excellent
It was a stimulating and engaging initiative. Children were protagonists: asked questions and looked for answers, just like a real researcher does.
A fruitful and exciting activity that placed the pupils at the center of the learning process, making them the protagonists of their own educational journey. An opportunity to experience the conscious and responsible use of new technologies.

Figure 3. Some climate change topics developed in the "4S Salvina and Samantha save species" Escape Room, played online on the occasion of the World Earth Day 2023.

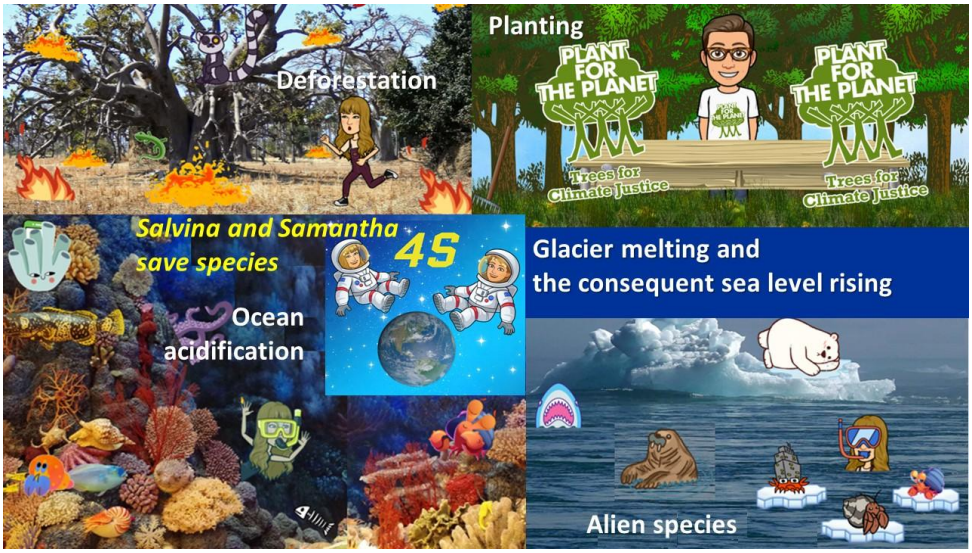


Figure 4. The peer education experience of "4S Salvina and Samantha save species" Escape Room, played in presence at Fosforo Science Festival 2023.

3. Discussion and conclusions

Escape Rooms are emerging as a new type of learning strategy to enhance student interest, involving them in engaging experiences. Thanks to the shift from traditional didactic models to the approach of *active learning*, Escape Rooms are increasingly used in *game-based learning* and *peer to peer* education activities (Wiemker *et al.*, 2015). One of the main goals of educational Escape Rooms is to contribute to the development of soft skills. In particular, both *"Let's free Salvina"* and *"4S Salvina and Samantha save species"* are focused on the dissemination of good behavioural practices. The first one concerns safe behaviour to save ourselves in case of natural risks. The latter has the pedagogical purpose of instilling eco-sustainable behaviour, solving enigmas on crucial issues concerning climate change. The educational path on risk involves cognitive and, above all, emotional and behavioural dimensions, with the main objective of changing personal and collective behaviour for everyone's good (Piangiamore *et al.*, 2024b). The long-lasting educational process (*lifelong learning*) involves all dimensions of human experience in relation to the social, cultural, natural and built context (Piangiamore, 2018). Educational strategies of *cooperative learning*, *'group' problem solving, goal-based-scenarios* and *inquiry-based learning* are applied to play online and in presence (*peer education*). Both Escape Rooms use storytelling to attempt engaging adventures, facing different situations from time to time, according to players' choices and solutions. In *"Let's free Salvina!",* the involved teams have to use their knowledge in Civil Protection matters to survive in the event of an earthquake, tsunami, landslide, and flood, learning from experiences to adapt to new conditions (Piangiamore & Maramai, 2024). Whereas in the *"4S Salvina and Samantha*

save species" students must use all their skills to protect the environment and to preserve biodiversity in different settings. All sets designed are educational playing activities according to students' competence level to facilitate the development of all key competences and citizenship skills, stimulating discussion among peers and with adults and fostering *critical thinking* to apply knowledge in *real-life* situations. The ambition to achieve common goals of *lifelong learning* triggers a process that fosters knowledge, awareness and best practices in the implementation of social interactions, both for facing natural risks and fighting climate change, in a *challenge-based learning* perspective too (Manojlovic, 2023). The digital Escape Rooms, created to support the teaching difficulties due to the Pandemic, has turned out to be a useful learning tool even after the health emergency because it allows simultaneous interaction between many classes remotely, stimulating learning. In fact, the competition triggers students' enthusiasm, facilitating the understanding of scientific issues (Borrego et al., 2017).

Acknowledgments

The authors thank Anna De Santis for technical support in the game design and during the special events and the teacher Daniela Pennesi and the 2A class of the «S. De Magistris» Middle School of Caldarola (MC) for the *"4S Salvina and Samantha save species"* Escape Room design and peer education experience. The authors are also grateful to Irene Rosati Valdambrini for the English language revision.

References

Awwal, N., Alom, M., & Care, E. (2015). Game design for learning to solve problems in a collaborative environment. *European Conference on Games Based Learning*, 25-34.

Borrego, C., Fernández, C., Blanes, I., & Robles, S. (2017). Room escape at class: Escape games activities to facilitate the motivation and learning in computer science. *Journal of Technology and Science Education, 7*(2), 162-171. https://doi.org/10.3926/jotse.247

Care, E., Griffin, P., Scoular, C., Awwal, N., & Zoanetti, N. (2015). Collaborative Problem Solving Tasks. In P. Griffin & E. Care (Eds.), *Assessment and Teaching of 21st Century Skills: Methods and Approach* (pp. 85-104). Springer. https://doi.org/10.1007/978-94-017-9395-7_4

Escribano, G. D. (2018). Escape rooms from a collaborative and interdisciplinary perspective. *Encuentro: Revista de Investigación e Innovación En La Clase de Idiomas*, *27*, 22-37.

Eukel, H., & Morrell, B. (2021). Ensuring Educational Escape-Room Success: The Process of Designing, Piloting, Evaluating, Redesigning, and Re-Evaluating Educational Escape Rooms. *Simulation & Gaming*, *52*(1), 18-23. https://doi.org/10.1177/1046878120953453

Griffin, P., & Care, E. (Eds.). (2015). *Assessment and Teaching of 21st Century Skills*. Springer.

Manojlovic, H. (2023). Escape Rooms and Collaborative Problem-Solving: Examining the Competence of Teacher Candidates. *Opus et Educatio, 10*(3), 253-261. DOI: 10.3311/ope.573

Manojlovic, H. (2022). Escape room as a teaching method. *Opus et Educatio, 9*(2). DOI: 10.3311/ope.504

Pan, R., Lo, H., & Neustaedter, C. (2017). Collaboration, Awareness, and Communication in Real-Life Escape Rooms. *Proceedings of the 2017 Conference on Designing Interactive Systems (DIS '17)*, 1353-1364. https://doi.org/10.1145/3064663.3064767

Piangiamore, G. L., & Maramai, A. (2024). "When the Past Teaches the Future: Earthquake and Tsunami Risk Reduction through Episodes of Situated Learning (ESL)". *Geosciences 2024*, *14*(3), 65. https://doi.org/10.3390/geosciences14030065

Piangiamore, G. L., Maraffi, S., & Sacerdoti, F. M. (2024a). A board game meets an App... this is GeoRisk! *Rendiconti Online della Soc. Geolog. Ital., 64*, 35-41. https://doi.org/10.3301/ROL.2024.47

Piangiamore, G. L., Trolese, P. Frione, A., & Cortopassi, P. (2024b). "Social Emotional Learning (SEL) and earthquake: the teaching of emotions meets Geoscience". *Rendiconti Online della Soc. Geolog. Ital, 62*(2024). https://doi.org/10.3301/ROL.2024.04

Piangiamore, G. L. & Maramai, A. (2022). "Gaming and Resilience: Teaching by Playing Together — Online Educational Competition at School during the Pandemic". *Applied Science 2022, 12*(23). MDPI editor. https://doi.org/10.3390/app122311931

Piangiamore, G. L., Falsaperla, S., Eva, E., & Musacchio, G. (2021). "Seismic risk communication: let's students show their own way". *Annals of Geophysics 2021, 63*. https://doi.org/10.4401/ag-8396

Piangiamore, G. L. (2018). Metodologie didattiche innovative di educazione dei rischi naturali nei progetti per le scuole del territorio spezzino. *PRISMA Economia - Società – Lavoro, 3*(2018), 113-133. DOI: 10.3280/PRI2018-003008

Wiemker, M., Elumir, E., & Clare, A. (2015). Escape Room Games: "Can you transform an unpleasant situation into a pleasant one?". *Game Based Learning*. https://www.academia.edu/38973807/

THE AI PRODUCTIVITY DIVIDE: EMERGING INEQUITIES IN AI-ENHANCED EDUCATION

Darya Ramezani, & Michael G. Wagner
Department of Digital Media, Drexel University (USA)

Abstract

A key consequence of AI's integration into education is a widening gap in productivity, separating those who effectively utilize AI tools from those who don't. This "AI Productivity Divide" operates across three fundamental dimensions: technical access disparities, AI literacy development, and institutional readiness. Unlike traditional technological divides, this new divide encompasses both access limitations and voluntary non-adoption, creating compound disadvantages in educational outcomes. To counter these effects, we propose an "AI Equity in Education" framework that outlines specific interventions—including comprehensive literacy programs, equitable access initiatives, and adaptive support systems—while emphasizing the importance of balancing AI integration with human-centered learning approaches.

Keywords: *Artificial intelligence, educational equity, AI productivity divide, AI literacy, educational policy.*

1. Introduction

Artificial intelligence (AI) has rapidly evolved from a specialized research tool into a transformative force that dramatically enhances individual productivity across all sectors of society. A clear trend shows that using advanced AI tools can lead to substantial improvements in both the quantity and the quality of work. This growing disparity in productivity between AI users and non-users, referred to here as the "AI Productivity Divide," creates an accelerating gap that negatively impacts not only those who lack access to AI tools but also those who choose not to adopt them. Unlike traditional technological divides that primarily reflect resource inequalities, this new divide therefore encompasses a broader spectrum of exclusion, where personal choice to abstain from AI usage may lead to the same productivity disadvantages as lack of access, raising profound questions about technological adoption in an AI-driven world.

Recent literature identifies three levels at which this AI productivity divide manifests: access, skills, and outcomes (Ball & Huang, 2023). At the access level, students and educators face infrastructural barriers including limited broadband and insufficient devices. Beyond access, a skills disparity persists in AI literacy—from basic digital fluency to understanding algorithmic operations—particularly in underfunded schools (Memon & Memon, 2025). The outcomes level reflects how trust in AI technologies and personal experiences shape adoption benefits, while systemic biases in AI systems can perpetuate societal inequities through inadequate representation of marginalized students (Diene, 2024). Usage divides further emerge when technology serves entertainment rather than learning purposes, especially in contexts lacking proper guidance (Memon & Memon, 2025).

While AI offers significant benefits, including personalized instruction, enhanced motivation through gamification, and collaborative learning opportunities, these advantages disproportionately benefit those with existing resources and digital literacies. Cultural differences in AI adoption create divergent outcomes, as some institutions embrace AI for democratizing learning while others prioritize traditional teacher-student relationships (Li, 2024). Ethical concerns—including data privacy and algorithmic discrimination—complicate equitable integration (Li, 2024), and over-reliance on AI can compromise critical thinking and interpersonal skills without proper balance with human-centered learning experiences (Capinding & Dumayas, 2024). Consequently, AI's rapid expansion risks intensifying existing educational disparities without deliberate and equitable implementation strategies.

Based on a conceptual analysis synthesized from recent literature, this position paper argues that a widening "AI Productivity Divide," where some effectively use AI tools while others do not, threatens educational equity even further. It extends beyond traditional digital divides, emphasizing that simply having access is not enough; learners and educators must be able to leverage AI for deeper cognitive and problem-solving benefits. To counter this challenge, the paper calls for technological and infrastructural investment, targeted policies, AI literacy initiatives, and inclusive teaching methods, culminating in a proposed "AI Equity in Education" framework.

2. The AI equity in education framework: Key dimensions and strategies

Recent research in educational technology reveals how artificial intelligence is fundamentally reshaping the learning landscape, creating new opportunities while simultaneously introducing complex challenges for equity and access. While traditional educational disparities often centered on tangible resources like textbooks and classroom materials, the integration of AI into education introduces a multi-layered challenge that encompasses technological infrastructure, cognitive tools, and institutional capacity.

These elements interact in ways that can either amplify or mitigate existing educational inequities. The OECD's comprehensive analysis demonstrates how variations in infrastructure quality, digital literacy levels, and institutional preparedness create compounding effects that influence student outcomes (OECD, 2024). When some institutions can fully leverage AI for personalized learning, efficient data analysis, and innovative teaching methods while others struggle with basic implementation, the resulting disparity in educational effectiveness becomes particularly pronounced.

This section examines three fundamental dimensions of this challenge—technical access, AI literacy, and institutional readiness—and presents strategic frameworks to address each. Additionally, it explores how educational institutions can maintain an appropriate balance between AI-enhanced learning and traditional pedagogical approaches, ensuring that technological integration enhances rather than diminishes the human elements of education.

2.1. Technical access and equitable distribution

Access to AI-driven educational tools and resources remains starkly uneven across socio-economic and geographic boundaries (OECD, 2024). In regions with limited infrastructure, particularly economically disadvantaged urban areas and remote rural communities, the absence of AI integration compounds existing educational disparities. While some nations have successfully implemented large-scale initiatives to provide AI-enhanced resources to underserved communities, many regions continue to struggle with insufficient broadband coverage, prohibitive device costs, and inadequate technical support infrastructure (Johnson & Davis, 2024).

To counteract these disparities, policymakers and educational leaders must pursue comprehensive, multi-level initiatives that address both immediate needs and long-term sustainability. Successful interventions often begin with targeted subsidies for AI devices and software licenses in underfunded schools, while simultaneously fostering public-private partnerships to expand reliable broadband coverage. These foundational efforts can be strengthened by creating incentive programs for technology companies to develop and offer reduced-cost or open-source AI platforms specifically designed for low-resource educational settings, thereby establishing sustainable pathways to technology access (Johnson & Davis, 2024).

Beyond initial implementation costs, institutions face significant ongoing challenges with system maintenance, regular upgrades, and comprehensive technical support—including critical software updates, robust cybersecurity measures, and scalable data storage solutions. These continuing operational requirements can impose a substantial long-term financial burden on underfunded institutions, potentially forcing them to make difficult choices between maintaining AI infrastructure and funding other essential educational needs (Panjwani, 2024). Moreover, equitable access must incorporate sophisticated assistive technologies for students with disabilities, ensuring AI-driven learning tools are universally accessible and adaptable to diverse learning needs.

Culturally responsive solutions play a crucial role in expanding meaningful access and adoption. In communities that particularly value traditional teacher-student relationships, AI deployment strategies must thoughtfully align with local pedagogical values and educational philosophies rather than simply replicating Western-centric models of technology integration (Li, 2024). The careful integration of local languages, cultural references, and context-specific needs into AI systems can cultivate broader community acceptance and reduce resistance to unfamiliar technologies, while simultaneously enhancing the educational relevance and effectiveness of these tools for diverse student populations.

2.2. AI literacy development and support programs

AI literacy extends far beyond basic digital fluency, encompassing a sophisticated understanding of algorithmic decision-making processes, critical evaluation of AI outputs, and ethical utilization of AI tools for research and learning (Ball & Huang, 2023). This dimension of the educational divide manifests in multiple ways, from gaps in educator preparedness to significant variations in student capabilities and comfort with AI technologies.

Effective integration requires carefully structured, comprehensive literacy programs targeting both educators and students. For educators, this encompasses intensive training in AI-related problem-solving methodologies and pedagogical integration strategies, alongside sustained professional development focused on identifying and addressing algorithmic biases in educational tools. Educators must receive ongoing support as they navigate the transition from traditional content delivery roles to becoming learning architects who can effectively blend AI-enhanced instruction with conventional teaching methods. This transition requires not only technical proficiency but also the development of confidence in designing and implementing AI-related activities that enhance rather than replace human instruction (Kurtz et al., 2024).

Student-focused initiatives must emphasize early and consistent introduction to AI concepts through engaging, hands-on, project-based activities. These programs should couple practical experience with AI tools with the development of sophisticated critical thinking skills necessary for evaluating AI outputs and understanding their limitations. Successful programs integrate ethics-focused exploration of AI implications while providing extensive practical experience with AI tools in varied educational contexts, ensuring students develop both technical proficiency and ethical awareness (Memon & Memon, 2025).

The literacy gap is particularly pronounced in underfunded schools, which often lack both curriculum design resources and comprehensive professional development opportunities to support these emerging skill sets (Brian & Owin, 2024). Limited access to expert guidance and up-to-date training materials can leave both teachers and students struggling to keep pace with rapidly evolving AI technologies. Additionally, inherent biases embedded in AI systems can further entrench literacy gaps, disproportionately affecting students from marginalized groups through flawed recommendations or misinterpretations of their learning patterns and needs (Diene, 2024).

The development of effective AI literacy programs must also account for varying levels of technological readiness among different student populations. While some students may enter the educational system with significant exposure to AI tools through home environments, others may require more fundamental support in building basic digital literacy skills before advancing to more complex AI applications. This disparity necessitates flexible, adaptive literacy programs that can accommodate diverse starting points while ensuring all students progress toward comprehensive AI literacy.

2.3. Institutional readiness and adaptive support systems

Institutional readiness encompasses a complex matrix of organizational capacities required to effectively adopt, manage, and optimize AI technology for teaching, assessment, and administrative tasks. This readiness extends beyond mere technological infrastructure to include organizational culture, staff capabilities, and administrative frameworks. While some well-resourced institutions successfully leverage AI-powered personalization and sophisticated data-driven decision-making systems, countless schools lack the necessary financial, technical, and administrative infrastructure to implement these tools effectively (OECD, 2024).

To address these multifaceted challenges, forward-thinking institutions are implementing comprehensive adaptive support systems that harness advanced data analytics for identifying at-risk learners while providing carefully differentiated resources based on individual student needs and learning patterns. These sophisticated systems guide teachers in crafting targeted interventions through real-time feedback loops and support strategic resource allocation decisions through predictive analytics. However, successful implementation requires clear leadership vision and robust policy support, coupled with comprehensive data governance frameworks that protect student privacy while maximizing the benefits of AI-driven insights. Institutions must establish and regularly update ethical guidelines for AI use, maintain systematic evaluation protocols for assessing AI's classroom impact, and ensure rigorous protection of student privacy and overall well-being (Capinding & Dumayas, 2024).

Cultural differences significantly complicate institutional readiness assessments and implementation strategies. While Western educational frameworks often champion AI as a powerful tool for democratizing knowledge access and personalizing learning experiences, other cultural contexts emphasize more traditional, relationship-driven pedagogies that necessitate different approaches to AI integration (Li, 2024). Educational institutions must navigate these cultural nuances thoughtfully, developing implementation strategies that respect local values while maximizing the benefits of AI-enhanced learning.

The development of institutional readiness also requires careful attention to change management processes and stakeholder engagement. Success depends not only on technological infrastructure but also on building broad-based support among administrators, educators, students, and parents. This involves creating clear communication channels, establishing transparent decision-making processes, and developing responsive feedback mechanisms that allow for continuous improvement of AI integration strategies. Institutions must also invest in building internal capacity for AI governance, including

specialized training for administrative staff and the development of dedicated teams responsible for overseeing AI implementation and maintenance.

Moreover, institutions must develop robust frameworks for measuring and evaluating the effectiveness of their AI initiatives. This includes establishing clear metrics for success, implementing regular assessment protocols, and maintaining flexible adaptation strategies that allow for rapid response to emerging challenges and opportunities. Such evaluation systems should track not only academic outcomes but also broader indicators of student engagement, well-being, and equitable access to AI-enhanced learning opportunities.

2.4. Balancing AI integration and human-centered learning

A critical consideration in addressing the AI Productivity Divide is maintaining an appropriate and dynamic balance between AI-enhanced methodologies and traditional pedagogical approaches. While AI demonstrates remarkable capabilities in automating routine tasks, personalizing learning pathways, and providing instant feedback, over-reliance on its outputs may inadvertently suppress the development of crucial human capabilities—including creativity, emotional intelligence, and sophisticated problem-solving skills—that are increasingly vital in our complex, rapidly evolving world.

Effective balance requires thoughtful, evidence-based curricular design that strategically interweaves AI-driven modules with collaborative, human-centered activities (Zhang & Zhang, 2024). Educational institutions should implement carefully structured blended learning models that alternate between AI-guided instruction and meaningful face-to-face interactions, while establishing clear ethical governance structures to define appropriate boundaries for AI use in various educational contexts. The preservation of direct mentorship opportunities, authentic peer-to-peer dialogue, and spontaneous classroom interactions remains essential for developing well-rounded learners capable of both technological proficiency and deep human connection.

The challenge of maintaining this balance becomes particularly acute in resource-constrained environments where the pressure to maximize efficiency through AI automation may overshadow the importance of human-centered learning experiences. Institutions must resist the temptation to view AI primarily as a cost-cutting measure, instead focusing on its potential to augment and enhance human teaching capabilities. This requires careful attention to the professional development needs of educators, ensuring they maintain autonomy in curriculum design and classroom management while developing the skills necessary to effectively integrate AI tools into their teaching practice.

Furthermore, institutions must develop sophisticated frameworks for evaluating the impact of AI integration on student development across multiple dimensions. This includes assessing not only academic achievement but also critical social-emotional skills, creative thinking capabilities, and collaborative competencies. Regular monitoring and adjustment of the balance between AI-enhanced and traditional learning methods ensures that technological integration serves to enrich rather than diminish the fundamental human elements of education.

Cultural considerations play a crucial role in determining appropriate balances between AI and human-centered learning approaches. Different communities may have varying perspectives on the role of technology in education, and successful integration strategies must respect these cultural values while maximizing the benefits of AI-enhanced learning. This might involve developing hybrid models that preserve traditional teaching methods while selectively incorporating AI tools in ways that align with local educational philosophies and community expectations.

This balanced approach ensures that AI serves its intended role as an enhancing technology that augments rather than replaces human teaching and learning processes. By maintaining this equilibrium, institutions can harness the efficiency and personalization benefits of AI while preserving the irreplaceable aspects of human interaction that foster social-emotional development, cultural understanding, and ethical reasoning capabilities.

3. Conclusion

The AI Productivity Divide in education presents a complex challenge that demands immediate and thoughtful intervention. Through our analysis of technical access barriers, AI literacy requirements, and institutional readiness factors, we have demonstrated how AI's rapid advancement creates unprecedented opportunities while risking the amplification of existing educational inequities. The exponential nature of AI-driven productivity gains, combined with the technology's capacity for cognitive augmentation and personalized learning, suggests that those who can effectively leverage these tools may advance at an accelerated rate compared to those who cannot—creating what we term a 'compound disadvantage effect.

To address this challenge, we propose an AI Equity in Education framework that emphasizes four key interventions: comprehensive AI literacy programs, equitable access initiatives, adaptive support systems, and carefully balanced integration strategies that preserve human-centered learning. Success in bridging this divide will require unprecedented cooperation between educators, technologists, policymakers, and communities, guided by evidence-based frameworks that prioritize equity alongside innovation. Future research should focus on conducting longitudinal studies of AI's impact across different socioeconomic contexts, understanding cultural influences on AI adoption, and developing robust mechanisms for evaluating algorithmic bias in educational AI systems. As AI becomes increasingly central to both education and workforce participation, ensuring equitable access to and proficiency with these technologies becomes fundamental to maintaining social mobility and economic opportunity in our rapidly evolving digital society.

Acknowledgments and AI Disclosure Statement

AI tools were used in the development of this paper. Claude 3.5 Sonnet assisted with the final editing of the text, while ChatGPT-01 Pro Mode evaluated the logical flow of the arguments presented. However, all arguments and ideas in this paper were conceived and developed by the human authors.

References

Ball, C., & Huang, K. T. (2023). Generative Artificial Intelligence (GAI) Divide: An Empirical Examination of the Micro–Macro Factors that Predict GAI Knowledge and Use. *Proceedings of the Association for Information Science and Technology, 60*(1), 878-880.

Brian, W., & Owin, O. L. O. (2024). An AI-driven approach to mitigate the digital divide in educational resources. *International Research Journal of Modernization in Engineering, Technology and Science, 6*(6), 2001-2007. Retrieved January 28, 2025, from: https://www.doi.org/10.56726/IRJMETS59086

Capinding, A. T., & Dumayas, F. T. (2024). Transformative Pedagogy in the Digital Age: Unraveling the Impact of Artificial Intelligence on Higher Education Students. *Problems of Education in the 21st Century, 82*(5), 630-657.

Diene, A. (2024). AI and Equity in Higher Education: Ensuring Inclusivity in the Algorithmic Classroom. In A. Ara & A. Ara (Eds.), *Exploring the Ethical Implications of Generative AI* (pp. 1-12). IGI Global.

Johnson, D. L., & Davis, C. G. (2024). Bridging the gap for underserved populations: Personalized AI solutions for college access and learning support. *New Directions for Higher Education, 2024*(207), 47-62.

Kurtz, G., Amzalag, M., Shaked, N., Zaguri, Y., Kohen-Vacs, D., Gal, E., ... & Barak-Medina, E. (2024). Strategies for Integrating Generative AI into Higher Education: Navigating Challenges and Leveraging Opportunities. *Education Sciences, 14*(5), 503.

Li, H. (2023). AI in Education: Bridging the Divide or Widening the Gap? Exploring Equity, Opportunities, and Challenges in the Digital Age. *Advances in Education, Humanities and Social Science Research, 8*(1), 355-355.

Li, W. (2024). The Influence of Artificial Intelligence on the Education System. *Lecture Notes in Education Psychology and Public Media, 65*, 137-142.

Memon, F. N., & Memon, S. N. (2025). Digital Divide and Equity in Education: Bridging Gaps to Ensure Inclusive Learning. In S. Siyal (Ed.), *Impact of Digitalization on Education and Social Sustainability* (pp. 107-130). IGI Global.

OECD. (2024). The potential impact of artificial intelligence on equity and inclusion in education. *OECD Artificial Intelligence Papers*, No. 23. Paris: OECD. Retrieved January 28, 2025, from: http://www.oecd.org/edu/workingpapers

Panjwani, M. M. (2024). Impact of AI in teaching and learning of CS in low-resourced schools. *International Journal of Science and Research Archive, 12*(2), 1933-1939.

Zhang, J., & Zhang, Z. (2024). AI in teacher education: Unlocking new dimensions in teaching support, inclusive learning, and digital literacy. *Journal of Computer Assisted Learning, 40*(4), 1871-1885.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

ACADEMIC RESPONSIBILITY IN ARTIFICIAL INTELLIGENCE (AI): LECTURERS' VIEWS ON CULTIVATING ETHICAL CHATBOTS

Paseka Patric Mollo
Faculty of Humanities, Central University of Technology, Free State (South Africa)

Abstract

The rapid advancements in Artificial Intelligence (AI) technology, particularly the emergence of AI chatbots, have significantly impacted the educational landscape. As these chatbots become increasingly integrated into teaching and learning practices, lecturers must actively shape their usage as a force for good. This empirical study examines university lecturers' opinions on their responsibilities for ensuring the ethical and beneficial use of AI chatbots in their classrooms. This paper is couched in the Transformative Learning Theory, which emphasises how lecturers critically reflect on their beliefs and experiences to transform their perspectives and practices. A qualitative research methodology, in the form of Interpretative Phenomenological Analysis (IPA), was employed through individual interviews to explore lecturers' perceptions of AI chatbots in their teaching and learning. A purposive sample of eight lecturers in the Department of Educational and Professional Studies at the University of Technology was used to collect data. The study examined the key challenges and opportunities presented by AI chatbots, as well as the strategies and considerations that lecturers believe are essential to ensure these technologies support ethical, inclusive, personalised, and compelling learning experiences. The findings contribute to the ongoing discourse on integrating AI in education and provide valuable insights for educational institutions and lecturers seeking to harness the potential of AI chatbots while mitigating the risks.

Keywords: *Artificial Intelligence, chatbots, ethics, interpretative phenomenological analysis, university.*

1. Introduction

The rapid advancement and integration of artificial intelligence into various facets of modern life have ignited critical discussions about the ethical implications and responsibilities associated with its development and deployment (Lu et al., 2023). Given the pervasive nature of AI, it is crucial to thoroughly understand its potential impacts, particularly within educational contexts that shape future generations (Labor et al., 2015). AI-powered chatbots, such as ChatGPT, have emerged as transformative tools, providing personalised support and enhancing the educational experiences of both lecturers and students (Chukwuere, 2024). As AI systems transition from being simple tools to perceived autonomous agents, it becomes essential to address the ethical dimensions of their decision-making processes as well as their broader societal and legal ramifications (Dignum, 2018). Educational institutions bear the responsibility of equipping student teachers with the skills to navigate the complexities of AI while also instilling a strong moral compass that will guide their innovations (Saleh et al., 2025). This necessitates a shift towards curricula that not only include technical training but also integrate ethical considerations, fostering a holistic approach to AI education. The objective is to prepare student teachers for the ethical challenges they may face in their future careers by imparting the critical ethical knowledge and skills necessary to adeptly navigate the complexities of AI technologies (Usher & Barak, 2024).

A key aspect of this responsibility involves proactively addressing the ethical implications of AI chatbots. Lecturers must ensure that such technologies adhere to principles of transparency, accountability, and respect for individual privacy and autonomy. This may involve establishing clear guidelines and policies for the appropriate use of AI chatbots and providing comprehensive training for both faculty and students on the ethical considerations surrounding their implementation.

Additionally, lecturers must be equipped with the necessary knowledge and skills to effectively leverage AI chatbots in their teaching practices. This includes understanding the technical capabilities and limitations of these technologies, as well as strategies for seamlessly integrating them into course curricula and learning activities to enhance student engagement and learning outcomes.

Furthermore, lecturers have a responsibility to ensure that the development and deployment of AI chatbots in higher education are inclusive and equitable, catering to students' diverse needs and learning preferences. By proactively addressing these challenges, lecturers can play a crucial role in shaping AI chatbots as a transformative force that positively impacts the educational landscape, fostering innovation, efficiency, and inclusivity.

Moreover, lecturers are uniquely positioned to influence the trajectory of AI usage by promoting research and innovation that prioritize ethical considerations and societal well-being. In light of these factors, this study aims to explore lecturers' perspectives on academic responsibility in AI, with a focus on the cultivation of ethical chatbots. It examines how educators approach integrating ethical considerations into their AI within the curriculum, particularly regarding the use of chatbots in teaching and learning. Three research questions guide this study. These questions explored lecturers' understanding and perceptions of deploying ethical AI chatbots in their classes. The study attempted to answer the following questions. **Question 1**: What are the critical responsibilities of university lecturers in shaping AI chatbots to be a force for good in higher education? **Question 2:** How can university lecturers address the ethical considerations of using AI Chatbots in academic settings, particularly academic integrity and plagiarism? **Question 3**: How can university lecturers leverage AI Chatbots to enhance teaching practices and improve student teachers' learning outcomes?

This paper is grounded in Transformative Learning Theory, pioneered by Jack Mezirow, which posits that learning involves critically examining and revising assumptions, beliefs, and values to develop a more inclusive, discriminating, and integrative perspective. This theory emphasizes the importance of reflection, critical discourse, and rational assessment of assumptions in facilitating personal and societal change. It emphasises the importance of challenging existing frames of reference and adopting new perspectives through informed reflection and critical analysis. Transformative learning involves a shift in consciousness, enabling individuals to make more informed decisions and take meaningful action in their lives (Gill et al., 2023). Mezirow identified ten distinct phases in the transformative learning process, starting with a disorienting dilemma that challenges an individual's existing beliefs and assumptions. This dilemma prompts self-examination and critical reflection on one's assumptions and values, leading to the recognition that one's discontent and the process of transformation are shared experiences (Lalor et al., 2015). Exploring options for new ways of acting then follows, building competence and self-confidence in new roles, committing to a plan of action, acquiring knowledge and skills for implementation, and ultimately integrating the new perspective into one's life (Lalor et al., 2015). This process highlights the iterative and deeply personal nature of transformative learning (Lalor et al., 2015).

Applying transformative learning theory to the context of AI in education, particularly in relation to ethical AI chatbots, offers a valuable lens through which to examine lecturers' roles and responsibilities. Lecturers, as key stakeholders in shaping the future of education, must critically assess their assumptions and beliefs about AI, its potential impact on teaching and learning, and its ethical implications.

Lecturers should engage in critical reflection on the ethical considerations surrounding the use of AI chatbots, including issues of bias, fairness, transparency, and accountability. This reflective process can lead to a deeper understanding of the potential harms and benefits of AI in education, as well as the need for ethical guidelines and practices. Lecturers can reevaluate their roles in light of AI advancements, considering how they can leverage AI tools to enhance teaching and learning while upholding ethical standards and academic integrity (Grieve et al., 2021).

2. Methodology

This study is situated within the interpretivism paradigm, which posits that reality is constructed through individuals' interactions with their surrounding environment (Maree, 2007). People shape the social world by sharing meanings, engaging with one another, and forming relationships (Maree, 2007). From the interpretive paradigm's perspective, research is motivated by the desire to understand human nature. Consequently, this study was conducted to gain insights into lecturers' perceptions of Artificial Intelligence (AI) chatbots and their applications in teaching and learning practices.

In keeping with the chosen paradigm, this research employed qualitative methods, specifically Interpretative Phenomenological Analysis (IPA). IPA is particularly well-suited for this study, as it focuses on understanding how individuals make sense of their lived experiences. This approach is advantageous for analyzing subjective experiences and uncovering the meanings that individuals attribute to those experiences (Tuffour, 2017).

The target population comprised lecturers who were approached and interviewed using open-ended, self-administered questions. Eight lecturers from the Department of Educational and Professional Studies at the University of Technology in South Africa were purposively selected to participate in this study. These participants were carefully chosen based on their experience and expertise

in AI usage and education, ensuring a diverse range of perspectives on the ethical challenges and responsibilities associated with AI. The interviews explored lecturers' perceptions of academic responsibility regarding AI, their strategies for incorporating ethical considerations into their curricula, and their perspectives on the challenges and opportunities in promoting ethical chatbots. Thematic analysis was employed to identify recurring patterns and key themes within the interview data, providing a nuanced understanding of lecturers' perspectives on the ethical dimensions of AI education.

3. Findings and discussions

The collected data was analysed thematically to identify key perceptions and opinions of the lecturers on cultivating ethical chatbots and their integration into learning. The thematic analysis of the interview data revealed several key themes regarding university lecturers' perspectives on their responsibilities in shaping AI chatbots as a force for good.

Promoting Ethical and Responsible AI

The lecturers emphasised their responsibility in advocating for the ethical and responsible usage of AI chatbots. They believed that university lecturers should actively engage with different AI chatbots, policymakers, and other stakeholders to ensure that the deployment of these technologies prioritises principles such as transparency, accountability, and fairness (Khan, 2024). Two of the participants stated that,

> *L 3: "We have to ensure that these AI systems are not perpetuating biases or making decisions that could unfairly disadvantage certain students."*

> *L6: "Lecturers have the responsibility to shape AI chatbots' usage in alignment with the fundamental values of higher education, which encompass critical thinking, intellectual discourse, and the pursuit of knowledge."*

Integrating AI Ethics into the Curriculum

The participants emphasised the importance of incorporating AI ethics and societal implications into their course curricula. By educating student teachers on the ethical considerations surrounding AI, they can empower the next generation of leaders and innovators to navigate the complexities of these technologies responsibly. Another lecturer indicated that:

> *L2: "As lecturers, it is our responsibility to provide student teachers with the knowledge and critical-thinking skills necessary to assess the ethical, social, and environmental implications of AI chatbots and other emerging technologies."*

Lecturers recognized their responsibility in exploring effective ways to integrate AI chatbots into the curriculum, leveraging their capabilities to enhance teaching and learning, while maintaining the human element in education. As one lecturer noted,

> *L: 7 "We need to find a balance between AI efficiency and the personalised attention that student teachers require from their lecturers."*

Skill Development

Lecturers expressed the need to guide student teachers in developing critical thinking and digital literacy skills to effectively navigate and utilise AI chatbots, recognising that these technologies should not replace human reasoning and problem-solving abilities. Systematic literature reviews have highlighted the importance of equipping students with the necessary skills to interact with AI chatbots.

This research underscores the significant role that university lecturers play in shaping the utilization of AI chatbots as a force for good in higher education (Al-Zahrani & Alasmari, 2024). The lecturers interviewed in this study emphasised the need to incorporate ethical considerations, transparency, and the implementation of AI chatbots. They also recognised their responsibility in exploring effective ways to integrate these technologies into the curriculum, leveraging their capabilities to enhance teaching and learning while maintaining the human element in education (Mah & Gross, 2024). Additionally, the lecturers emphasised the importance of guiding student teachers in developing critical thinking and digital literacy skills to effectively navigate and utilise AI chatbots, recognising that these technologies should not replace human reasoning and problem-solving abilities.

The findings of this study align with the existing literature on the integration of AI-based technologies in higher education. Previous studies have emphasized the potential benefits of AI chatbots, such as personalised support, enhanced student engagement, and streamlined administrative tasks (Labadze et al., 2023). However, the literature also highlights the critical need to address ethical concerns, such as

algorithmic bias, privacy, and the potential displacement of human interaction in the educational sphere (Akinwalere & Ivanov, 2022).

The insights gained from this research can inform the development of policies, training programs, and educational practices that promote the ethical and responsible use of AI-based technologies in the academic setting.

4. Conclusion

The findings of this study underscore the significant impact university lecturers can have in harnessing the potential of AI chatbots to drive positive advancements in higher education. The lecturers interviewed emphasised a multifaceted approach, highlighting the crucial need to incorporate ethical considerations into AI applications. They emphasised the importance of developing effective pedagogical strategies to enhance student engagement and learning through these technologies. Furthermore, the lecturers stressed their role in mentoring students to cultivate the skills necessary for navigating and critically evaluating AI technologies. This mentorship is designed to equip students with the understanding required to use AI responsibly, ensuring they are well-prepared for the future challenges of an increasingly digital world.

Informed by these insights, academic institutions can establish comprehensive policies and training programs that not only promote the ethical and responsible use of AI technologies but also foster an inclusive learning environment. By actively participating in the ethical implementation of AI chatbots, university lecturers can play a pivotal role in ensuring that these tools not only enrich the educational experience but also embody the core principles and values that underpin higher education, all while safeguarding the welfare of their student teachers.

References

Akinwalere, S. N., & Ivanov, V. (2022). Artificial Intelligence in Higher Education: Challenges and Opportunities. *Border Crossing, 12*(1), 1-15. https://doi.org/10.33182/bc.v12i1.2015

Al-Zahrani, A. M., & Alasmari, T. (2024). Exploring the impact of artificial intelligence on higher education: The dynamics of ethical, social, and educational implications. *Humanities and Social Sciences Communications, 11*(912). Palgrave Macmillan. https://doi.org/10.1057/s41599-024-03432-4

Chukwuere, J. E. (2024a). *The future of generative AI chatbots in higher education*. In arXiv (Cornell University). https://doi.org/10.48550/arxiv.2403.13487

Chukwuere, J. E. (2024b). *Developing generative AI chatbots conceptual framework for higher education.* In arXiv (Cornell University). https://doi.org/10.48550/arxiv.2403.19303

Dignum, V. (2018). Ethics in artificial intelligence: introduction to the special issue. *Ethics and Information Technology, 20*, 1-2. https://doi.org/10.1007/s10676-018-9450-z

Gill, S. S., Xu, M., Patros, P., Wu, H., Kaur, R., Kaur, K., Fuller, S., Singh, M., Arora, P., Parlikad, A. K., Stankovski, V., Abraham, A., Ghosh, S. K., Lutfiyya, H., Kanhere, S. S., Bahsoon, R., Rana, O., Dustdar, S., Sakellariou, R., … Buyya, R. (2023). Transformative effects of ChatGPT on modern education: Emerging Era of AI Chatbots. *Internet of Things and Cyber-Physical Systems, 4*, 19. https://doi.org/10.1016/j.iotcps.2023.06.002

Khan, Z. R. (2024). *Ethics of Artificial Intelligence in Academia*. In Springer International Handbooks of Education (p. 1551). Springer Nature (Netherlands). https://doi.org/10.1007/978-3-031-54144-5_188

Labadze, L., Grigolia, M., & Machaidze, L. (2023). Role of AI chatbots in education: systematic literature review. *International Journal of Educational Technology in Higher Education, 20*(1). https://doi.org/10.1186/s41239-023-00426-1

Lalor, J., Lorenzi, F., & Rami, J. (2015). Developing Professional Competence through Assessment: Constructivist and Reflective Practice in Teacher-Training. *Eurasian Journal of Educational Research, 15*(58). https://doi.org/10.14689/ejer.2015.58.6

Lu, Q., Luo, Y., Zhu, L., Tang, M., Xu, X., & Whittle, J. (2023). *Developing Responsible Chatbots for Financial Services: A Pattern-Oriented Responsible AI Engineering Approach*. (Cornell University). https://doi.org/10.48550/arxiv.2301.05517

Mah, D.-K., & Gross, N. (2024). Artificial intelligence in higher education: exploring faculty use, self-efficacy, distinct profiles, and professional development needs. *International Journal of Educational Technology in Higher Education, 21*(1). Springer Nature. https://doi.org/10.1186/s41239-024-00490-1

Maree, K. (2007). *First steps in research*. Pretoria: Van Schaik Publishers.

Saleh, Z. T., Rababa, M., Elshatarat, R. A., Alharbi, M., Alhumaidi, B. N., Al-Za'areer, M. S., Jarrad, R. A., niarat, T. F. A., Almagharbeh, W. T., Al-Sayaghi, K. M., & Fadila, D. E. S. (2025). Exploring faculty perceptions and concerns regarding artificial intelligence Chatbots in nursing education: potential benefits and limitations. *BMC Nursing, 24*(1). https://doi.org/10.1186/s12912-025-03082-0

Tuffour, I. (2017). A critical overview of interpretative phenomenological analysis: A contemporary qualitative research approach. *Journal of healthcare communications*, *2*(4), 52.

Usher, M., & Barak, M. (2024). Unpacking the role of AI ethics in online education for science and engineering students. *International Journal of STEM Education, 11*(1). https://doi.org/10.1186/s40594-024-00493-4

APPLICATION OF AUGMENTED REALITY FOR WORKING MEMORY IMPROVEMENT TO DEVELOP EXECUTIVE FUNCTIONS: A CASE STUDY

Alba Gilabert-Cerdá, & Elena Pérez-Vázquez
Department of Evolutionary Psychology and Didactics, University of Alicante (Spain)

Abstract

Working memory, a fundamental component of executive functions, plays a key role in regulating behaviour, decision-making and learning. In the last decade, Augmented Reality (AR) has emerged as a promising technology for education, due to its ability to provide interactive environments that enhance learning and concentration. In this context, the present pilot study aims to examine the efficacy of an AR-based intervention to improve the executive ability of working memory in a primary school student. To achieve this general objective, a methodology based on a quantitative approach with a single-case quasi-experimental design, using pretest and posttest, has been implemented. For this design, the sample was purposively selected in a non-probabilistic manner and consists of a 7-year-old female student. Specifically, the BRIEF2® (Behaviour Rating Inventory of Executive Function-2) was used as an instrument to measure working memory skills. The intervention was carried out in a school in Alicante, Spain. As for the procedure, it consisted of five individual sessions of 30 minutes each, where tasks designed to increase cognitive load were performed in a gradual and controlled manner based on the common thread 'Let's go to the zoo'. During the sessions, the student was asked to perform specific working memory exercises, adapted using AR software that incorporates interactive visual and auditory stimuli. These stimuli are adjusted in real time to the user's responses, allowing for a high level of personalisation and encouraging participant engagement. The results were obtained from the assessment test applied before and after the intervention. Preliminary findings indicate a significant improvement in working memory measures and suggest that Augmented Reality can be a viable and engaging tool for training executive functions. In addition, teacher feedback highlights the potential of AR to provide an immersive experience that fosters motivation and active learning, making it a valid alternative to traditional cognitive training methods. In conclusion, this pilot study not only demonstrates the potential of AR to positively impact working memory, but also provides a methodological basis for future research with larger samples.

Keywords: *Augmented reality, working memory, executive functions, primary education.*

1. Introduction

Since the end of the twentieth century, emerging technologies have transformed education, with Augmented Reality (AR) standing out for its ability to integrate digital information with the physical environment in real time, creating interactive and immersive experiences (Tarafdar et al., 2024). Through devices such as smartphones and viewers, AR stimulates student attention and participation (Cabero-Almenara & García-Jiménez, 2015). In addition to being motivating, it strengthens essential cognitive skills, such as working memory, improving information processing and retention (Martínez-Pérez et al., 2021). It also promotes personalized and student-centred learning, encouraging their participation and curiosity (Zhang et al., 2022).

On the other hand, working memory is the ability to temporarily retain and manipulate information for complex cognitive tasks such as language, learning, and reasoning (Christoff, 1992). It is key in planning, problem-solving and decision-making (Baddeley, 2000), as well as being essential for executive functions, allowing information to be updated, adapting to changes and resisting distractions (Nee et al., 2013).

In this sense, it should be remembered that executive functions (EF) are cognitive processes that allow behaviour to be managed to achieve goals, especially in complex situations (Kontostavlou & Drigas, 2022). They are key in the academic, professional and everyday spheres, facilitating adaptation, decision-making and problem solving (Diamond, 2013). Their development depends on internal and external factors, which has driven the search for pedagogical strategies to strengthen them from childhood.

Integrating AR into education improves working memory and executive functions (Squires, 2017). Their immersive experiences increase attention and concentration (Lim et al., 2019), adapting to different learning styles (Papanastasiou et al., 2018). Furthermore, by combining real and virtual elements, it reduces cognitive load and optimizes information processing and retention (Thees et al., 2020). For their part, Bacca et al., (2014) highlight that AR facilitates visual and experimental learning, promoting the consolidation of knowledge and cognitive development. Their interaction with digital content in real environments motivates students, improving their performance and solving complex tasks (Poupard et al., 2024). Additionally, its interactive nature increases engagement, favouring the retention and recall of information (Basumatary & Maity, 2023).

2. Objectives

The main objective of this project is to examine the effectiveness of an intervention based on Augmented Reality to improve the executive skill of working memory in a Primary Education student. The following research questions have been extracted from the general objective that supports this intervention:

1. Are there any changes in the scores obtained in the items associated with working memory after the implementation of the intervention?
2. Are there significant differences in working memory before and after developing the intervention?

3. Method

This study employs a quantitative approach with a quasi-experimental single-case design, due to its flexibility and customizability (Krasny-Pacini & Evans, 2017). The sample, selected in a non-probabilistic manner (Etikan et al., 2016), consists of a 7-year-old student. To create the AR environments, the tutor and the family were interviewed. After the intervention and data collection, the analysis was performed with SPSS 29.0.

3.1. Description of the context and participant

This study addresses the case of a 7-year-old girl who is in the second year of Primary Education in a state-subsidised school in Alicante. Without academic or socio-emotional difficulties, they show performance in line with their development, actively participate in class and interact positively. Their family environment is structured and promotes healthy habits. The case is part of a broader study on the use of AR to improve executive functioning in Primary, complying with ethical and data protection regulations.

3.2. Study variable and instrument

This research analyses working memory through an AR intervention through a tablet. For its evaluation, the BRIEF2® scale was used, applied as a pre-test and post-test in a 7-year-old student. The teacher answered a questionnaire of 63 items on a three-point Likert scale, read aloud by the researcher and digitally recorded in *TEACorrige*. Particularly, 17 items of the BRIEF2® assess difficulties in retaining information during a task. Unlike its previous version, this scale integrates working memory and its maintenance into a single domain due to its high correlation.

3.3. Procedure

The educational intervention consisted of a series of activities to assess and strengthen working memory using AR. Visual learning allowed the system to reinforce correct answers and guide in case of errors. The stages were:

1. Initial contact: The educational team was met; the study was explained, and family consent was obtained.
2. Preparation: Activities were designed, and the tutor was interviewed to create the AR environments.
3. Pretest: BRIEF2® was applied, with the tutor responding on a Likert scale while the researchers recorded the data in *TEACorrige*.
4. Intervention: Five individual sessions of 30 minutes were held in three weeks, with AR activities on the theme Let's go to the Zoo to develop working memory.
5. Post-test: The evaluation was repeated with BRIEF2® to measure the student's evolution.

3.4. Data analysis

After planning and implementing the intervention, as well as collecting the data, the analysis of the results was carried out. To do this, version 29.0 of the statistical software SPSS for Windows (Statistical

Package for Social Sciences) was used. In this context, a descriptive analysis was first performed to calculate the mean, standard deviation and median of the data obtained in the participant's pre-test and post-test. Subsequently, Wilcoxon's non-parametric signed range test, designed for related samples, was applied in order to detect possible significant differences between the student's pre-test and post-test results.

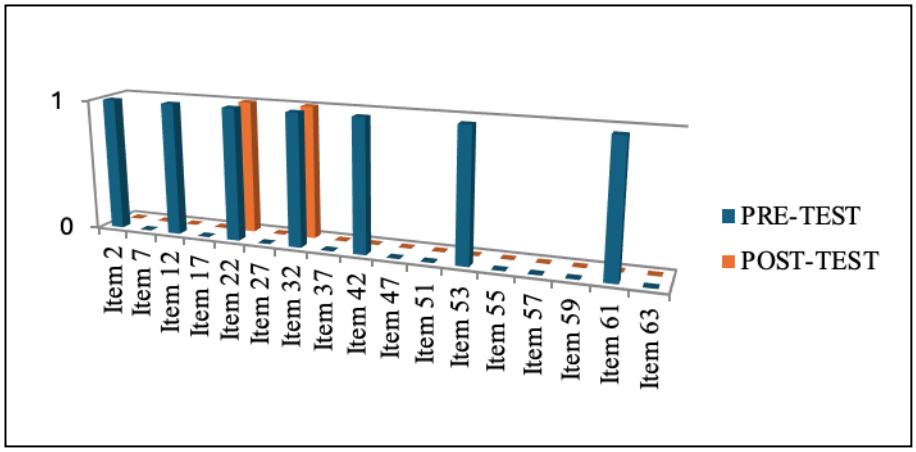
4. Results

As for the results, after analysing the data collected, they have been shown in different graphs and tables. These representations illustrate the answers linked to the X research questions formulated according to the central variable of the study.

4.1. Descriptive analysis of the participant

In particular, the first figure shows the participant's scores on the items related to working memory in BRIEF2®. Specifically, it presents the results corresponding to the pre-test and the post-test. The vertical axis of the graph shows the values 0, 1, and 2, corresponding to the Likert scale: 0 (never), 1 (sometimes) and 2 (frequently).

Figure 1. Scores of the participant's working memory.



In relation to the data obtained in the pre-test and post-test on working memory, reflected in Figure 1, a decrease of 29.41% was observed in the items evaluated. Specifically, a reduction of one point was recorded on the Likert scale in the following aspects: difficulty remembering and carrying out two consecutive tasks (item 2), difficulty maintaining concentration on recreational activities (item 12), difficulty completing initiated tasks (item 42), lack of persistence or effort in carrying out activities (item 53), and difficulty maintaining attention (item 61). It should be noted that, according to the BRIEF2®, higher scores indicate a greater presence of difficulties in this executive function. However, in the remaining 70.59% of the items, the participant obtained the same scores in both the pre-test and the post-test. It should be noted that 10 of the 17 items that make up the working memory were already obtained in the pre-test.

Similarly, Table 1 shows the results of the descriptive analysis.

Table 1. Descriptive statistics of the participant's working memory.

	N	***Stocking***	***Desv. standard***	***Medium***
Pre-test	1	0,41	0,507	0
Post-test	1	0,12	0,332	0

4.2. Possible significant differences in working memory between the results of the participant's pre-test and post-test

After analyzing the data using the nonparametric Wilcoxon signed range test for two related samples, the results are summarized in Table 2. To interpret the data, the following conditions are considered: (a) Post < Pre; (b) Post > Pre; (c) Post = Pre.

Table 2. Statistical testing of Wilcoxon's signed ranges for dependent samples in working memory for the participant.

	Ranges	***N***	***Average Range***	***Sum of ranks***
Post-test – Pre-test	Negative Range	5[a]	3	15
	Positive Range	0[b]	0	0
	Draws	12[c]		
	Total	17		

The statistical results of the Wilcoxon signed range test are shown below in Table 3.

Table 3. Wilcoxon signed-rank test statistics for the participant.

Z	***Sig. asin. (bilateral)***
-2,236	0,025

As shown in Table 3, the results corresponding to the participant indicate a significance of $p < .05$.

5. Discussion and conclusions

Based on the results obtained in this study and on the research questions formulated, the conclusions derived from the data analysis are presented. Specifically, there was evidence of a decrease in difficulty in remembering and executing two consecutive tasks. This result coincides with the findings of Makhataeva et al., (2023), who highlight that AR systems can increase mental representations of objects, leading to reduced cognitive load and greater accuracy of performance in tasks that involve memory, such as remembering positions of objects in a space. This suggests that AR can help execute consecutive tasks by relieving the mental load. In addition, a decrease in scores was detected in aspects such as difficulty in maintaining concentration in recreational activities. These results are consistent with those of Buchner et al., (2021), who argue that AR appears to be less cognitively demanding and leads to higher performance in learning environments.

Likewise, the immediate visual feedback offered by AR could help reduce the difficulty in completing initiated tasks by improving the user's performance and attention. According to Othman et al., (2020), this factor can make learning experiences more enjoyable and less monotonous, which can help reduce boredom and therefore finish the activity. Similarly, there was a decrease in the lack of persistence or effort in carrying out activities. In this context, the AR system can provide different levels of instructional support, which can reduce the complexity of perceived tasks and physical exertion, especially in assembly tasks. This adaptability is particularly beneficial for students with lower cognitive abilities (Vanneste et al., 2023). Finally, there was a reduction in difficulty in maintaining attention, and along these lines, several studies explore AR as a tool to help reduce difficulties in maintaining attention, mainly among people with attention-related disorders (Ghasemi et al., 2024).

In conclusion, the results obtained in this study suggest that AR can be an effective tool to improve working memory and attention in learning environments. Although the effects were not homogeneous in all the items evaluated, the improvements observed in certain areas suggest that this technology has great potential in the educational field. In particular, there was evidence of progress in aspects such as the ability to remember, concentration and the ability to complete tasks. Visual feedback and AR interactivity appear to have been key factors in these changes. Therefore, it would be relevant to continue exploring its impact on different executive functions and to evaluate its effectiveness in a larger sample of participants. In addition, future research could focus on the permanence of these long-term effects and on the adaptation of the intervention to different learning styles and cognitive levels.

References

Bacca, J., Baldiris, S., Fabregat, R., Graf, S., & Kinshuk. (2014). Augmented reality trends in education: A systematic review of research and applications. *Educational Technology & Society, 17*(4), 133-149.

Baddeley, A. D. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences, 4*(11), 417-423.

Basumatary, D., & Maity, R. (2023). Effects of Augmented Reality in Primary Education: A Literature Review. *Human Behavior and Emerging Technologies*. https://doi.org/10.1155/2023/4695759

Buchner, J., Buntins, K., & Kerres, M. (2021). The impact of augmented reality on cognitive load and performance: A systematic review. *Journal of Computer Assisted Learning, 38*, 285-303. https://doi.org/10.1111/jcal.12617

Cabero-Almenara, J., & García-Jiménez, E. (2015). Augmented Reality in Education: An Overview. *Virtual Campuses, 4*(2), 25-40.

Christoff, K. (1992). Working memory. *Science, 255*(5044), 556-559. https://doi.org/10.1016/s0079-7421(08)60452-1.

Diamond, A. (2013). Executive functions. *Annual Review of Psychology, 64*, 135-168.

Etikan, I., Musa, S., & Alkassim, R. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics, 5*(1). https://doi.org/10.11648/J.AJTAS.20160501.11

Ghasemi, S., Behravan, M., Uber, S., & Gračanin, D. (2024). Attention and Sensory Processing in Augmented Reality: Empowering ADHD population. *ArXiv*, abs/2405.01218. https://doi.org/10.48550/arXiv.2405.01218

Kontostavlou, E. Z., & Drigas, A. S. (2022). Executive functions training and giftedness. *Challenges: New Trends in Physical Education, Sport and Recreation, 43*, 1005-1014.

Krasny-Pacini, A., & Evans, J. (2017). Single-case experimental designs to assess intervention effectiveness in rehabilitation: A practical guide. *Annals of physical and rehabilitation medicine, 61*(3), 164-179. https://doi.org/10.1016/j.rehab.2017.12.002

Lim, T., Nonis, J., & Hedberg, J. (2019). Immersive learning: Using augmented reality to enhance learning experiences. *Journal of Educational Computing Research, 56*(4), 502-527.

Nee, D., Brown, J., Askren, M., Berman, M., Demiralp, E., Krawitz, A., & Jonides, J. (2013). A meta-analysis of executive components of working memory. *Cerebral cortex, 23*(2), 264-282. https://doi.org/10.1093/cercor/bhs007

Martínez-Pérez, S., González-González, C. S., & Navarro-Adelantado, V. (2021). Augmented reality for learning: Systematic review of applications in educational settings. *Educational Research Review, 34*, 100396.

Makhataeva, Z., Akhmetov, T., & Varol, H. (2023). Augmented-Reality-Based Human Memory Enhancement Using Artificial Intelligence. *IEEE Transactions on Human-Machine Systems, 53*, 1048-1060. https://doi.org/10.1109/THMS.2023.3307397

Othman, F., Adnan, W., & Nasruddin, Z. (2020). Augmented Reality Storytelling Teachers and Preschool Children Experience. In X. S. Yang, R. S. Sherratt, N. Dey, & A. Joshi (Eds.), *Proceedings of Fifth International Congress on Information and Communication Technology* (pp. 155-164). https://doi.org/10.1007/978-981-15-5856-6_15

Papanastasiou, G., Drigas, A., Skianis, C., Lytras, M., & Papanastasiou, E. (2018). Virtual and augmented reality effects on K-12, higher and tertiary education students' twenty-first century skills. *Virtual Reality, 23*, 425-436. https://doi.org/10.1007/s10055-018-0363-2

Poupard, M., Larrue, F., Sauzéon, H., & Tricot, A. (2024). A systematic review of immersive technologies for education: Learning performance, cognitive load and intrinsic motivation. *British Journal of Educational Technology, 56*(1), 5-41. https://doi.org/10.1111/bjet.13503

Squires, D. (2017). Working Memory & Augmented Reality's Trajectory: A Literature Review of AR in Education, Online Learning, Workforce Training, and Working Memory Research. *Journal on Educational Technology, 14*, 55-63. https://doi.org/10.26634/JET.14.3.13860

Tarafdar, P., Leung, A. C. M., Yue, W. T., & Bose, I. (2024). Understanding the impact of augmented reality product presentation on diagnosticity, cognitive load, and product sales. *International Journal of Information Management, 75*, 102744. https://doi.org/10.1016/j.ijinfomgt.2023.102744

Thees, M., Kapp, S., Strzys, M., Beil, F., Lukowicz, P., & Kuhn, J. (2020). Effects of augmented reality on learning and cognitive load in university physics laboratory courses. *Computers in Human Behavior, 108*, 106316. https://doi.org/10.1016/j.chb.2020.106316

Vanneste, P., Dekeyser, K., Ullauri, L., Debeer, D., Cornillie, F., Depaepe, F., Raes, A., Noortgate, W., & Said-Metwaly, S. (2023). Towards tailored cognitive support in augmented reality assembly work instructions. *Journal of Computer Assisted Learning, 40*, 797-811. https://doi.org/10.1111/jcal.12916

Zhang, J., Li, G., Huang, Q., Feng, Q., & Luo, H. (2022). Augmented Reality in K–12 Education: A Systematic Review and Meta-Analysis of the Literature from 2000 to 2020. *Sustainability, 14*(15), 9725. https://doi.org/10.3390/su14159725

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

EXPLORING THE POTENTIALS AND LIMITATIONS OF AI-BASED CAD DESIGN FOR MECHANICAL ENGINEERING

Michael Wendland
Dr., Department of Mechanical Engineering, Westphalian University of Applied Science, Bocholt (Germany)

Abstract

This paper investigates the integration of large language models (LLMs), specifically ChatGPT, with CAD software to support the generation of 3D models for mechanical engineering applications. A literature review of recent AI-to-CAD research identifies current capabilities and gaps regarding CAD integration, parametric modeling, and adherence to engineering norms. A proof-of-concept case study demonstrates how ChatGPT can generate parametric Python scripts for Fusion 360 across four mechanical test cases with varying complexity. The results show that AI-generated models can reproduce simple standardized components, support parametric design, and aid in educational settings by prompting users to explicitly define design intent. However, challenges persist with spatial reasoning, complex geometry, and integration depth. The study concludes that while current LLMs offer value for design automation and CAD education, significant development is needed to support complex and norm-driven engineering design workflows.

Keywords: *AI-assisted CAD design, AI design automation, LLM, engineering education.*

1. Introduction

The recent advances in Artificial Intelligence (AI) have impacted many engineering fields in academia as well as in industry. In both cases, AI is sometimes seen as a silver bullet to evade the ever-increasing time, cost and quality constraints. While this has still to be seen, the general potential for increasing efficiency and the overall level of automation remains undisputed.

This paper explores the publicly available AI-tool ChatGPT, which is a Large-Language-Model (LLM), in the context of Computer-Aided Design (CAD) for Mechanical Engineering. Since the traditional creation of 3D-CAD models for designing and manufacturing mechanical parts is a labor-intense manual process that requires extensive engineering domain knowledge and modelling skills, only limited automation is available and mostly restricted to predefined, standardised parts. But for the vast majority of all other mechanical parts, there is a strong need for automation and support in the CAD design process. This paper investigates these potentials and limitations of coupling a LLM with CAD-software to support design engineers. Three main research questions shall be answered:

1. Which research approaches with AI-tools for creating 3D-CAD models are currently available? What are advantages / limitations of the approaches for Mechanical Engineering?
2. How can a state-of-the-art LLM be used to help generate mechanical parts with CAD?
3. Which potentials does coupling a LLM with CAD-Software offer and which barriers exist?

2. Analysis of existing research for creating 3D-CAD models in Mechanical Engineering

Due to the fast development in AI-research, this analysis is not meant to be comprehensive but rather presents an excerpt of the current research state in the field of coupling AI2CAD and aims to give an overview. In order to evaluate existing approaches and AI-tools for their usage in the mechanical engineering domain, the following criteria with points ranging from 1-3 (0=no, 1=low, 2=medium, 3=high) are defined:

- *Integration Level CAD<->AI* (1=manual, 2=semi-automatic+manual input, 3=automatic)
- *Technical Maturity* (1=very basic, 2=still prototype, 3=professional tool)
- *Library of Mechanical Elements* (1= no library, 2=few elements, 3=comprehensive library)
- *Geometric Modification* (1=no change, 2=few changes, 3=complete parametric design)
- *Integration of Drawing and Part Norms* (1=no support, 2=few norms, 3=comprehensive)

In the first approach (Alrashedy et al., 2024), an iterative workflow is described that links a LLM with a vision-based feedback loop to generate code for a CAD environment. A text prompt is used to create an OpenSCAD model, which is then rendered and visually evaluated by a vision-language model. Discrepancies between the target and the generated geometry lead to corrective prompts, repeating the cycle until the model meets expectations. While the system automates certain steps, human intervention remains necessary for oversight. The approach is currently limited to simple parts and academic test cases. Domain-specific design logic, such as the use of standardized machine elements, is not addressed.

In the second approach (Khan et al., 2024), a method for generating CAD models based on natural language descriptions using a transformer-based architecture is proposed. The system receives a text prompt and returns a sequence of modeling operations that can be interpreted by a CAD backend. A dataset of paired CAD sequences and associated prompts was created for this purpose. The method focuses on reproducing geometric primitives and basic construction logic, such as extrusions or sketches. More complex constraints, tolerancing, or domain-specific functions are not covered. The model produces varying results depending on phrasing and manual post-processing is typically required. While the study highlights the feasibility of text-to-CAD translation, the technical depth remains limited and it does not meet the requirements of the mechanical design domain.

The third concept of Li et al. presents an approach for CAD model generation that combines GPT-4 with a scripted design logic (Li et al., 2024). Based on a textual description, the system generates a CAD script, primarily using Python and CadQuery, to produce simple 3D parts such as gears, nuts, and shafts. The framework includes visual inspection capabilities via image rendering, enabling limited model validation. The solution is restricted to elementary mechanical components with standard topology and does not generalize to complex parts or assemblies. The integration with CAD environments is indirect, and the system is not directly designed for iterative adaptation.

Mallis et al. (2024) propose a tool-augmented agent framework that connects a vision-language model with CAD operations via the FreeCAD Python API (Mallis et al., 2024). The system decomposes user prompts into sub-tasks, which are sequentially executed by external tools such as geometric modeling functions or knowledge retrieval components. The results, e.g., generated shapes or constraint feedback, are returned to the LLM for further processing. This approach allows iterative refinement of the model. From a technical viewpoint, this setup moves closer to real CAD workflows. Mechanical engineering knowledge like existing norms, load paths, standardized parts or interfaces are not embedded.

The fifth paper (Nelson et al., 2023) investigates the use of ChatGPT for generating OpenSCAD code to design microfluidic devices. The study follows a conversational workflow in which the user iteratively refines text prompts based on ChatGPT's code outputs and their renderings. Several basic geometries are realized, including spiral channels and splitters, which are then 3D printed and tested for fluid flow. The authors highlight the system's ability to recover from syntax errors and produce human-readable code. However, the setup offers currently no integration into other CAD software than OpenSCAD and is not applying any existing norms or standardized machine elements from the mechanical engineering domain.

The sixth research approach of Wang et al. does not focus on a single solution, but compares different models with regard to their usability and introduces a framework named CADFusion (Wang et al., 2025). This alternating training approach, switching between two stages, seeks to balance textual and visual learning signals. While the method shows promise in generating basic CAD models from textual descriptions, it currently lacks integration with standard CAD software and does not address complex design constraints or domain-specific requirements.

The last paper of Yavartanoo et al. proposes a pipeline that translates textual part descriptions into 3D CAD models by leveraging image generation and projection techniques (Yavartanoo et al., 2024). The system first uses a diffusion-based model to create isometric images from text prompts. These images are then converted into orthographic projections according to drawing norms (top, front and side view), which serve as the basis for reconstructing 3D geometry. While the approach effectively demonstrates the feasibility of generating simple mechanical components from textual descriptions, it currently lacks integration with standard CAD software and does not address complex design constraints or uses standardized machine elements or their design norms.

Figure 1 gives an overview of the selected research and summarizes the evaluation. As noted before, there is far more research available on LLM and CAD integration. However, the approaches shown above were selected because they are focused on practical examples and directly apply AI2CAD in the mechanical domain, which is the main target of this paper. More fundamental research which also covers other domains can e.g., be found in

- Ma et al. (2023) for assisting engineering designers via LLM in the concept phase
- Filippi (2023) for general concept generation in electronics
- Ege et al. (2024) for a discussion of strength and weaknesses of LLM against humans

Regarding the presented research and the first criteria of the integration level of AI and CAD, most approaches are basic with the exception of Mallis et al., Nelson et al. and Yavartanoo et al., because they link to existing CAD software (FreeCAD, OPENSCAD, Photo2CAD). Yet none of this software is considered in an industrial setting. Since all approaches represent current research topics, the technical maturity of the solutions ranges from basic to prototype-level at maximum. Regarding the mechanical engineering domain, none of the examined papers contains a library of standardized, mechanical elements that are typically used in an industrial or professional setting. Focusing on the possibility of parametric modification of the created CAD models, all approaches focus on creating unique models which are not directly suitable for parametric modification. Regarding the last criteria of norm integration, none of the approaches tried to integrate typical norms for standardized elements of the mechanical engineering domain.

Figure 1. Evaluated research approaches with AI-usage for CAD.

Evaluation Criteria / Research Approach	Integration Level CAD<->AI	Technical Maturity of Solution	Library of Mechanical Elements	Parametric Modification	Integration of Norms
CADCode + Vision Feedback (Alrashedy et al., 2024)	●○○	●○○	●○○	●○○	○○○
Text2CAD (Khan et al., 2024)	●○○	●●○	●○○	●●○	○○○
LLM4CAD (Li et al., 2024)	●○○	●●○	●○○	●●○	○○○
CAD-Assistant (Mallis et al., 2024)	●●○	●●○	●○○	●●○	○○○
ChatGPT + OpenSCAD (Nelson et al., 2023)	●●○	●●○	○○○	●●○	○○○
CADFusion (Wang et al., 2025)	●○○	●●○	●○○	●●○	○○○
Text2CAD via Drawings (Yavartanoo et al., 2024)	●●○	●●○	○○○	●●○	○○○

To summarize, the identified research shows a clear gap for an AI-supported CAD-design process which takes the norms of the mechanical engineering domain into account and creates parametric models, which can be easily adapted afterwards to be reused. The used CAD software does not yet reflect professional solutions like Siemens NX, Autodesk Fusion/Inventor or Catia. Therefore, an approach for coupling a LLM with an industrial CAD software is presented in the next chapter.

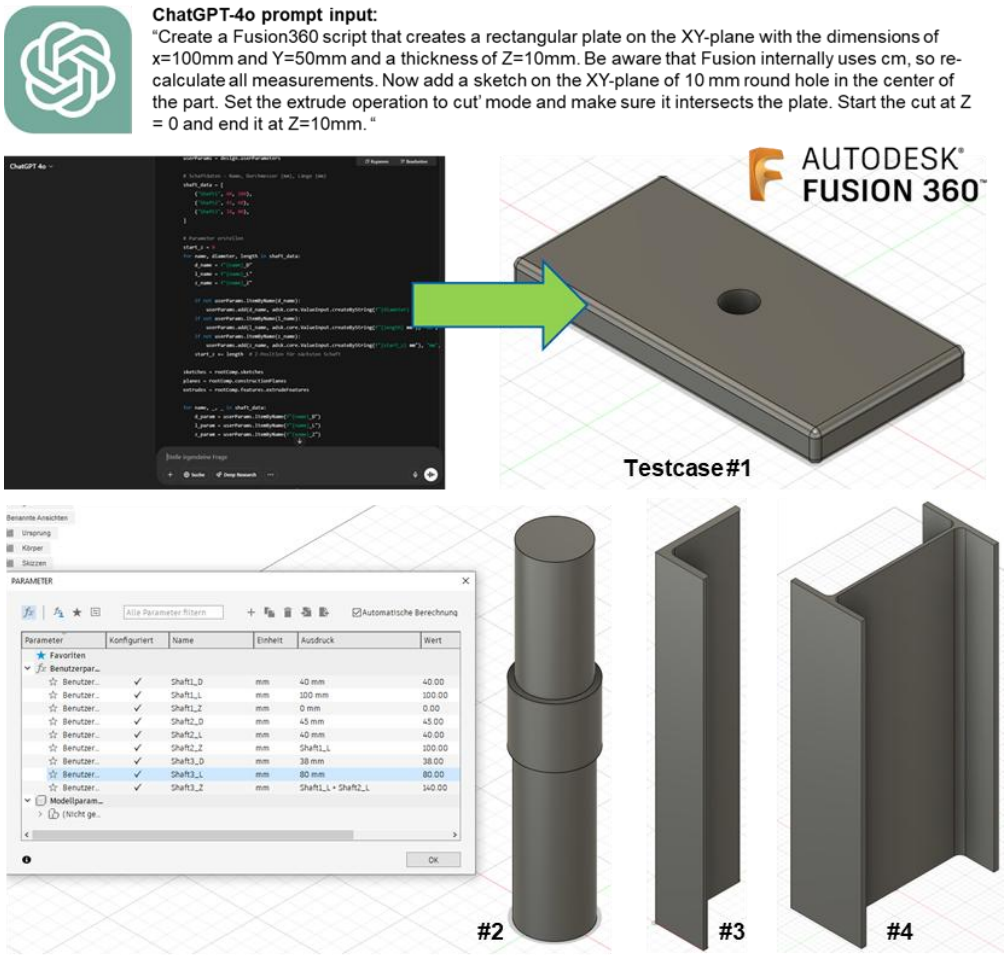
3. Approach of coupling a Large-Language-Model with CAD-design software

The real strength of coupling AI with CAD-design software is not to create unique models but to create 3D models that are parametric, which means they can be easily changed. Most experienced CAD users can create 3D models more quickly than “novices using AI” due to their spatial awareness and their understanding of the overall design and norms. When using LLMs, spatial awareness needs to be explicitly created for each element in order to locate them appropriately. This extra effort and the usual iterations to generate a bug-free, working script code by AI leads to a more time-consuming process. The huge advantage of employing AI is the possibility to create parametric 3D models that can be easily changed and reused many times, making the time investment more feasible.

For the chosen approach, the current “ChatGPT 4o” model has been selected together with Fusion 360 as the CAD software. The LLM is prompted to generate a Python script which can be directly executed in Fusion 360 and generates the CAD model. To evaluate the potentials and limits of this technique, four test cases have been created, which offer different levels of design complexity, elements and spatial arrangement.

Figure 2 shows the four test cases with varying complexity and the typical workflow with AI to generate the parametric CAD models. Test case 3 and 4 also integrate existing mechanical engineering norms for standardized parts and rely on the AI to identify the right dimensions of the parts using these norms. To showcase the potential of AI2CAD, the testcase #2 was prompted to be generated as a parametric design. This means that the design parameters like shaft diameter and length of each sections are not hardcoded with one value but rely on a parameter that can be changed afterwards (see figure 2, left side table). By changing i.e., “Shaft1_L” from 100mm to 50mm, the CAD model updates itself and the first section of the shaft is shortened.

Figure 2. Typical AI2CAD workflow and the selected four testcases.



The same additional prompt ("Make the design parametric") was successfully used on the third and fourth testcase and offers a huge advantage over standard hardcoded CAD models.

4. Identified potentials and limitations of the chosen approach

The evaluation of AI-supported CAD generation reveals several practical advantages, particularly for early-stage design tasks and instructional use in engineering education. One of the key potentials lies in the ability of LLMs to rapidly generate standardized sketches, such as cross-sections of profile systems, in accordance with common drafting norms. By simply stating the norm ID, the AI looks up the corresponding values for the sketch, which significantly accelerates the modelling of rule-based geometries. For simple to moderately complex components, parametric CAD scripts produced by the AI enable reproducible results and allow iterative refinement. Even multi-body parts can be generated successfully, provided that spatial relationships between features are clearly defined and consistently maintained.

An additional benefit is the possibility to preview the AI's geometric interpretation before finalizing the code. This mirrors the traditional process of sketching in engineering: visualizing intent before formal implementation. From a pedagogical perspective, the method proves instructive. It compels novice designers to articulate all relevant parameters of a part, making implicit knowledge explicit. For experienced users, this interaction can highlight common gaps in communication and serve as a didactic tool to better understand the difficulties faced by learners.

However, several limitations currently constrain the practicality. Complex components are difficult to describe in natural language with sufficient clarity, and the resulting prompts often lack the detail required for accurate reconstruction. It could be observed that as geometries become more intricate, the likelihood of misinterpretation by the AI increases. Decomposing the task into smaller steps and verifying each feature individually becomes necessary. The most frequent errors arise from incorrect spatial arrangement of features, suggesting that current AI models still lack robust 3D spatial reasoning capabilities.

5. Conclusion and outlook

The presented approach of coupling an AI with CAD software shows promising potential both for industrial and academic use cases that range from simple to medium complexity. One of the success factors is the spatial awareness of the model features. If the user is able to accurately describe the spatial arrangement, the AI design usually succeeds. Interestingly, this corresponds to by the author observed human performance levels of engineering students in academia. One decisive difference between novice and expert CAD students is the ability to understand and communicate the spatial arrangement of features in a model.

Furthermore, it could also be shown that existing mechanical engineering norms can be successfully built into the design process with AI. This provides great potential for creating designs that rely on standardized parts or norms. Even if the corresponding norm is not known by the user, the AI can be tasked to search for applicable norms to the given geometry, part or sketch, which massively helps novice CAD users and students alike. Moreover, the research revealed that the combination of AI & CAD can be used as teaching tool for novice CAD users or students, since it highlights missing information (e.g., dimensions or spatial arrangement) and allows the users to understand which information they have to explicitly share or express.

Further research is necessary and will be conducted with regards to the AI prompts in order to create a library of prompts for standard mechanical parts. Also, it is still unclear how a successful AI supported process could look like for more complex mechanical parts. Once these steps have been cleared, the path is open to generate complete modules or assemblies of multiple parts by AI.

References

Alrashedy, K., Tambwekar, P., Zaidi, Z., Langwasser, M., Xu, W., & Gombolay, M. (2024). *Generating CAD Code with Vision-Language Models for 3D Designs*. arXiv. Retrieved April 7, 2025, from https://arxiv.org/abs/2410.05340

Ege, D. N., Øvrebø, H. H., Stubberud, V., Berg, M. F., Elverum, C., Steinert, M., & Vestad, H. (2024). *ChatGPT as an inventor: Eliciting the strengths and weaknesses of current large language models against humans in engineering design*. arXiv. https://doi.org/10.48550/arXiv.2404.18479

Filippi, S. (2023). Measuring the Impact of ChatGPT on Fostering Concept Generation in Engineering Design. *Electronics, 16*, 3535.

Khan, M. S., Sinha, S., Sheikh, T. U., Stricker, D., Ali, S. A., & Afzal, M. Z. (2024). *Text2CAD: Generating Sequential CAD Models from Beginner-to-Expert Level Text Prompts*. arXiv. Retrieved April 7, 2025, from https://arxiv.org/abs/2409.17106

Li, Z., Srivatsan, R. A., McCormick, A., & Ingram, S. (2024). LLM4CAD: Multi-Modal Large Language Models for 3D CAD Generation. In *ASME IDETC/CIE Conference 2024*.

Ma, K., Grandi, D., McComb, C., & Goucher-Lambert, K. (2023). Conceptual Design Generation Using Large Language Models. In *ASME IDETC/CIE Conference 2023*.

Mallis, D., Karadeniz, A. S., Cavada, S., Rukhovich, D., Foteinopoulou, N., Cherenkova, K., Kacem, A., & Aouada, D. (2024). *CAD-Assistant: Tool-Augmented VLLMs as Generic CAD Task Solvers*. arXiv. Retrieved April 7, 2025, from https://arxiv.org/abs/2412.13810

Nelson, M. D., Goenner, B. L., & Gale, B. K. (2023). Utilizing ChatGPT to Assist CAD Design for Microfluidic Devices. *Lab on a Chip, 17*, 3778-3784.

Wang, R., Yuan, Y., Sun, S., & Bian, J. (2025). *Text-to-CAD Generation Through Infusing Visual Feedback in Large Language Models*. arXiv. Retrieved April 7, 2025, from https://arxiv.org/abs/2501.19054

Yavartanoo, M., Hong, S., Neshatavar, R., & Lee, K. M. (2024). *Text2CAD: Text to 3D CAD Generation via Technical Drawings*. arXiv. Retrieved April 7, 2025, from https://arxiv.org/abs/2411.06206

MAKING NEW FRIENDS: AN EXPERIENCE REPORT ON THE USE OF THE GROUP PIANO METHODOLOGY WITH YOUNG PEOPLE WITH INTELLECTUAL DISABILITIES FROM THE ASSOCIAZIONE NUOVI AMICI IN RECANATI (ITALY)

Priscila Gambary
Associate Professor, Departamento de Música, Universidade Federal de Sergipe (Brazil)
Visiting Professor (Post-Doctoral Course), Dipartimento di Studi Umanistici,
Università di Macerata (Italy)

Abstract

This study focuses on reflecting on the benefits and advantages of group piano teaching using the traditional American methodology for individuals with intellectual disabilities at the *Associazione Nuovo Amici* in Recanati, Macerata, Italy. The qualitative research was based on seven weekly in-person sessions held from January to February 2025, each lasting two hours, and was conducted through the development and application of a social behavior checklist for autism research, adapted by the author. The activities carried out during the sessions with the seven young participants from the institution were selected from various exercises in the textbook *Piano 101*, specifically designed for group piano lessons for teenage and adult beginners, aiming to create and nurture positive and meaningful musical and cultural memories for their human and social development. Based on a participant logbook structured by the author and collaborators from *Associazione Nuovi Amici*, who attended the sessions, it was possible to observe how the group piano teaching methodology positively impacted not only those who wished to learn specific musical contents, but especially in fostering creative, collaborative, and supportive behaviors – essential for a healthy life in a society that still segregates, labels, and marginalizes so many people.

Keywords: *Social collaboration, intellectual disability, group piano.*

1. Introduction

Music is a powerful tool for social inclusion, providing significant benefits that can improve anyone's quality of life, regardless of age. Gonçalves and Cunha (2018, p. 2) argue that it functions as a universal language, facilitating the understanding and expression of ideas and emotions, helping to create semiotic systems that give meaning to an individual's life. This study emerges from a practical group piano teaching experience using a methodology that asserts "music is for everyone," applied to seven young individuals at *Associazione Nuovi Amici* in Recanati, Italy.

The research addresses key guiding questions: How does the group piano methodology engage beginners? Do the proposed activities promote relaxation, fun, focus, self-listening, and listening to others? Do they enhance memory, motor coordination, and social interaction? Do they encourage emotional regulation and non-aggressive communication while stimulating dialogue and shared experiences?

The relevance of this study lies not only in promoting an emerging piano teaching methodology, but also in reinforcing the idea that musical learning is a human right, regardless of cognitive, motor, or social challenges. Full inclusion still faces significant barriers in many cultures, including Italy, where piano teaching remains traditionally conservative.

This research does not focus on the specific learning difficulties of individuals with intellectual disabilities, but examines how group piano methodology can be effective and democratic for beginners and how it can positively impact overall development. Thus, it seeks to demonstrate that music can be a vehicle for inclusion and personal growth, aligned with the belief that everyone has unique potential and limitations. This study contributes to the discussion on the importance of creating inclusive educational spaces where all can share experiences and learn collaboratively.

2. Starting with the piano

Rather than focusing on traditional music theory and notation, this work emphasizes creating a stimulating and playful environment where students can explore the piano keys intuitively, enjoyably, and relaxingly – particularly through improvisation and body percussion games, as advocated by Di Pangia (2020). This approach allows them to connect with their own musicality as well as their emotional and creative experiences.

Improvisation is central to this process, as it promotes personal expression and skill development, serving as a way to "reprogram" musical decision-making. It also fosters a collaborative environment where students express themselves without fear of mistakes, transforming errors into learning opportunities. This approach breaks the idea of competition, as noted by Maria Montessori, and instead encourages cooperation, creating an atmosphere of peace and solidarity – essential values in education.

Music, as a universal language, also plays a key role in peace education, as argued by Vygotsky, who saw language as a tool for organizing reality. Early musical practice should focus on exploration and discovery, prioritizing the experience of playing without the pressure of traditional notation. In the initial stages, traditional sheet music is replaced by pre-reading activities, where students interact with the keyboard playfully without needing theoretical knowledge. Methods such as reference keyboards and pentachord or interval-based exercises are introduced later.

Rhythm, another fundamental component, is taught through word association and body movement. Dalcroze argued that music should be taught through natural body movements, such as walking or dancing, enhancing rhythmic perception in an enjoyable and effective way. This work proposes that well-structured group piano practice, guided by the teacher, can be a powerful tool for musical learning that goes beyond technique, fostering discovery, cooperation, and individual expression.

3. Origins of group piano and method philosophy

The concept of group piano instruction dates back to the 19th century, notably with German musician Bernhard Logier (1777-1846), who believed theory and harmony should be learned directly at the keyboard. While the methodology spread across Europe, it gained traction in the United States in the late 19th century, particularly through Calvin Brainerd Cady's proposal to integrate it into American schools. Cady viewed group teaching as an effective way to develop musicality, critical listening, and musical knowledge by combining instrumental practice, music appreciation, movement, and creativity.

Campitelli and Mendes (2021, p. 2) report that group piano's introduction in American schools was propelled by educators like Thaddeus Giddings and Otto Miessner. In 1925, Columbia University adopted the methodology for higher education, and in 1956, Robert Pace systematized one of the first textbooks on the subject, *Piano for Classroom Music*. Throughout the 20th century, pedagogues like James Lyke, Richard Chronister, and Frances Clark advanced this field. Today, educators such as Lisa Zdechlik (University of Arizona) continue exploring its transformative potential.

A key distinction of group piano is its collaborative, non-competitive learning atmosphere, where students strive for collective beauty and harmony rather than individual perfection. The facilitator must embrace Montessori's principle that love is the most vital force in human development. Thus, all participants – regardless of limitations – can contribute to the group, fostering self-confidence and collective growth.

This methodology transcends musical practice: it nurtures affective communication, conflict resolution, and improves auditory and rhythmic perception. The focus shifts from competition to mutual growth, harmonizing differences to play "in sync" collaboratively.

4. Objectives

This study aims to examine the benefits of group piano instruction via traditional American methodology for beginners, by stimulating the creation of positive, meaningful musical and cultural memories not only for human development, but also for awakening creative, collaborative, and supportive behaviors.

5. Methods

The group piano classes at Associazione Nuovi Amici began on January 13, 2025, at 5 PM, at the association's headquarters. During the first four weeks, the initial focus was observing participants' interaction with the instrument, based on a checklist adapted by the author and used in the research with autistic children, *"Tu, Io e Il Robot"* (You, Me, and the Robot), conducted by Università di Macerata,

Clementoni, and the institution Omphalos in the Marche Region, Italy. Not only the interest in the keyboard but also the behavior during the proposed activities were analyzed. Out of the seven participants, only one showed reluctance to explore the piano, frequently expressing feelings of fear and discomfort.

The lesson structure was designed to balance movement and rest, focus and relaxation, creating a routine to help beginners feel comfortable in the musical environment. Additionally, visual aids—or alternative communication tools—were used, including drawings created by students from the Music Education course at Università di Macerata in December 2024. These visual resources, combined with auditory communication, are essential for beginner students, who often need complementary visual stimuli.

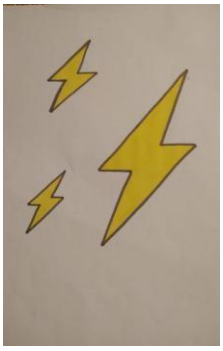
Understanding that each student has a unique way of learning, a flexible approach was adopted, recognizing that the same proposed activity might not be performed identically by everyone. The strategy was personalized according to each participant's needs, aiming to provide creative alternatives to overcome learning barriers.

6. Discussion

Drawings such as lightning bolts were used to signal moments requiring attention. To indicate when students should remain seated during practice, a drawing of a clock was placed on the table, with the instruction that they should not stand up while the symbol was active – this helped create a more inclusive learning environment, respecting each participant's individual needs.

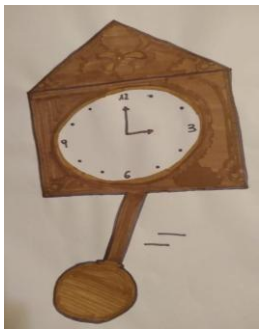
One of the biggest challenges for beginners is keeping a steady pulse in a song or musical piece. To reinforce the idea that we were in a collaborative setting where everyone should "walk hand in hand" at the same tempo, a drawing of a heart was raised whenever someone tended to play faster or slower than the rest of the group. These visual cues were only used until the fourth week, as by the fifth week, all participants were able to make eye contact with the teacher and understand verbal instructions without the need for drawings.

Figure 1. Non-verbal communication.



Movement attention

Heart of the Music



Time to practice

Rhythmic games involving each person's name and words were very helpful for this understanding, as were choreographies using clapping, foot stomping, and spins. These activities were carried out in the middle of the class or when the facilitator noticed signs of fatigue in the group. For beginners, the ideal is to hold shorter classes – 40 minutes long, twice a week – but since the participants lived in different cities, logistical reasons led to the classes being condensed into a single day.

The first suggested activity was drawing their right and left hands, which they could freely color, including numbering the fingers. Except for one participant who initially struggled to approach the piano, everyone else identified him/herself with the proposed task, remaining relaxed, in a playful mood, and attentive to the instructions. They also gave positive feedback through facial expressions and verbal responses.

After finishing their drawings, colorful stickers with finger numbers were placed on the participants' hands—a moment they greatly enjoyed—to help them begin associating their own hands with the drawings.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

Figure 2. Right and left hands with finger numbers.

The first piece taught was an exercise on the black keys, adapted from the book *Piano 101*. The sheet music was modified by the facilitator, with letters assigned to finger numbers to help students distinguish long and short notes – without using traditional rhythmic notation. Students explored the piece by singing, clapping, and choreographing movements, with the command "statue" signaling held notes. During keyboard practice, though not all used the correct fingers, half the participants focused on the black keys, and two executed the activity accurately by the second lesson. Feedback was overwhelmingly positive, with expressions of enjoyment, relaxation, and happiness.

One participant initially resisted, even attempting to leave the class, but this attitude shifted in the second lesson thanks to the facilitator's emotional support. Communication improved, and she began engaging attentively in subsequent sessions. Each lesson included a recap of prior content to reinforce memorization, with significant progress emerging by the fourth week.

By the end of the second session, the black-key activity was completed. Pieces should remain short for beginners' limited focus, though repetition can extend engagement. The second part of the piece was also shared through lyrics. After playing the full piece, students reflected on its character, describing it as "joyful"—a perception reinforced by drawings of the sun, warm colors, oceans, and flowers, plus a mini colorful umbrella added to amplify the mood.

While discussing the concept of a "happy day," one participant asked, *"What would a 'sad day' sound like?"* Through analogies like rain and melancholy, the group built emotional references. Collective reflection—via verbal/non-verbal communication, dance, singing, and choreography—strengthened musical and social bonds, fostering collaboration over time.

Conflicts emerged in the first month: overlapping conversations or solo practice attempts. Headphones weren't used, as this was an introductory experience with shared keyboards. By week five, individual mediation sessions helped regulate emotions during disputes.

In week three, pairs played simultaneously with the facilitator before full-group play, teaching students to appreciate peers' efforts and give positive feedback. For those without keyboards at home, hand-position diagrams were created. After three weeks, all began taking keyboards home, with many self-initiating practice and improvisation.

Week four introduced the C major position (one finger per white key), using a clock-face diagram (without hands) to associate notes with fingers.

Creative strategies flourished: note-name stickers on keys, musical hopscotch (stepping on note-labeled mats while singing), and physical/vocal/instrumental interplay. By week five, individual moments with the facilitator deepened emotional bonds – e.g., a distracted student motivated by stickers of his interests (food, soccer team *Juventus*), improving his coordination and focus.

Group practice grew more dynamic, including a violinist who enriched the collaborative environment. Initially reluctant to follow the piano method individually, he engaged eagerly when playing with peers. Parents noted marked improvements in their children's coordination and engagement. In just seven weeks, progress was evident: the distracted student, aided by alternating *Juventus*-colored stickers, mastered note positions. Group cohesion strengthened, and students gained confidence in ensemble playing.

The method also improved rhythmic pulse, attention, and peer bonding, fostering a positive learning environment.

Adaptability was key – e.g., practicing silently on unplugged keyboards to imagine sounds while coordinating on black keys. The project's success led to its expansion. One mother shared emotionally that her child, through the piano, was overcoming a fear of animals. The group piano methodology proved effective in nurturing musical skills, emotional growth, and social integration for beginner participants.

7. Conclusion

Educators must move beyond deficit-based perspectives, embracing inclusive approaches that prioritize relational pedagogy and belonging.

At *Nuovi Amici*, activities were social experiences as much as musical ones. Despite technical challenges, participants uniquely contributed to the "musical work," proving that differences create the most beautiful harmonies. Disabilities do not limit the freedom to dream. The group piano methodology—centered on behavior and interpersonal relationships—enhanced emotional regulation, social interaction, motor skills, creativity, and cognitive development.

The experience with the group piano methodology alongside the Nuovi Amici led us to the conclusion that the results of the philosophy behind the method are significant, especially regarding behavior, from the very first lessons. It contributes positively to psychological and emotional regulation, adherence to rules and routines, interaction with others and with the group, respect for different viewpoints and opinions, improvement of motor coordination, conflict resolution skills, and the development of an attitude of sharing and collaboration within and with the context in which the participant is inserted.

In the end, the collective performance of the piece, with everyone participating inclusively, conveyed the message that everyone is equally important. The exchange of gestures, smiles, and hugs highlighted the power of unity and the positive impact of feeling part of a group.

References

Campitelli, J., & Mendes, A. (2021). *Piano em grupo para quê? Reflexões sobre o estudo de piano em grupo para educadores musicais.* Available at: https://abemeducacaomusical.com.br/anais_congresso/v4/papers/966/public/966-4315-1-PB.pdf

Di Nicola, P. (2020, March 24). *Facciamo musica! La metodologia Orff-Schulwerk per l'educazione musicale*. Retrieved March 2025 from: https://www.cdmt.it/formazione/seminari/

Gonçalves, J., & Cunha, E. (2018). *Ensino de música para pessoas com deficiência intelectual: análise de uma experiência no município de Dias D'Ávila-Bahia*. Salvador: Anais XIV Encontro Regional Nordeste da Associação Brasileira de Educação Musical.

Neves, M. T., Parizzi, B., Freire, M., & Nunes, N. (2022). *Tocando do jeito delas: o piano como instrumento musicalizador de crianças com transtorno do espectro do autismo*. Belo Horizonte: Annals 8o Nas Nuvens... Congresso de Música.

Uszler, M., Gordon, S., & Mcbride-Smith, S. (1999). *The Well-Tempered Keyboard Teacher*. Boston: Cengage Learning.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

CRITICAL ENBIAGOGY (Εμβιαγωγική): BIOCENTRIC (INTERSPECIES) CRITICAL-PRAXICAL EDUCATION & COMMUNICATION BEYOND HUMAN BEINGS – DE-ANTHROPOCENTRISM

Antonis Hourdakis, Yannis Ieronymakis, & Marina Souka
Department of Primary Education, University of Crete, C.S.R.H.E.T.P. (Greece)

Abstract

Any radical and innovative educational theory poses the following questions: How should we learn about and teach regarding every living being? What is the appropriate place of animals in human education? Is there an alternative education? A critical interspecies pedagogy of beings that opens up other knowledge about human-animal relations? In other words: What happens to education when humans are not considered the centre of teaching subjects? In the field of Critical Pedagogy, the issue of animal rights requires due consideration. Foucauldian biopower leads to the exploitation of animals, which is linked to racism, class discrimination, and multiple forms of violence and hierarchy. As Nehm (2019) highlights, a paradigm shift presupposes the adoption of theories of conceptual change. This adoption concerns our scientific, research, and educational removal from pedagogical science and sciences of education towards a new enbiagogy and is even critical in the third decade of the 21st century. The basic concepts that constitute the core of an inter-/trans-species perspective, according to Taylor (2017), can be summarized as follows: a. Humans are members of the earthly living community, in the same sense, with the same value, and on the same terms as other living beings. b. Humans have no greater inherent value than other living beings. Why should we assume that they do not think, have feelings, grieve, suffer, or are not aware of the world around them? On many occasions we have misused the very animals' names as swear words. Is this the correct approach in a new framework in regard to our 21st century education? This is The Question to be Answered.

Keywords: *De-anthropocentrism, enbiocentrism, critical enbiagogy, interspecies education.*

1. The deadlocks of anthropocentrism

As we progress through the third decade of the 21st century, it continues to be asserted that the central challenge by the end of the century will largely concern the survival of the human species on the planet; or at the very least, the improvement of human life conditions. This is primarily due to the ecological crisis, global conflicts, pandemics, and other existential threats. When discussions regarding humanity's survival pivot toward solutions or risk prevention, emphasis is typically placed on the decisive role of education and citizen upbringing. The term *anthropocentric* is frequently employed to describe an educational approach that places humans at its core, purportedly equipping individuals to meet their needs and confront the challenges of our era.

This text, structured as a scientific manifesto, articulates a novel proposition that stands in stark contrast to the academic, social, and cultural *status quo*; a proposition framed as an "urgent call" for social action (Sinkey, 2002). In this context, we critique the anthropocentric nature of education, which perpetuates the notion that only humans can act as moral agents within nature; an idea we argue is responsible for humanity's deadlocks and the imbalance in its relationship with the natural world.

The urgency of this manifesto is brought to life, vividly depicted and visualized through the gaze, body posture, and, by extension, the "voice" of a living being - a cat - seated a top an old school desk, next to an equally aged school bag (once belonging to either a teacher or a student) (Image 1). These two objects - artifacts of social and historical significance - carry their own stories and are part of the museum collection exhibited as an outdoor (visual) installation at the Museum of Education of the University of Crete. The school desk is layered with mud, as it had previously been repurposed as scaffolding for the construction of a building; an indication of its devaluation by humans and its transformation into a purely utilitarian object. Likewise, the school bag, once a vessel for carrying educational materials, was instead used to transport construction tools, thereby stripped of its original intellectual purpose.

Within this framework, the desk and the bag - timeless signifiers of the school institution - are now devoid of the pedagogical function they were meant to fulfill. They symbolize *natura morta* (still life), or alternatively, the imprisoned past and present of education, burdened with the deadlocks and crises accumulated by humanity's arrogance toward nature.

Figure 1.

As evident from the spontaneous capture of the image by a visitor to the Museum, the cat has taken its place on the school desk, having left behind the 'bars' visible in the photograph. It now occupies the position of the one who teaches humans. From this perspective, the cat urges us to reflect on the past while simultaneously calling for an immediate shift - before it is too late - toward a new educational paradigm. This shift necessitates the adoption of novel conceptual frameworks that will distance us from a now lifeless pedagogy and guide us toward a critical and emancipatory *enbiagogy* that extends to all living beings. Its gaze - both imperative and stern - 'instructs' us on the urgent need to re-educate ourselves in ways of being and acting that will ensure ethics, justice, and sustainability among all species.

The ongoing conflict between nature and humanity - of which the ecological crisis is but one consequence - stems from the dualism between humans and nature, as well as the unchecked exploitation of non-human animals by humans. This worldview grants humanity the exclusive privilege of reason and culture. As a result, human supremacy is legitimized through teleological and ontological reasoning, as well as theological constructs (Asproulis, 2023). Within this framework, humans are placed at the center of the world, occupying a hegemonic position that subjugates all other beings.

This dominant anthropocentric worldview is constructed upon a value system that prioritizes human survival over the needs of other living organisms (Hourdakis, 2023). Within this framework, respect for the natural environment and non-human beings is confined merely to their protection from uncontrolled exploitation. Furthermore, the anthropocentric assumption that non-human beings lack consciousness, reason, or communicative abilities reduces them to the status of 'animal-objects,' thereby legitimizing various forms of oppression and violence against them, ranging from captivity and slaughter to their 'education' in ways that align with socially sanctioned demands, personal desires, and everyday routines (e.g., animals as companions, servants, etc.) (Spannring, 2019).

It is evident that these practices constitute a brutal exercise of anthropocentric *bio-power*, aimed at the subjugation of nature through the manipulation and control of its objectified populations in service of maximizing utilitarian productivity (Foucault, 2002:312).

What is urgently required, then, is a paradigm shift, aligning with A. Leopold's (1966) argument that what we need is an *ethic of the human toward the Earth*. The following discussion aims to articulate this alternative paradigm, while also exploring its educational implications.

2. Biocentric worldview, inter-species relations and enbiagogy

At this juncture, we turn to a sustainable and non-exploitative relationship between living and non-living beings; one that does not position humans as the center of existence. Drawing upon philosophical thought, a thorough re-examination of Aristotle's definition of the human as a *political animal* compels us to critically reconsider the interrelation between animality/embodiment, sentience, and their political viability. The enbiocentric perspective we advocate (in direct opposition to anthropocentrism) begins with the premise that humans are members of the Earth's community of life, possessing equal intrinsic worth and existing under the same conditions as all other living beings (Taylor, 2017). This reconceptualization of nature necessitates a fundamental redefinition of anthropocentric environmental ethics.

The human species, along with all other species, constitutes an element within a system of interdependence. Recognizing humans as symbiotic beings embedded within an interspecies community dismantles the notion of human individuality and superiority over other species. All organisms function as *teleological centers of life*, meaning that each is a unique entity with its own intrinsic characteristics,

pursuing a common purpose in its own distinctive way. At the same time, organisms co-create co-evolutionary networks that foster symbiotic relationships of cooperation, thus driving the evolutionary processes of nature. Such symbiotic relationships are foundational to all life forms on the planet, including human existence, within the framework of a responsible *symbiotic biopolitics* (Sen, 2009).

From a biocentric perspective, humans do not possess greater intrinsic value than other living beings, nor is their relationship with them transactional. Consequently, a new ethical and value-based framework emerges concerning the existence and interactions of living and non-living beings, significantly expanding the ways in which we think, interpret, and ultimately learn.

At the educational level, we are talking about an interspecies, critical, emancipatory, transformative, and liberatory pedagogy (critical enbiagogy), which raises the following questions: How should we 'teach' and learn about living beings? What is the proper place for all beings in education? Is there an alternative education that opens up new knowledge and experiences for human relationships? Ultimately, how is education realized when humans are not considered the only 'students'?

An interspecies/enbiocentric education is called upon to accept each living species as a unique entity and leads us to reconsider how human individualism constitutes the 'anthropomorphic' politics of sustainability. The enbiocentric questions raised promote an interspecies ethics and introduce us to a new postmodern-Earth rationalism, which refers to rational living beings that possess consciousness, intelligence, and culture and, as such, can teach humans (Hourdakis, 2023). This interspecies ethics challenges the traditional 'norms' of human-animal relationships (Pedersen, Håkansson & Wals, 2019) and recognizes that animals also have a right to planetary resources for a flourishing life that is sustained over time. In such an epistemological perspective, which changes the way we think about education, the 'human political animal' no longer holds exclusivity (Massumi, 2014).

This requires a post-anthropocentric pedagogy that seeks an extended learning process for humans, involving the continuous deconstruction of ingrained expectations and beliefs, leading to reflective thinking regarding the personal relationships humans form with animals. This process would enable individuals to reshape their choices and see themselves as beings willing to grow and "create new possibilities in the world" in a dialogical interspecies learning space (Dolby, 2017: 86).

What concerns us is how an education centered around critical analysis of hegemony, respect for nature, interspecies dialogue, and empathy for all living beings offers methods for dismantling violence, oppression, and hierarchical systems within our living culture (Andrzejewski, Pederson, & Wicklund, 2009). In this context, the exploitation of animals and natural resources becomes a matter of ethical concern (Weil, 2004). Therefore, the concept of dialogue and the critical dialectic of liberatory pedagogy includes all beings in an egalitarian condition of coexistence within the framework of a 'biocentric literacy of planetarity' (Kahn & Humes, 2009: 181). According to Bookchin (2016: 245), reintroducing humans into the natural evolution restores their fruitful coexistence in the world of life and leads to the naturalization of humanity.

3. How do non-human animals teach us?

How can we immerse ourselves in a cross-species dialectic in education, based on the assumption of overcoming our cultural prejudices that shape the way we think about non-human animals, and how can they teach humans?

A series of studies refer to various mechanisms/types of animal teaching, such as "opportunity teaching," where the teacher places the student in an educational problem, situation, or condition that encourages the acquisition of new knowledge, experience, or skills; "guidance teaching," where behavioral change results from encouragement or punishment; and "unintentional" social learning, which occurs through non-systematic or informal learning, such as imitation, etc. (e.g., Hoppitt et al., 2008). Therefore, we see how apparent the similarity of learning mechanisms is across all living beings, and how similar the terminology describing animal and human teaching appears.

Despite these findings, there is an opinion that examples of teaching in animals are fundamentally different from human teaching (Premack, 2007). This is the anthropocentric perspective, which considers teaching as evidence of specific human-like cognitive abilities, a distinction that is based on a hierarchy of living beings and ignores that teaching in animals is based on entirely different mechanisms from human teaching.

Therefore, the study of teaching in animals could offer valuable lessons in human education. Some examples include: a) Anatomy-Biology: common characteristics shared by humans and animals - eyes, nose, teeth, skin, limbs, stomach, lungs, kidneys, liver, brain. b) Language-Communication: animals have linguistic systems to transmit information and emotions. c) Social-Emotional Skills: many animals have a strong sense of responsibility to their social group, their brains produce dopamine in response to signs of affection, etc. d) Hierarchy of Needs: an animal accustomed to saving lives during disasters might set aside

its inherent survival instincts. e) Psychosomatic Symptoms: an abused pet may show signs of neurosis or aggression. f) Therapeutic Beings: for example, the horse, by absorbing the confusion in humans, offers them the opportunity to recognize this confusion and creates space for its overcoming. g) Life Cycle: animals are born, grow, age, get sick, and die.

A fusion of these “lessons” from animals with human lessons could form an ecocentric program for all living beings. In this program, for example: a) The school garden and field trips will be revived (walking ecoagogy). b) Animals will become teachers and classmates of humans. c) The social and political education of living beings will include the rights of animals (see the Universal Declaration of Animal Rights). d) A new environmental ethics will be cultivated. e) Learning contents will acquire a liberating and critical-practical value (e.g., in Aesop’s fables, we learn about the psychology of "sour grapes" and understand the benefits of the ant's industriousness; in religious parables, we appreciate creation as an ethical - ecocentric - refinement; in history, we understand that animals and abiotic nature have much to tell us about the past; in chemistry, the production of must is linked to the emotions created by chemical compounds, etc.).

In essence, based on the above, a new curriculum emerges with the introduction of thematic units that will ensure the harmony of relationships among all living and non-living organisms, without even requiring our conscious processes, in a harmonious way that will, rather than constrain us, liberate us. This will allow us to connect with the natural joy provided by the enbiocentric-ecocentric worldview, with new “lessons” now, such as: a) Rights - Justice - Freedom - Equality, b) Love - Care - Solidarity - Happiness, c) Friendship - Kindness - Empathy - Compassion - Altruism, d) Observation - Patience - Perseverance - Industriousness, e) Cohesion - Teamwork - Sociability - Communication, f) Sustainability - Continuity - Diversity - Similarity - Harmony.

4. Identity of the field

Based on the analysis thus far, we attempt to codify the characteristics of the new enbiocentric paradigm, following Fensham’s (2004) three criteria for identifying a scientific field. These criteria are:

1. The Scientific/Research Criterion: The critical enbiagogy, based on the theoretical framework developed, clearly approaches human life and its relationship with other living beings and the abiotic environment from a cross-species perspective. It seeks an alternative education system that opens up a new field for human-animal relationships. Within this context, the goal is to understand how *inter-species* knowledge is built, from preschool to higher education, to design learning environments in formal, non-formal, and informal education that effectively support the construction of this cross-species knowledge. Additionally, it aims to contribute to the re-examination of curriculum programs, design new interdisciplinary learning paths for specific subjects, and contribute to the development of sustainability and new global models through critical rethinking of dilemmas that may be related to these issues. It aims to adequately prepare educational staff and professional teams in enbiocentric paradigms and contributes to the advancement of research in this field through the implementation of research programs and experimental applications. Furthermore, it aims to prepare cross-species literate citizens.

2. The Criterion of Educational Impact: In the enbiocentric paradigm, the educational impacts concern: a) Critical-practical enbioagogical strategies and teaching methodologies, b) Evaluation of how students and teachers perceive the enbiocentric paradigm and how their perceptions evolve over time - conceptual change, interest, motivation, values, decision-making on bioethical issues, enbiocentric scientific thinking and understanding, c) The connection between formal, non-formal education, and informal learning, utilizing the theoretical and methodological tools of cross-species research and teaching.

3. The Structural-Institutional Criterion: Critical enbiagogy must govern academic research and teaching as an organically structured interdisciplinary field within academic institutions. The treatment of the object of enbiagogy is realized at the University of Crete (UoC) through the “Center for the Study and Research of the History of Education and the Teaching Profession” (C.S.R.H.E.T.P.) at the Department of Primary Education. The research work of C.S.R.H.E.T.P. addresses the educational and teaching needs in the field of studying and documenting the history of education and the teaching profession over time. The C.S.R.H.E.T.P. archival collections include numerous materials (printed and object-based) connected to living beings and the abiotic environment. Part of this educational material forms the museum collection/exhibition of the Museum of Education at C.S.R.H.E.T.P. Under the auspices of C.S.R.H.E.T.P., the Master's Program in "Educational Sciences, Critical Pedagogy, and Teacher Education" is organized and operated, in which postgraduate students are taught and practiced in the field of enbiagogy in both formal and non-formal education settings based on critical and practical pedagogical principles.

5. Support for the research proposal

C.S.R.H.E.T.P., as an academic entity at UoC, connects the study, research, and teaching of critical enbioagogy, mainly through the archival collections and museum exhibitions at the Museum of Education. Here, visits, workshops, and experimental applications are conducted. Additionally, within the framework of the Master's Program in Critical Pedagogy, the theoretical approach of enbiagogy is linked to critical-practical research and teaching methods. Thus, an interdisciplinary investigation and experimental application of enbiagogy is possible through C.S.R.H.E.T.P. in relation to the utilization of archival documents-museum material referring to inter-speciesism, the training of candidate and/or active teachers, the reformulation of the curriculum and interactive learning with the use of cutting-edge technologies in formal, non-formal and informal educational environments.

References

Andrzejewski, J., Pederson, H., & Wicklund, F. (2009). Interspecies education for humans, animals, and the earth. In J. Andrzejewski, M. Baltodano, & L. Symcox (Eds.), *Social justice, peace, and environmental education* (pp. 136-154). New York, NY: Routledge.

Ασπρούλης, Ν. (2023). Τα ζώα και το κατ' εικόνα: μια συμπλήρωση στη χριστιανική ανθρωπολογία; *Πολυμερώς και πολυτρόπως*. Retrieved from https://www.polymerwsvolos.org/2023/03/23/ta-zoa_kai_to_-kat-ikona/

Bookchin, M. (1991). *The Ecology of Freedom: The Emergence and Dissolution of Hierarchy*. New York: Black Rose Books.

Dolby, N. (2017). Critical experiential education in the honors classroom: animals, society, and education. *Honors in Practice, 13*, 71-88.

Fensham, P. J. (2004). *Defining an identity: The evolution of science education as a field of research*. Ντόρντρεχτ: Kluwer.

Foucault, M. (2003). *Society Must Be Defended*. Lectures at the Collège de France 1975-1976. Translated by David Macey. New York: Picador (Original work published 1997).

Hoppitt, W. J., Brown, G. R., Kendal, R., Rendell, L., Thornton, A., Webster, M. M., & Laland, K. N. (2008). Lessons from animal teaching, *Trends in ecology & evolution, 23*(9), 486-493.

Hourdakis, A. (2023), "Critical Digital Skills: from the Human Politics of Sustainability to its Interspecies Revision". In the International (online) Workshop entitled "*Key determinants and aspects of Sustainability: Interdisciplinary Approaches*", organized by the KEDIVIM- UoC and the International Cultural Communication Centre Malaysia (ICCCM). May 9 2023.

Kahn, R., & Humes, B. (2009). Marching out from Ultima Thule: Critical Counterstories of Emancipatory Educators Working at the Intersection of Human Rights, Animal Rights, and Planetary Sustainability. *Canadian Journal of Environmental Education, 14*(1), 179-195.

Leopold, A. (1966). *A sand county almanac: With essays on conservation from round river*. Random House Publishing Group.

Massumi, B. (2014). *What animals teach us about politics*. Duke University Press.

Nehm, R. H. (2019). Biology education research: Building integrative frameworks for teaching and learning about living systems, *Disciplinary and Interdisciplinary Science Education Research, 1*(1), 15.

Pedersen, H., Håkansson,J., & Wals, A. E. J. (2019). Introducing Critical Animal Pedagogies in Higher Education. In O. Franck (Ed.), *Vetenskaplighet i högre utbildning: Erfarenheter från lärarutbildning* (pp 315–334). Lund: Student litteratur.

Premack, D. (2007). Human and animal cognition: Continuity and discontinuity. *Proceedings of the national academy of sciences, 104*(35), 13861-13867.

Sen, A. (2009). *The concept of justice*. London: A. Lane.

Sinkey, A. (2002). *The Rhetoric of the Manifesto* (Doctoral Dissertation). Retrieved from https://etd.library.emory.edu/concern/etds/8c97kq58m?locale=pt-BR

Spannring, R., & Grušovnik, T. (2019). Leaving the Meatrix? Transformative Learning and Denialism in the Case of Meat Consumption. *Environmental Education Research, 25*(8), 1190-1199. doi:10.1080/13504622.2018.1455076

Taylor, S. (2017). *Beasts of burden: Disability studies and animal rights*. Duke University Press, 2017.

Weil, Z. (2004). *The power and promise of humane education*. Gabriola Island, BC: New Society Publishers.

THE EFFECT OF LENGTH MEASUREMENTS DIGITAL GAMIFICATION ON VAN HIELE LEVELS OF GEOMETRIC THINKING

Amtiaz Fattum[1], Fahda Sawid[2], & Amal Sharif-Rasslan[2]
[1]Department of Computer Science, The Academic Arab College of Education (Israel)
[2]Department of Mathematics, The Academic Arab College of Education (Israel)

Abstract

Geometry is one of the basic branches of mathematics that has developed over the years according to the need for objects measurements around us. Van Hiele theory is one of the essential theories in teaching geometry which may help to design instructional materials to improve students' mathematics performance. This model describes five levels of geometric thinking, such that it is impossible to bypass or skip a level and move to the next while learning a geometrical content. It comprises five levels: visualization, analysis, informal order/abstraction, deduction, and rigor. The aim of this study is to examine the effect of digital gamification that deal with the length concept on the geometric levels of thinking according to Van Hiele, among 5th graders. This study is an experimental one and was edited by basically quantitative method. A total of 55 fifth graders participated in the current study. Data was collected by two questionnaires; one questionnaire was before an intervention program (15 lessons) based on digital gamification in measuring length and the second questionnaire was after the intervention. Kuder-Richardson 20 (KR-20) was employed to estimate internal consistency of the questionnaires, $r_{KR20} = 0.566$. The main finding of this study was that digital gamification contributes significantly to the development of the Van Hiele thinking levels which deal with the length concept. There was significant progress from low-thinking level before the intervention to a higher level after the intervention; the percentage of students who reached the third Van Hiele level improved, 31% to 55% pre and post the intervention program respectively. Moreover, the visualization thinking level was affected significantly by the intervention in all skills except the logical one; in the analysis thinking level the intervention affected the applied skill prominently. And in ordering level the effect of the intervention on the visual skills was negligible. Based on this study it is recommended to integrate digital gamification in teaching length measurement among students, particularly fifth grade students.

Keywords: *Geometry, Van Hiele theory, length measurement, digital gamification.*

1. Introduction

Geometry is a basic branch of mathematics, it is based on fundamental concepts, axioms, and properties. To achieve a deep understanding of geometry, the student needs to develop thinking skills related to the subject of geometry; spatial perception is the basis for learning geometry and contributes to the development of geometric thinking (Van Hiele, 1999). Many scholars investigated students' understanding and geometrical thinking, i.e., Astuti & Suryadi (2018) referred to Van Hiele's theory to understand students' geometric thinking levels. This theory has three aspects: the existence of levels, the properties of the levels, and the progress from one level to the next level. According to Van Hiele theory, there are five levels of thinking or understanding in geometry: Level 1 (recognition/visualization)- at this level students start analyzing and naming properties of geometric figures. They do not see relationships between properties. Although they can measure, fold and cut paper, use geometric software etc., they do not see a need for proof of facts discovered empirically. Level 2 (analysis): At this level students perceive relationships between properties and figures, but they cannot explain the relationship between these traits and cannot understand the definition. Level 3 (order/abstraction): At this level students can see the relationship of properties on one or many geometry objects, students can create abstract definitions, discover the properties of various objects using informal deduction, and classify them hierarchically. Level 4 (deduction): At this level students can give deductive geometric proofs. They are able to differentiate between necessary and sufficient conditions. They identify which properties are implied by others. They understand the role of definitions, theorems, axioms and proofs. And level 5 (rigor): At this level students

understand the way mathematical systems are established, can work in different geometric or axiomatic systems, and can compare systems based on different axioms and can examine geometry without presenting a concrete model (Clements, 2003; Moyer, 2003; Prapowo & Eri, 2011; Van de Walle, 2011).

Hoffer (1981) outlined five essential skills for mastering geometry. The first is 'visual skill', which involves the ability to recognize various geometric figures and spatial relationships, identify centers and symmetries, understand how parts relate to the whole, classify shapes, and mentally visualize geometric models. The second is 'verbal skill', which includes the ability to name and describe geometric objects accurately, interpret and construct definitions, express relationships between figures, generalize concepts, and comprehend the logical structure of verbal problems. The third is 'drawing skill', refers to the capacity to sketch geometric figures, label significant points, translate verbal descriptions into diagrams, create figures based on properties, enhance images with relevant elements, recognize the limitations of sketches, and construct geometric models. The fourth is 'logical skill', which entails comparing and classifying geometric objects based on their properties, applying essential definitions, drawing logical conclusions, developing proofs, and understanding the use and limitations of deductive reasoning. Finally, 'applied skill' involves recognizing geometric concepts in real-world contexts, building models from physical objects, applying geometric properties to these models, representing natural phenomena with geometric reasoning, and solving problems using these representations.

In the field of geometry education, early introduction at the elementary level and the implementation of active pedagogical strategies are strongly recommended (Salifu et al., 2018). These recommendations underscore the need for educational researchers to explore innovative teaching methods that can transform traditionally passive and disengaging mathematics classrooms into dynamic, interactive learning environments. One promising alternative to conventional instruction is the adoption of active learning approaches, such as educational games, which have been shown to enhance student participation and conceptual understanding (Nand et al., 2019; Ting et al., 2019). Within this context, 'gamification' - defined as the integration of game elements such as points, rewards, challenges, tasks, and immediate feedback into the learning process (Lämsä et al., 2018)- emerges as a particularly effective strategy. Empirical studies have demonstrated that gamification can yield positive outcomes in mathematics education broadly (Baldeón et al., 2015; Stoyanova et al., 2017), and it has shown specific benefits in the teaching and learning of geometry, particularly in terms of increasing learner engagement and academic achievement (Aridi & Saad, 2020; Kamalodeen et al., 2021).

Length measurement is a fundamental component of the mathematics curriculum. However, Sarama et al. (2022) highlights that students often exhibit significant difficulties in developing a sound understanding of measurement concepts. Common challenges include the inability to determine the length of an object using a ruler without numerical labels, failure to align the object with the zero point of the measuring tool, and a tendency to count hash marks rather than the intervals between them, which leads to an error that frequently results in inaccurate measurements. Additionally, students often struggle to place physical units of length end-to-end along an object without leaving gaps or overlaps, further indicating a lack of conceptual grasp of continuous measurement. Following these claims, it is necessary to investigate students' usage of digital gamification in length measurements.

2. Objectives

The purpose of this study is to examine the effect of digital gamification that deals with the length concept on the geometric levels of thinking according to Van Hiele, among 5th graders.

Research Questions

1. To what extent did 5th graders control the Van Hiele levels and the five Hoffer's skills before digital gamification usage?
2. To what extent did 5th graders control the Van Hiele levels and the five Hoffer's skills after digital gamification usage?
3. How does digital gamification impact the progression of 5th-grade students through the Van Hiele levels of thinking in relation to the concept of length?

3. Methodology

This study was designed by quantitative method.

3.1. Participants

A total of 55 fifth graders (28 males and 27 females) participated in the current study from the north zone of our country. The range of the participants' mathematics average was (60% - 75%). The participants had similar socioeconomic status.

3.2. Instruments

In this study the following instruments were used:

a. Two (pre, and post) mathematical achievement questionnaires related to the "length measurement" content. Both questionnaires included 15 length measurement problems due to the three first van-Heile thinking levels: The first five problems (1-5) test the first level, the recognition level, problems from (6 – 10) test the second level, the analysis level, and problems (11 – 15) test the third level, the ordering level. Kuder-Richardson 20 (KR-20) was employed to estimate internal consistency of the questionnaires, $r_{KR20} = 0.566$
b. An intervention program (15 lessons) based on digital gamification in measuring length. Table 1 details the units and some online digital game length measurement examples.

Table 1. Intervention units' content.

Unit*	aim	Games' sites- example
1	**Measuring length at the recognition level**	• https://www.ixl.com/math/grade-4/measure-using-an-inch-ruler • http://www.softschools.com/measurement/games/ruler/measuring_length_in_cm/
2	**Measuring length at the analysis level**	• http://www.mathplayground.com/geoboard.html • http://phet.colorado.edu/sims/estimation/estimation_en.html • http://www.iboard.co.uk/activity/Measuring-Lines-Make-1m-270 • https://www.ixl.com/math/grade-5/perimete
3	**Measuring length at the order level**	• https://www.ixl.com/math/grade-6/find-side-lengths-of-similar-figures • http://pbskids.org/cyberchase/math-games/sleuths-on-the-loose • https://www.ixl.com/math/grade-3/relationship-between-area-and-perimeter

(*) Each unit includes 5 lessons.

4. Results

Table 2 presents the percentages of students according to Van Hiele levels and Hoffer skills pre and post digital gamification.

Table 2. Percentage of students' right solutions pre and post gamification according to van Hiele levels and Hoffer skills.

van Hiele level	van Hiele Level Control* (%)		Skill	Right Solutions (%)	
	Pre gamification	Post gamification		Pre gamification	Post gamification
Recognition	58	83	Visual	51	96
			Verbal	60	87
			Drawing	38	92.7
			Logical	72.7	63.6
			Applied	67	76
Analysis	55	71	Visual	60	51
			Verbal	69	80
			Drawing	32.7	66.5
			Logical	36	76
			Applied	78	81.8
Order	34	55	Visual	60	71
			Verbal	34.5	41.8
			Drawing	31	56
			Logical	23.6	51.6
			Applied	21.8	55.5

(*) Control means when a student passing from a van Hiele level of geometrical thinking to the next level.

4.1. Research question no. 1

The first research question was: " To what extent did 5th graders control the Van Hiele levels and the five Hoffer's skills before digital gamification usage?"

Table 2 (columns 3 and 5) shows that pre digital gamification van Hiele levels, 58%, 55% and 34% according to recognition, analysis and order respectively. Moreover, the table presents the ranges of each Hoffer skills level: 38%-67%, 36%-78%, and 21.8%-60% (according to the van Hiele first three levels respectively).

4.2. Research question no. 2

The second research question was: " To what extent did 5th graders control the Van Hiele levels and the five Hoffer's skills after digital gamification usage?"

Table 2 (columns 4 and 6) shows that post digital gamification van Hiele levels, 83%, 71% and 55% according to recognition, analysis and order respectively. Moreover, the table presents the ranges of each Hoffer skills level: 63.6%-96%, 51%-81.8%, and 41.8%-71% (according to the van Hiele first three levels respectively).

4.3. Research question no. 3

The third research question was: "How does digital gamification impact the progression of 5th-grade students through the Van Hiele levels of thinking in relation to the concept of length?"

Table 2 presents clear differences in van Hiele levels and Hoffer skills in favor of the post digital gamification usage. Recognition level jumped from 58% to 83%, analysis level jumped from 55% to 71% and the order level jumped from 34% to 55%. In addition, each skill increased significantly for each van Hiele level.

5. Discussion

The findings of this study indicated that digital gamification contributes significantly to the development of the Van Hiele thinking levels which deal with the length measurement concept. There was significant progress from low-thinking level before the intervention to a higher level after the intervention. Moreover, the visualization thinking level was affected significantly by the intervention in all skills except the logical one; in the analysis thinking level the intervention affected the applied skill prominently. And in ordering level the effect of the intervention on the visual skills was negligible.

The current study investigated students' digital gamification usage, which is an innovative teaching method, an interactive learning environment. Thus, our findings may be explained by Salifu et al. (2018) who suggested that games are an active learning pedagogy and transform the dull learning environments in mathematics classrooms into smart ones.

6. Conclusions

This study recommends integrating digital gamification into teaching length measurement among students.

References

Aridi, S. N., & Saad, M. M. (2020) Gamification for elementary geometry learning: Is it a recommended scenario? *Proceedings of first conference Alexandria pedagogical innovation and technology enhance, APITEL*, Egypt.

Astuti, R., & Suryadi, D. (2018, November). Analysis on geometry skills of junior high school students on the concept congruence based on Van Hiele's geometric thinking level. *Journal of Physics: Conference Series, 1132*(1), 012036. IOP Publishing.

Baldeón, J., Puig, A., Rodríguez, I., Lopez, M., Grau, S., & Escayola, M. (2015). Gamification of elementary math learning: A game designer role-playing experience with kids. *Workshop on Gamification in Education*: Barcelona, Spain.

Clements, D. (2003). *A research companion to principles and standards for school mathematics. Teaching and Learning Geometry* (New York State University)

Hoffer, A. (1981). Geometry is more than proof. *Mathematics teacher, 74*(1), 11-18.

Kamalodeen, V. J., Ramsawak-Jodha, N., Figaro-Henry, S., Jaggernauth, S. J., & Dedovets, Z. (2021). Designing gamification for geometry in elementary schools: insights from the designers. *Smart Learning Environments, 8*(1), 36.

Lämsä, J., Hämäläinen, R., Aro, M., Koskimaa, R., & Äyrämö, S. M. (2018). Games for enhancing basic reading and maths skills: A systematic review of educational game design in supporting learning by people with learning disabilities. *British Journal of Educational Technology, 49*(4), 596-607.

Moyer, T. O. (2003). *An investigation of The Geometer's Sketchpad and van Hiele levels*. Temple University.

Nand, K., Baghaei, N., Casey, J., Barmada, B., Mehdipour, F., & Liang, H. N. (2019). Engaging children with educational content via Gamification. *Smart Learning Environments, 6*(1), 1-15. https://doi.org/10.1186/s40561-019-0085-2

Prabowo, A., & Ristiani, E. (2011). Rancang bangun instrumen tes kemampuan keruangan pengembangan tes kemampuan keruangan Hubert Maier dan identifikasi penskoran berdasar teori Van Hielle. *Kreano, Jurnal Matematika Kreatif-Inovatif, 2*(2), 72-87.

Salifu, A. S., Yakubu, A. R., & Ibrahim, F. I. (2018). van Hiele geometric thinking levels of pre-service teachers of EP college of education, Bimbilla-Ghana. *Journal of Education and Practice, 9*(23), 108-119.

Sarama, J., Clements, D. H., Barrett, J. E., Cullen, C. J., Hudyma, A., & Vanegas, Y. (2022). Length measurement in the early years: teaching and learning with learning trajectories. *Mathematical Thinking and Learning, 24*(4), 267-290.

Stoyanova, M., Tuparova, D., & Samardzhiev, K. (2017). Impact of motivation, gamification and learning style on students' interest in Maths classes—A Study in 11 high school grade. *International conference on interactive collaborative learning* (pp. 133-142). Springer, Cham. https://doi.org/10.1007/978-3-319-73204-6_17

Ting, F. S. T., Lam, W. H., & Shroff, R. H. (2019). Active learning via problem-based collaborative games in a large mathematics university course in Hong Kong. *Education Sciences, 9*(3), 172.

Trimurtini, Waluya, S. B., Sukestiyarno, Y. L., & Kharisudin, I. (2022). A systematic review on geometric thinking: A review research between 2017-2021. *European Journal of Educational Research, 11*(3), 1535-1552. https://doi.org/10.12973/eu-jer.11.3.1535

Van de Walle, J. A. (2001). Geometric Thinking and Geometric Concepts. In *Elementary and Middle School Mathematics: Teaching Developmentally* (4th Ed.). Boston: Allyn and Bacon.

Van Hiele, P. M. (1999). Developing geometric thinking through activities that begin with play. *Teaching Children Mathematics, 5*(6), 310-316.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

REIMAGINING EDUCATOR SUPPORT: A FRAMEWORK FOR A MULTI-TIERED SYSTEM TO PROMOTE TEACHER WELL-BEING AND MENTAL HEALTH

Lee Ann Rawlins Williams
University of North Dakota (USA)
PhD, CRC, CFLE

Abstract

This paper presents a conceptual framework for a Multi-Tiered System of Support for Teachers (MTSS-T) aimed at addressing the well-being of educators, developed through a comprehensive review of existing literature. While MTSS models have been widely implemented to support student well-being, similar frameworks for supporting teachers remain underdeveloped. The growing prevalence of burnout, stress, and mental health challenges among educators underscores the urgent need for a structured, scalable approach tailored specifically to their well-being. This paper proposes a three-tiered model designed to meet the diverse needs of educators: Tier 1 (universal support) for all teachers, Tier 2 (targeted support) for those showing early signs of stressor need for additional instructional support, and Tier 3 (intensive, individualized support) for teachers needing personalized interventions or facing severe challenges in the classroom. Drawing on research from psychology, educational theory, and organizational studies, this review synthesizes evidence-based strategies that have proven effective in supporting educator mental health. These include stress management programs, mindfulness practices, peer support networks, and organizational changes to reduce workplace stressors. The proposed MTSS framework provides a conceptual model that adapts existing student-focused interventions to meet the unique needs of educators while recognizing the distinct pressures teachers face. The review identifies key findings, including the critical role of early intervention in preventing burnout, and the importance of a tiered approach in ensuring equitable access to support. Despite significant progress in supporting student mental health, research on effective mental health interventions for educators is limited. This paper highlights these gaps and advocates for further studies on the scalability and systemic integration of mental health support for teachers. In conclusion, this paper argues that a comprehensive MTSS model for educators could significantly improve teacher mental health, enhance job satisfaction, and contribute to a positive classroom environment. By adapting the successful principles of student mental health support to meet the needs of educators, this review offers a foundational framework for future research and practical implementation of teacher-focused mental health initiatives.

Keywords: *Multi-tiered system of support (MTSS), educator mental health, teacher well-being, burnout prevention, mental health support for teachers.*

1. Introduction

The teaching profession is increasingly characterized by high rates of burnout and attrition, with research indicating that teachers face extreme emotional and psychological challenges due to heavy workloads, secondary trauma, and insufficient institutional support (Cells, et al., 2023; Ha, et al., 2025; Reinke, et al, 2025; Williams, 2024). These challenges are not confined to any one region but are a global phenomenon affecting educators in diverse educational systems. The World Health Organization (WHO) and United Nations Educational, Scientific and Cultural Organization (UNESCO) have recognized teacher stress and burnout as a growing crisis, particularly in low-resource and conflict-affected regions (World Health Organization & United Nations Educational, Scientific and Cultural Organization, 2021).

In many parts of the world, teachers work under stressful conditions exacerbated by economic instability, political conflict, and natural disasters. For example, in disaster-prone areas such as Southeast Asia and the Caribbean, educators must navigate post-disaster trauma, school closures, and increased student emotional distress while managing their own well-being (Hoffman & Blecha, 2020; UNICEF, 2023). In conflict zones, such as parts of the Middle East and Sub-Saharan Africa, teachers frequently act

as first responders to students experiencing war-related trauma, placing additional emotional burdens on them (Sam & Gupton, 2024; Sharifian, & Kennedy, 2019). Similarly, the COVID-19 pandemic underscored the need for systematic educator support, as teachers worldwide were required to rapidly shift to remote instruction while managing personal and professional stressors (Barron, et. al., 2021).

Traditional interventions for teacher well-being are often reactive rather than preventative, failing to systematically address the multifaceted challenges educators face. This paper proposes a Multi-Tiered System of Support for Teachers (MTSS-T) as an innovative, research-driven model aimed at providing structured, proactive support at varying levels of need. By integrating a tiered system that ranges from universal preventive measures to targeted interventions and crisis response, this model ensures that educators receive tailored support at every stage of their professional journey.

This paper introduces ***The Multi-Tiered System of Support for Teachers Framework (MTSS-T)*** as a necessary and adaptable approach to enhancing global teacher retention, well-being, and sustainable educational systems. The model emphasizes the importance of scalable interventions tailored to diverse educational contexts, including those affected by natural disasters, pandemics, and humanitarian crises, ensuring that educators receive appropriate levels of support based on their needs. The MTSS-T framework offers a structured, evidence-based approach that shifts education systems from reactive crisis management to proactive, long-term resilience-building for educators worldwide.

2. Design

This study employs a conceptual framework approach to developing a Multi-Tiered System of Support for Teachers (MTSS-T). By synthesizing existing literature on teacher burnout, mental health interventions, and tiered support systems, this model is structured to address varying levels of need. This framework draws upon best practices from student-focused MTSS models, psychological theories of resilience, and organizational strategies for workplace well-being. The goal is to create a research-informed model that can be applied across diverse educational settings.

To ensure a comprehensive and systematic review, a set of keywords and search terms was used to identify relevant literature. The following keywords were utilized across academic databases such as PsycINFO, ERIC, Google Scholar, and PubMed:

- "Teacher burnout"
- "Compassion fatigue in educators"
- "Mental health interventions for teachers"
- "Multi-Tiered System of Support (MTSS) for educators"
- "Workplace well-being in education"
- "Stress management programs for teachers"
- "Organizational support for teachers"
- "Resilience and professional development in education"

Inclusion criteria prioritized peer-reviewed articles, government reports, and policy documents published within the last 15 years, with a focus on educator mental health, professional development, and systemic interventions. Studies that focused exclusively on student MTSS without connections to educator well-being were excluded. The findings from this literature review were synthesized to develop a structured, scalable MTSS framework tailored specifically for teachers.

3. Methodology

A comprehensive review of peer-reviewed literature, policy documents, and global education reports was conducted to assess the existing research on teacher well-being and burnout interventions. Sources were analyzed to identify common themes related to teacher mental health, multi-tiered intervention frameworks, and institutional support structures. Key areas of analysis included:

- Studies on teacher burnout and compassion fatigue
- Research on existing mental health interventions for educators.
- Comparative analyses of international teacher support models
- Policy recommendations from UNESCO, United Nations, OECD, and national education ministries.

Findings from this review informed the development of a structured, tiered intervention model designed to be scalable and adaptable across different education systems.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

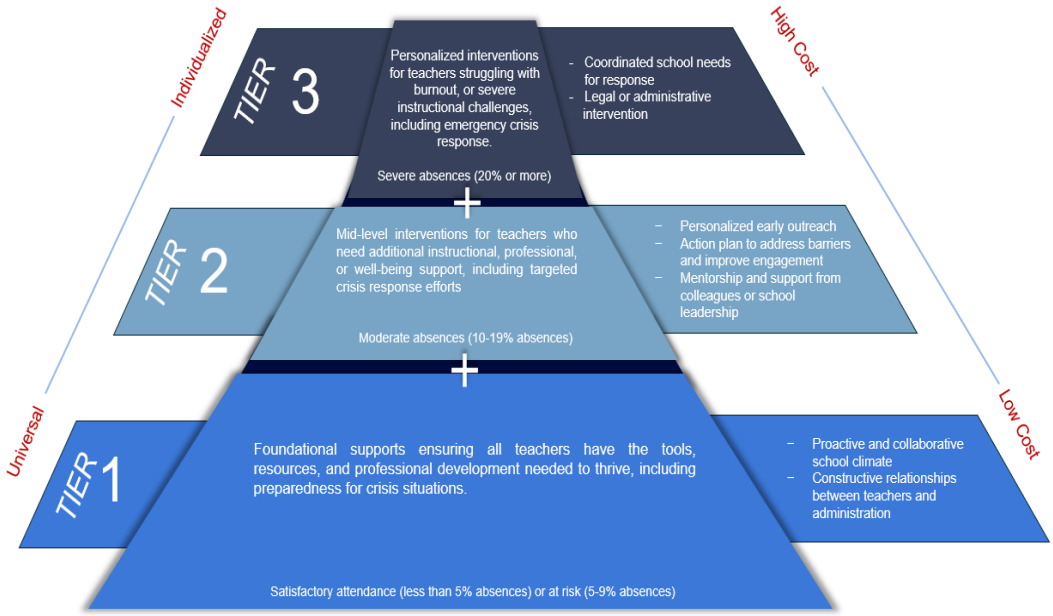
4. Discussion

The ***Multi-Tiered System of Support for Teachers Framework (MTSS-T)*** provides a structured, tiered approach to addressing educator well-being, professional growth, and crisis intervention. Unlike traditional support mechanisms that often function in isolation, this model integrates multiple layers of intervention to provide comprehensive, ongoing support based on individual teacher needs. By adapting the well-established principles of MTSS, which have been successfully implemented in student interventions, this model ensures that educators receive proactive, systematic support rather than relying on reactive measures when challenges arise.

The Multi-Tiered System of Support for Teachers Framework (MTSS-T)

To systematically address teacher well-being and burnout, this study proposes a **three-tiered MTSS framework (MTSS-T)** tailored to the needs of educators. This model ensures that teachers receive appropriate levels of support based on their risk of burnout or mental health challenges. The framework is structured as noted in Figure 1.

Figure 1. Multi-Tiered System of Support for Teachers Framework (MTSS-T).



Implications of the MTSS-T Framework for Educator Well-Being

A key strength of this framework is its ability to differentiate support based on need, ensuring that universal strategies are available to all teachers while providing targeted and intensive interventions for those at greater risk of burnout or crisis. **Tier 1 interventions** emphasize systemic efforts to promote teacher well-being through professional development, mentorship, and workplace wellness initiatives. These strategies create an institutional culture that prioritizes teacher mental health, reducing the stigma associated with seeking support and fostering an environment where self-care is normalized.

For teachers showing early signs of burnout or need for additional instructional support, **Tier 2 interventions** offer structured, mid-level supports such as peer mentoring, personalized early outreach, and flexible workload accommodations. Research indicates that timely intervention at this stage can prevent more severe emotional and psychological distress, improving long-term teacher retention rates. Additionally, in schools with high stress levels due to external crises such as natural disasters, school violence, or economic instability, targeted support at this level are critical for maintaining teacher resilience and instructional effectiveness.

At the most intensive level, **Tier 3 interventions** ensure that teachers facing significant challenges needing individualized support, including severe instructional challenges, access to emotional support, crisis response services, and alternative career pathways if needed. The inclusion of crisis response mechanisms acknowledges the reality that teachers often experience instructional challenges and extreme stress in their roles, particularly in under-resourced or high-risk environments. Schools implementing this model must prioritize access to emotional support services, administrative accommodation, and structured recovery plans to support teachers facing acute challenges.

This model has important implications for education policy, school leadership, and global implementation. Countries with existing teacher support frameworks can integrate the MTSS for Teachers approach into their professional development and wellness programs. In low-resource settings or disaster-prone regions, flexible adaptations of this model can be developed, focusing on peer-support networks and if needed external interagency services. Future research should explore how this framework can be piloted in diverse educational contexts and assess its long-term impact on teacher retention, job satisfaction, and student outcomes.

5. Conclusion

The Multi-Tiered System of Support for Teachers Framework (MTSS-T) represents a proactive, scalable solution to the growing crisis of teacher burnout, stress, and challenges in the classroom. By applying a tiered intervention model, this approach ensures educators receive appropriate levels of support, ranging from universal well-being initiatives to targeted and intensive interventions. Through structured mentorship, workload adjustments, psychological first aid, and crisis response mechanisms, this model provides a comprehensive strategy to enhance teacher resilience and professional sustainability.

The implementation of this model requires institutional commitment, cross-sector collaboration, and policy integration. School leaders, policymakers, and researchers must work together to establish data-driven teacher support systems that prioritize educator well-being as a core component of educational success. Additionally, future research should examine the scalability of this model in different educational settings, particularly in regions affected by economic hardship, political instability, or environmental disasters.

By shifting from reactive, short-term interventions to a structured, long-term framework, the MTSS for Teachers Framework (MTSS-T) has the potential to transform the teaching profession, ensuring that educators receive the support they need to thrive. Investing in teacher well-being ultimately enhances student outcomes, school environments, and overall educational effectiveness, reinforcing the critical need for a multi-tiered, data-informed approach to educator support worldwide.

By adapting the evidence-based principles of MTSS-T to address teachers' instructional and emotional needs, this model provides a structured, tiered approach to fostering teacher success and well-being. Recognizing that teachers, like students, require differentiated support, the MTSS for Teachers Framework (MTSS-T) offers a proactive, data-driven strategy to combat burnout, improve job satisfaction, and enhance overall educational effectiveness.

Future research should explore how this framework can be implemented at scale across varying education systems, particularly in under-resourced or crisis-affected regions. By prioritizing teacher well-being as a core component of educational reform, policymakers and school leaders can create environments that support both educators and the students they serve. Without a clearly defined multi-tiered framework for teacher support, many educators are left navigating challenges alone, leading to higher attrition rates and declining job satisfaction. Addressing this gap requires a shift in how schools and districts conceptualize teacher well-being—not as an add-on to professional development but as an integrated, essential component of the educational system. Future research should explore how existing MTSS principles, such as universal screening, tiered interventions, and data-driven decision-making, can be adapted to create a sustainable support system that enhances teacher resilience, professional growth, and long-term retention.

6. Summary

The MTSS for Teachers Framework (MTSS-T) extends the evidence-based principles of Multi-Tiered Systems of Support beyond student interventions, addressing the instructional, emotional, and professional needs of educators. Recognizing that teachers, like students, require differentiated and tiered supports, this model introduces a structured, data-driven framework to combat burnout, enhance job satisfaction, and improve retention rates.

By embedding teacher well-being into school policies and professional development structures, MTSS-T fosters an adaptive, proactive approach to sustaining educators' resilience throughout their careers. Moreover, its inclusion of crisis-responsive support ensures that teachers receive the resources they need to navigate both daily challenges and extraordinary circumstances.

As educational institutions continue to grapple with workforce shortages and increasing teacher attrition, MTSS-T offers a sustainable, systemic solution that prioritizes educators' mental health while ultimately enhancing student learning and school-wide stability. Implementing this model is not only an investment in teacher success but a critical step toward ensuring the long-term effectiveness of the education system as a whole.

References

Barron, M., Cobo, C., Munoz-Najar, A., & Sanchez Ciarrusta, I. (2021, February 18). The changing role of teachers and technologies amidst the COVID-19 pandemic: Key findings from a cross-country study. *World Bank Blogs - Education for Global Development*. https://blogs.worldbank.org/education/changing-role-teachers-and-technologies-amidst-covid-19-pandemic-key-findings-cross

Cells, P., Sabina, L.L., Touchton, D., Shankar-Brown, R. & Sabina, K.L. (2023). Addressing teacher retention within the first three to five years of employment. Athens Journal of Education, 10(1), p. 345-364. https://files.eric.ed.gov/fulltext/EJ1377742.pdf

Ha C., Pressley T., Marshall D.T. (2025) Teacher voices matter: The role of teacher autonomy in enhancing job satisfaction and mitigating burnout. PLoS ONE 20(1): e0317471. https://doi.org/10.1371/journal.pone.0317471

Hoffmann, R., & Blecha, D. (2020). Education and disaster vulnerability in Southeast Asia: Evidence and policy implications. *Sustainability*, *12*(4), 1401. https://doi.org/10.3390/su12041401

Ozturk, M., Wigelsworth, M., & Squires, G. (2024). A systematic review of primary school teachers' wellbeing: Room for a holistic approach. *Frontiers in Psychology*, vol. 15. https://doi.org/10.3389/fpsyg.2024.1358424

Reinke, W.M., Herman, K.C., Stormont, M. et al. (2025). Teacher stress, coping, burnout, and plans to leave the field: A post-pandemic survey. *School Mental Health*. https://doi.org/10.1007/s12310-024-09738-7.

Sam, C. & Gupton, J. (2024). Reconceptualizing teachers as first responders. *Journal of Trauma Studies in Education*, 3(2). https://doi.org/10.70085/jtse.v3i2.5414

Samosa, R, Blanquisco, M.J., & Mangansat, N.J. (2023). Professional well-being of public-school teachers and their school organizational health: Input for mindfulness-based intervention programs. International Journal of Academic Pedagogical Research (IJAPR), 7(5), p. 1-17. https://eric.ed.gov/?id=ED629257

Sharifian, M.S. & Kennedy, P. (2019). Teachers in war zone education: Literature review and implications. *International Journal of the Whole Child*, 4(2), p. 9-26.

UNICEF. (2023). Youth present roadmap for resilient education at CDM conference. Retrieved from https://www.unicef.org/easterncaribbean/press-releases/youth-present-roadmap-resilient-education-cdm-conference.

Williams, L.A. (2024, January 18). Students do better and schools are more stable when teachers get mental health support. *The Conversation*. https://theconversation.com/students-do-better-and-schools-are-more-stable-when-teachers-get-mental-health-support-219071

World Health Organization, & United Nations Educational, Scientific and Cultural Organization. (2021). *Making every school a health-promoting school: Global standards and indicators*. https://www.who.int/publications/i/item/9789240025059

EDUCATION IN THE TIMES OF POSTHUMANISM

Valerija Vendramin
Educational Research Institute (Slovenia)

Abstract

My main starting point is a basic definition of posthumanism as a critical theory in the humanities and social sciences that – in short – delves into the question of the relations between the actors in the so-called cybernetic triangle: human/animal/machine (or technology). Critical posthumanism should consequently be understood as a postanthropocentric deconstruction of cultural and technological determinism. I would like to start exploring how these relations are relevant to education. As this is a humanist perspective, I will not be presenting any data analysis; the methods used here are mainly (1) qualitative analysis to confront the official or recognized "common sense" view of social reality, social and political relations, history, and conceptual categories from the perspective of alternative views; and (2) comparative analysis of fundamental concepts. In the current situation, i.e., the "absolute" need to introduce technology in schools as soon as possible (which is partiality induced by the COVID-19 pandemic), we can ask ourselves about the role/relationship of schooling and technology, and the perception of the former and the latter. One view of contemporary education is that digital technology makes education "better" (or: more efficient, more available, etc.) – which should be thought of alongside both technophobia and a purely utilitarian understanding of technology to be better able to navigate between the oppositions of discomfort and euphoria. Through a posthumanist lens, I expect to be able to lay some foundations for critically interrogating not only the introduction (or perhaps non-introduction) of technology in schools and the role of education in general but also the initial conceptual basis for confronting a market logic that is increasingly understood as something on a par with ethical and epistemological systems.

Keywords: *Posthumanism, human, technology, education, epistemology.*

1. Introduction

In this short contribution, I would first like to address the issue of conceptual (and practical as well) interconnectedness of the definition(s) of education and the definition(s) of the human. In my opinion, both need to be thought together, and that is especially salient today when modern (i.e., digital) technology is rapidly becoming a vital part of education. This text is part of the ongoing research, which is aimed at reflecting on several other aspects in the field of education, edtech, and policy making.

If education means leading the subject (student, pupil) into humanity and being fully human, how does this definition need to be reshaped today? Following will be the reflection on the relationship between the conceptualizations of new technologies within a given theory of education and the kind of subject, envisaged as the outcome of such education (Snaza, 2013). At the same time, which perhaps is not at the forefront here, we need to ask ourselves what the re-imagined end(s) of the human might be and when – if – human stops being human (Callus & Herbrechter, 2012).

In short, we need to rethink (among several other things such as development, ecology etc., and, of course, what it means to be human) education as "a process of in-duction: leading the pupil into being 'human'" (Snaza, 2013). Although "what it means to be human is constructed differently at different historical moments, by biology, philosophy, political theory, and educational institutions" (Snaza et al., 2014).

My main starting point is thus a rudimentary definition of posthumanism as a critical theory in the humanities and social sciences that – in short – delves into the question of the relations between the actors in the so-called cybernetic triangle. This triangle consists of the now well-known human/animal/machine (or technology) components of which the relations are – in the light of contemporary rethinking and various posthuman, even transhuman, possibilities – reconfigured and rethought. We can also think of that as "three crucial boundary breakdowns" (Haraway, 1991) when the temporal and spatial coordinates no longer allow the border wars to be won easily.

It might be worth noting here that there is more than one version of posthumanism as regards the ontology of human, relations to technology, envisaging the future (techno-utopias), and the like. But this is beyond the scope of this contribution.

Another important factor here (often overlooked) is the market logic that is increasingly understood as something on a par with ethical and epistemological systems. The technology used in the classroom is not only (or not predominantly) classroom gadgets/tangible devices, but "rather something much broader, that encompasses the imagined benefits of data, vast data collection infrastructures, complex data-driven technologies and their associated expertise, and the scaled effects of algorithmic and networked systems" (Knox, 2019). Such technology is "fuelling a capitalistic desire for data" (Knox, 2019). This dimension is very often put aside by e.g. the policy makers or not forefronted enough, together with the environmental costs of the digital (the use of rare metals, exploitation of natural resources, pollution, and the like) which amount to the lack of a broader understanding of the socio-technical systems (Knox, 2019).

2. Posthumanist discontents

Posthumanism, as it is usual with such terms, can mean many things to many people and often comes with a doubt of its relevance, the fear that the era of human might be over (are there alternative ways of being human?), or that we have heard all this before. When I use the term, I understand posthumanism as the need or aspiration of non-hegemonic ways of understanding human today.

I stand on a position – in line with feminist posthumanities – that humanist hierarchical conceptualizations clearly show that all humans do not belong to the same category of humanity. This needs to be questioned rigorously, together with human exceptionalism (i.e., the primacy of humans over nonhuman animals) as it affects the epistemic privileges and, of course, the knowledge formed in those processes (Vendramin, 2023). The prefix "post-", as in posthumanism, does not mean a complete break with the main part of the term, but rather is a sign of the ongoing deconstruction of what it "prefixes". It is a kind of "conceptual parasite that inhabits humanism itself and tries to get it to address its own contradictions" (Herbrechter, 2018). This definition neatly does away with the sometimes redundant worries of how to understand the "post-" (as in: is this a break, did we humans become obsolete?) and at the same time stresses a shift in perspective. It does not only posit a posthuman "as a potential evolutionary step (or leap) of the human" (Ferrando, 2013). The perspectival shift needed must encompass various dimensions, such as political, ethical, also epistemological, and last but not least (and I will return to this shortly), educational (see above the outline of what "traditional" definition of the aims of education is like).

Stefan Herbrechter (n.d.) names various questions that need to be addressed and eventually answered, such as: "What does it mean to be human? What is the role of technology in evolution and hominisation? Is a postanthropocentric world picture possible, desirable, or even necessary?" Besides, "We have always been technological" (Snaza et al. 2014), and that is the statement that brings in the co-evolution of human and technology. This means that "at no stage in the process of hominization can you reach a point where you have, on the one side, the human, and, on the other side, the technical" (Herbrechter, 2018). They co-evolved in the past and will co-evolve in the future.

The above questions certainly surpass the issue of education alone; they are to be thought of in a wider frame, but they are important for the future definition of the role of education, which will – quite possibly – be modified, at least to a certain extent.

This is "is not to be confused with a nostalgia for another human, or a new humanism. Instead, it is part of a new theoretical paradigm emerging from all these challenges to humanism, humanity, and the human, and which are causing the erosion of traditional demarcations between humans and nonhumans and are calling for alternative ways of thinking" (Herbrechter, n.d.). (This is not to say that such rethinking was not present until now, there are philosophical traditions that delve into precisely such questions.)

3. Posthumanist education or (post)education?

All this brings us to the question of how to define education in light of changes at several levels in our societies and traditions. Will education be defined as something completely different, will it, say, side-track the role of teachers, schools, curricula, socialization, etc. contrary to the understanding that education means "'pure' human relationships between teachers and their students, or amongst constructivist social groupings" (Knox, 2019)?

As put by N. Snaza et. al. (2014), posthumanism "allies itself with the politico-pedagogical projects of feminism, postcolonialism, anti-racism, and queer activism as it confronts the systematic dehumanization of people under the hegemonic Western form of political right". If education makes us human, if education is a practice of humanization (Snaza, 2013), it is high time we (re)define what human is, considering various de-humanized and even non-human Others that have hereto been relegated to a

lower step on the hierarchical scale of our anthropocentric world. It remains to be seen to what extent and how these changes will take place and how they will "reform" the definition of education and education itself in an ongoing process. (I am not talking here about changes brought in by digitalization and the like.)

N. Friesen (2018) mentions educational posthumanism (do we need the term post-education?) and sees a lot of problems if we embark on a posthumanist ship unconditionally: "For better or worse, education cannot be anything else but predominantly human. […] To the degree that posthumanisms deny human agency and responsibility, they also 'post' the project of education; to the degree that they affirm these human characteristics, they cannot be called posthumanist". He continues: "Through its denial of the centrality of human agency and choice, posthumanism also requires us to reconceptualize the most fundamental assumptions and understandings of education itself."

I want to return here to the question of human (and humanity) and the definition of it as this has a profound effect on how to approach the issue of education. Do we – if we opt for a transformed definition of human (a moral human being) and education (purposive and normative that it is) – lose the education's addressee (Herbrechter, in Friesen, 2018) and with that the edifice that supports humanity? I want to think that posthumanism can make positive transformations in education in several ways. According to Snaza et al. (2014):

> First, it forces us to reckon with how resolutely humanist almost all educational philosophy and research is. Second, it allows us to reframe education to focus on how we are always already related to animals, machines, and things within life in schools […] Third, […] it enables us to begin exploring new, posthumanist directions in research, curriculum design, and pedagogical practice.

To briefly comment and/or stress those three interconnected points or upsides of posthumanism: first, we can start reflecting on the new possibilities of educational research and practice, including the exclusions within humanism regarding human and non-human others. Second, reframing education could only be an enrichment without – hopefully – losing the education itself. And, thirdly, if pedagogical practice needs to deal with the issue of technology on a conceptual and practical level (and it does), there might be new possibilities that would improve education.

4. Conclusion

One of the main contributions of critical posthumanism to the current educational debates – and I am shunning here the term post-education – is posing some very relevant questions that are "far from techno-utopian or -dystopian, but instead involve an entirely new understanding of the relationship between education, technology and the human" (Herbrechter, 2018). This might also mean de-essentializing all of the three, along with the problematization of thinking "in essences and universals" (Mambrol, 2018), to find "a way out of the maze of dualisms in which we have explained our bodies and our tools to ourselves (Haraway, 1991).

Besides, discussions of pedagogy driving technology, or vice versa, reinforce a false dichotomy. Pedagogy is not just a method; technology is not just a vehicle for implementing that method (Fawns, 2022). The adjustments sooner or later needed in our educational practices include the *meaningful* introduction of technology (understood here in the narrower sense as digital technology) in schools; and *beforehand* identifying the social and educational problems we have and why we have them (Jamison & Haraway, 1992). It might turn out that virtual or digitally transmitted experiences do not always offer "the same kind of experience one has in a lived experience", as technology transforms both people and their experiences (Jamison & Haraway, 1992). It is counter-productive to view technology as a threat, and – at the same time – to view it as a final accomplishment that will help solve all our troubles and problems, be it educational or others.

Acknowledgment

This contribution is a research result of the project, financed by The Slovenian Research and Innovation Agency (ARIS): N5-0272, Education at the Frontiers of the Human: The Challenge of New Technologies (EDUCAT(H)UM).

References

Bijuklič, I., & Vendramin, V. (2023). Izobraževanje v času zapovedane digitalizacije. *Alternator*. Retrieved March 11, 2025, from https://doi.org/10.3986/alternator.2023.32

Callus, I., & Herbrechter, S (2012). Introduction: Posthumanist Subjectivities, or, Coming After the Subject … *Subjectivity, 5*, 241-264.

Fawns, T. (2022). An Entangled Pedagogy: Looking Beyond the Pedagogy—Technology Dichotomy. *Postdigital Science and Education, 4*, 711-728.

Ferrando, F. (2013). Posthumanism, Transhumanism, Antihumanism, Metahumanism, and New Materialisms: Differences and Relations. *Existenz. An International Journal in Philosophy, Religion. Politics, and the Arts, 8*(2), 26-32.

Friesen, N. (2018). Posthumanism = Posteducation. A Reply to Siân Bayne's "Posthumanism: A Navigation Aid for Educators". *On Education. Journal for Research and Debate, 1*(2).

Haraway, D. (1991). *Simians, Cyborgs, and Women. The Reinventions of Nature*. London: Free Association Books.

Herbrechter, S. (2018). Posthumanism and the Ends of Education. *On Education. Journal for Research and Debate, 1*(2).

Herbrechter, S. (n.d.). *Critical Posthumanism*. Retrieved March 11, 2025, from https://stefanherbrechter.com/

Jamison, P. K., & Haraway, D. (1992). No Eden Under Glass: A Discussion with Donna Haraway. *Feminist Teacher, 6*(2), 10-15.

Johnson, Ch. (2013). The Prehistory of Technology: On the Contribution of Leroi-Gourhan. In Ch. Howells & G. Moore (Eds.), *Stiegler and Technics* (pp. 34-52). Edinburgh: Edinburgh UP.

Knox, J. (2019). What Does the 'Postdigital' Mean for Education? Three Critical Perspectives on the Digital, with Implications for Educational Research and Practice. *Postdigital Science and Education, 1*(1), 357-370.

Mambrol, N. (2018). *Posthumanist Criticism*. Retrieved March 21, 2025, from https://literariness.org/2018/07/25/posthumanist-criticism/

Snaza, N., Appelbaum, P., Bayne, S., Carlson, D., Morris, M., Rotas, N., Sandlin, J., Wallin, J., & Weaver, J. A. (2014). Toward a Posthumanist Education. *Journal of Curriculum Theorizing, 30*(2), 39-55.

Snaza, N. (2013). Bewildering Education, *Journal of Curriculum and Pedagogy, 10*(1), 38-54.

Vendramin, V. (2024). The "Encounter" Between Posthumanism, Technology and Education. In M. Carmo (Ed.), *Education and new developments. Volume 2* (pp. 57-60). Lisbon: inScience Press. Retrieved from https://end-educationconference.org/wp-content/uploads/2024/06/Education-and-New-Developments_2024-_Vol_II.pdf

Vendramin, V. (2023). (Posthumanist) Reflection on Universal Knowers and the Nature of Knowledge. In *Arts and Humanities in Digital Transition: Book of Abstracts* (pp. 4-5). Lisbon, Nova University of Lisbon, 6-7 July 2023. Retrieved from https://ah-digitaltransition.fcsh.unl.pt/wp-content/uploads/2023/07/ONLINE_Book_of_Abstracts.pdf

Vendramin, V. (2021). "Kako smo postali posthumani?": o človeku, tehnologiji in izobraževanju. In I. Ž. Žagar, & A. Mlekuž (Eds.), *Raziskovanje v vzgoji in izobraževanju: medsebojni vplivi raziskovanja in prakse* (pp. 61-71). Ljubljana: Pedagoški inštitut.

BEYOND THE ALGORITHM: EXPLORING STUDENT ACCEPTANCE OF AI GRADING THROUGH AN ADAPTED TAM FRAMEWORK

Hayden Noel, Adam King, Julia Sabin, Jamal Bell, & Kay Gomes Saul
University of Illinois, Urbana-Champaign (United States)

Abstract

Artificial Intelligence (AI) has become increasingly prevalent in education, from completing student assignments to analyzing research and grading tasks using large language models (LLMs). AI-assisted grading systems introduce new complexities regarding trust, fairness, and learning outcomes. This study presents findings from an experiment in a business course. Students participated in an assignment evaluated under both traditional instructor and AI-supported grading. Survey data assessed perceived fairness, satisfaction, and trust. Results revealed that students in the AI + human oversight condition rated fairness higher and exhibited greater trust in the system. This led to the development of the Technology Acceptance Model for AI Grading (TAM-AIG), which includes constructs such as perceived fairness, transparency, trust, and human oversight. These findings inform the ethical and practical implementation of AI in assessment practices.

Keywords: *AI grading, technology acceptance, fairness, student trust, TAM-AIG.*

---

1. Introduction

AI is rapidly transforming the landscape of higher education, prompting renewed attention to how students engage with algorithmically generated outputs. While prior studies have examined AI's role in generating text, solving problems, and supporting research (Kasneci et al., 2023; Akgun & Greenhow, 2023), fewer have investigated how students experience AI-assisted grading, particularly when human oversight, fairness, and transparency are at stake. As AI-augmented assessment systems become more widespread, questions arise about their legitimacy, impact on learning, and potential to reinforce or alleviate concerns about grading bias and accountability.

To explore these issues, we conducted an experimental study examining how students in a marketing course respond to different forms of AI-supported grading. Using a writing-intensive assignment, students were exposed to varied grading conditions that manipulated the role and visibility of AI. We developed and tested a theoretical framework—the TAM-AIG—which adapts the original TAM (Venkatesh & Davis, 2000) to account for constructs central to algorithmic judgment: Perceived Fairness, Transparency, Trust in AI, Usefulness, Consistency, and Human Oversight.

This study builds on educational technology adoption research (Alharbi & Drew, 2014; Park, 2009; Farah et al., 2023) and recent literature on the ethical implementation of AI in education (Jussupow et al., 2023; Zhang & Dafoe, 2023). Our goal was not only to measure student acceptance of AI grading but also to determine which factors—such as framing, prior experience, and feedback quality—mediate or moderate this acceptance. The findings validate TAM-AIG as a useful model for understanding student attitudes toward AI grading and highlight design and policy implications for educational institutions.

2. Theoretical framework

The Technology Acceptance Model (TAM), initially developed by Venkatesh & Davis (2000), has long served as a foundational lens for examining technology use behavior. TAM posits that perceived usefulness and perceived ease of use drive technology adoption. However, in AI-assisted educational settings—particularly for grading—these constructs are insufficient for capturing the ethical, relational, and procedural concerns that arise when algorithmic systems evaluate student work. This study proposes and validates the **Technology Acceptance Model for AI Grading (TAM-AIG)**, which extends the traditional TAM by integrating six constructs central to algorithmic decision-making judgements: **Perceived Fairness**, **Transparency**, **Trust in AI**, **Usefulness**, **Consistency**, and **Human Oversight**. These dimensions reflect

emerging consensus across AI ethics and educational technology research (Farah et al., 2023; Kasneci et al., 2023; Jussupow et al., 2023; Zhang & Dafoe, 2023).

TAM-AIG posits the following relationships:

- **Transparency → Fairness**
- **Fairness → Satisfaction** and **Trust**
- **Usefulness → Trust** (stronger than consistency)
- Moderation by **AI Experience** (positive) and **GPA** (non-significant)

The rationale behind these paths is rooted in algorithmic fairness theory, procedural justice, and the sociotechnical framing of AI in classroom environments. **Fairness** is foundational, shaping students' perceptions of legitimacy and acceptance. **Transparency** enhances fairness and trust by clarifying how AI feedback is generated (Yu & Shen, 2022). **Trust** mediates between system design and behavioral acceptance (Farah et al., 2023). **Usefulness** aligns with TAM's original constructs, but in this context, refers to students' beliefs that AI-generated feedback enhances learning. **Consistency** reflects expectations for unbiased judgment, while **human oversight** reassures students that the system is accountable (Jussupow et al., 2023).

3. Experimental design

To investigate how students perceive fairness, trust, and satisfaction in AI-assisted grading, we designed a between-subjects field experiment within an undergraduate and graduate marketing course at a U.S. university. The same course material was taught in both classes. 125 students were randomly assigned to one of four experimental conditions, each reflecting a different approach to grading an in-class case assignment: human-only (Group A), AI with human oversight (Group B), AI-only with (Group C) or without (Group D) a grading rubric shared.

Each student responded to a distribution exercise that required short answers and received a standardized grade along with rubric-based feedback. While all students received the same type of final evaluation, the presentation of who or what generated the grade varied by group. This manipulation aimed to isolate the effect of perceived grader identity on students' evaluations of fairness and trust aligning it with prior work on framing effects in technology adoption and AI trust research (e.g., Rindfleisch et al., 2024).

After receiving their grade and feedback several days later, students completed a post-survey with Likert-scale measures of perceived fairness, satisfaction, trust, grading transparency, and their history of using AI. Where applicable, demographic data and self-reported GPA were collected. We proposed seven hypotheses to enhance our understanding of this proposed TAM-AIG model.

4. Results

H1: Framing AI as collaborative increases fairness perceptions

A one-way ANOVA revealed a significant effect of grading condition on perceived fairness (**$F(3, 121) = 7.82$, $p < .001$**). Tukey HSD post hoc analysis confirmed that students in **Group B (AI + Human)** rated their feedback as significantly fairer than those in **Group A (Human only)** (**mean difference = –1.04, $p = .002$**). No statistically significant difference was found between Group B and Group C, although Group B also trended higher (*see Figure 1*). These results support H1 and indicate that the AI-Human collaborative framing enhances fairness perceptions beyond both human-only and AI-only graders.

H2: Fairness positively predicts satisfaction

Correlational analysis found a strong positive association between fairness and satisfaction (**$r = .88$**), confirming H2 (*See Figure 2*). Students who perceived their feedback as fair were significantly more likely to report satisfaction with their grade and the feedback they received.

H3: Transparency improves fairness perceptions

Items measuring grading transparency—such as whether grading criteria were clearly explained—were positively correlated with fairness ratings. Specifically, the correlation between clarity of grading criteria and fairness was **$r = .74$**, providing strong support for H3.

H4: Prior AI tool use predicts fairness and satisfaction

When prior AI use was analyzed as an ordinal variable, regression results showed it to be a significant positive predictor of both fairness (**$\beta = .60$, $p < .001$**) and satisfaction (**$\beta = .53$, $p < .001$**). H4 is thus supported.

H5: Trust in AI increases in low-stakes tasks

This hypothesis could not be directly tested in the current design because assignment stakes were held constant across all groups. As such, H5 remains inconclusive.

H6: Consistency predicts trust more than usefulness

Contrary to expectations, regression analysis revealed that perceived **usefulness** of feedback significantly predicted trust (**β = .78, p < .001**), while consistency was not significant (**β = .18, p = .15**). These findings refute H6 and suggest that usefulness may be a more critical factor in student trust than consistency alone.

H7: GPA moderates fairness and satisfaction

Self-reported GPA was not a significant predictor of fairness (**β = –.06, p = .47**) and showed only a marginal association with satisfaction (**β = –.15, p = .07**). Thus, H7 is not supported in this dataset.

Figure 1. Average Fairness Ratings by Condition
*This bar chart shows that students in **Group B (AI + Human Oversight)** reported the highest fairness ratings, followed by **Group C (AI Transparent)**, **Group D (AI Non-transparent)**, and **Group A (Human only)**.*

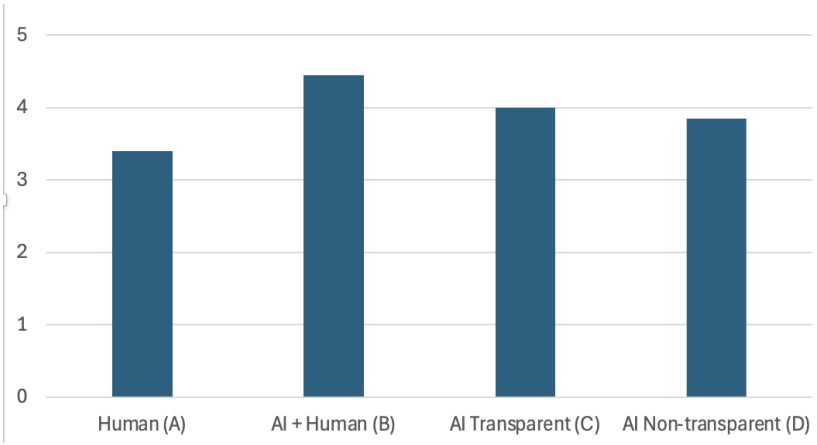
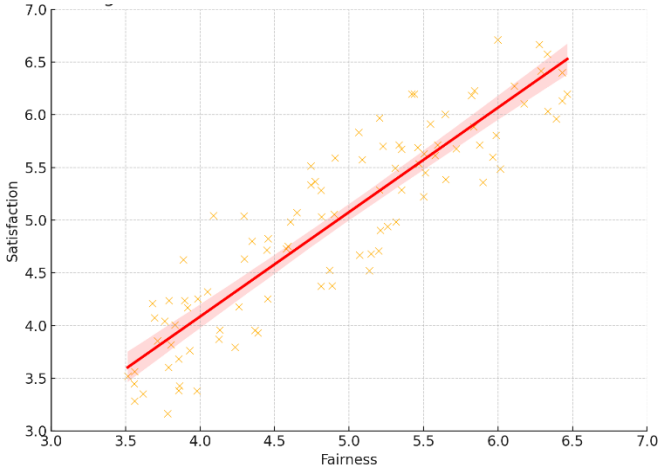


Figure 2. Correlation Between Fairness and Satisfaction
This scatterplot demonstrates a strong positive correlation between fairness and satisfaction ratings, consistent with the statistical result r = .88. The regression line (in red) highlights this linear relationship.



5. Discussion

This study provides new empirical insights into how students experience AI-assisted grading in real classroom settings. Our findings reinforce and extend the TAM by highlighting perceived fairness as a central driver of satisfaction and trust in AI-based educational tools. The data show that **students respond more favorably to AI grading when human oversight is involved**, aligning with broader trends in human-AI collaboration literature (Ding et al., 2024).

The confirmation of H1 through H4 suggests that psychological framing, perceived transparency, and prior AI exposure impact students' attitudes. Students are not necessarily opposed to AI evaluation per se; instead, **they are sensitive to how the AI is positioned in relation to authority and fairness**. The collaborative AI condition (AI + Human) improved fairness perceptions and enhanced student satisfaction, suggesting that co-framing may be a best practice for introducing AI grading.

Unexpectedly, the **perceived usefulness of the feedback was a stronger predictor of trust than consistency**, counter to H6. This finding suggests students may tolerate some perceived inconsistency if the feedback is substantively helpful—an important insight for automated assessment systems design.

That GPA and perceived academic standing (H7) did not significantly moderate fairness or satisfaction points to the **universality of fairness concerns** across performance levels. Regardless of GPA, students valued clear, transparent, and justifiable evaluations, emphasizing the importance of equity in AI-driven pedagogy.

These findings contribute to both AI research in marketing education and the applied conversation around fairness in algorithmic systems. In line with the conviviality perspective articulated by Rindfleisch et al. (2024), we argue that **to achieve learners' acceptance, AI grading tools should be positioned as empowering supplements**, not replacements, for human educators. The goal is not merely automation, but augmentation that enhances transparency, fairness, and student learning outcomes.

6. Limitations

This exploratory study had several constraints. First, the moderate sample size and business course setting restrict generalizability. Second, the experiment took place in a low-stakes context with minimal grading consequences, potentially not reflecting perceptions under high-stakes summative evaluation. Finally, as the experiment was conducted by the instructor in his own class, self-report biases and social desirability could have affected survey responses.

7. Future research

Future studies should explore how TAM-AIG performs across disciplines (e.g., STEM vs. humanities) and educational levels (undergraduate vs. graduate). Longitudinal designs could examine how attitudes toward AI grading evolve over time and whether transparency interventions shift trust trajectories. Additional pathways might explore instructor acceptance of AI grading and its effects on pedagogical practice. Finally, contrasting AI roles in formative versus summative grading contexts would refine our understanding of AI's educational fit.

8. Practical recommendations

Table 1.

Principle	Recommendation
Transparency	Clearly explain how AI feedback is generated and how instructors oversee it.
Oversight	Include human verification and an appeal process for all AI-generated grades.
Feedback Usefulness	Emphasize learning-oriented feedback rather than numerical scoring.
Fairness	Make rubrics public and consistent across grading types.
Student Training	Provide AI literacy to help students interpret automated feedback.

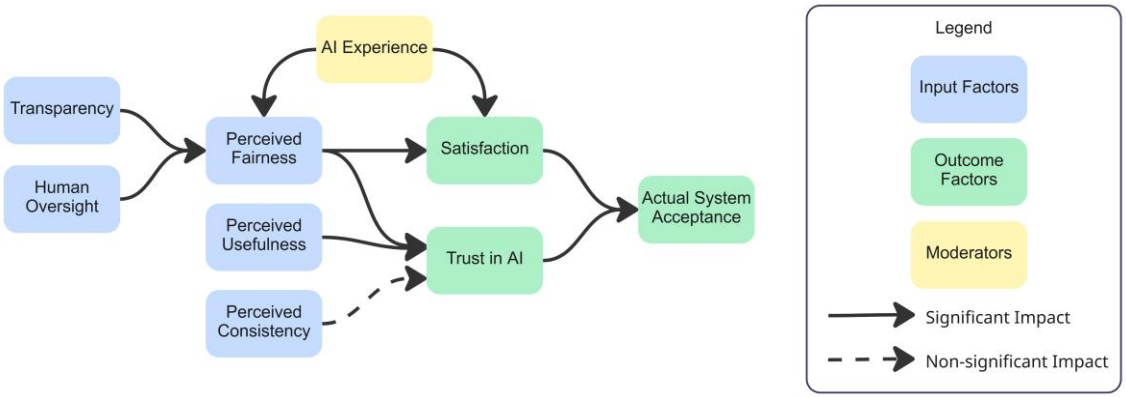
9. Conclusion and implications

This study demonstrates that student acceptance of AI-assisted grading is driven by core principles of fairness, transparency, and usefulness. The validated TAM-AIG framework illustrates that students are more likely to trust and accept AI in educational settings when systems provide clear feedback and include human oversight. Transparency leads to perceived fairness, which predicts both satisfaction and trust. Feedback usefulness plays a stronger role in trust formation than consistency alone (*See Figure 3*). These findings have direct implications for the design and implementation of AI in academic settings. Institutions considering AI-supported grading should avoid fully automated systems and instead focus on hybrid models that emphasize instructor involvement and transparent processes.

Ultimately, the effective AI integration in assessment relies not only on technological accuracy but also on pedagogical and ethical alignment with student expectations. The TAM-AIG model serves as a valuable tool for guiding the responsible deployment, evaluation, and refinement of AI assessment systems in higher education.

Figure 3. TAM-AIG Model – Post-Experiment.

- ***Inputs:*** *Transparency, Usefulness, and Consistency*
- ***Core Pathways:*** *Transparency → Fairness → Trust & Satisfaction; Usefulness → Trust*
- ***Moderators:*** *AI Experience (significant); GPA (not significant)*



References

Akgun, M. & Greenhow, C. (2023). Artificial intelligence in education: Addressing ethical challenges in the era of ChatGPT. *AI & Society*. https://doi.org/10.1007/s00146-023-01624-3

Alharbi, S. & Drew, S. (2014). Using the Technology Acceptance Model in understanding academics' behavioral intention to use learning management systems. *International Journal of Advanced Computer Science and Applications, 5*(1), 143-155.

Bailey, D. R. (2023). Student perceptions of ChatGPT use in a college essay assignment. *Journal of Educational Technology Development and Exchange, 16*(1), 1-20.

Ding, L., Wang, Y. & Liu, M. (2024). *Enhancing teacher AI literacy and integration through different types of cases in teacher professional development.* Retrieved from https://www.researchgate.net/publication/379739010_Enhancing_Teacher_AI_Literacy_and_Integration_through_Different_Types_of_Cases_in_Teacher_Professional_Development

Farah, I., Saleh, M. & Wang, Y. (2023). Exploring user adoption of ChatGPT: A Technology Acceptance Model perspective. *Journal of Educational Computing Research, 61*(4), 567-588. https://doi.org/10.1177/07356331231180767

Jussupow, E., Heinzl, A. & Spohrer, K. (2023). Grading by AI makes me feel fairer? How different evaluators affect college students' perception of fairness. *Computers & Education, 205*, 104832. https://doi.org/10.1016/j.compedu.2023.104832

Kasneci, E., Sessler, K. & Bannert, M. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Instruction, 85*, 101748. https://doi.org/10.1016/j.learninstruc.2023.101748

Park, S. Y. (2009). An analysis of the Technology Acceptance Model in understanding university students' behavioral intention to use e-learning. *Educational Technology & Society, 12*(3), 150-162.

Rindfleisch, A., Kim, S. & Lee, S. (2024). Toward a conviviality perspective on artificial intelligence: Reclaiming agency in the age of algorithms. *Journal of the Association for Consumer Research, 9*(1), 71-80. https://doi.org/10.1086/726434

Sachdev, M., Narang, D. & Liu, Y. (2024). Toward pedagogically aligned AI in assessment: Student feedback, formative grading, and instructor trust. *Working Paper*.

Venkatesh, V. & Davis, F. D. (2000). A theoretical extension of the Technology Acceptance Model. *Management Science, 46*(2), 186-204. https://doi.org/10.1287/mnsc.46.2.186.11926

Yu, Z. & Shen, J. (2022). Applying the Technology Acceptance Model (TAM) to automatic grading technology for large projects. *Education and Information Technologies, 27*(5), 6821-6842. https://doi.org/10.1007/s10639-021-10794-2

Zhang, B. & Dafoe, A. (2023). Attitudes surrounding an imperfect AI autograder. *AI & Society, 38*(1), 45-63. https://doi.org/10.1007/s00146-022-01400-7

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

DIGITAL FLUENCY IN HIGHER EDUCATION: INVESTIGATING TECHNOLOGY INTEGRATION IN PEDAGOGICAL PRACTICES OF PORTUGUESE EDUCATORS

Tatiana Sanches[1], Mariana Batista[2], Cristina Duarte[3], & Joana P. Miranda[4]
[1]UIDEF, Instituto de Educação, Universidade de Lisboa (Portugal)
[2]Faculty of Veterinary Medicine, Lusófona University, Lisbon University Centre (Portugal)
[3]Centre for Public Administration and Public Policies, Institute of Social and Political Sciences, Universidade de Lisboa (Portugal)
[4]Research Institute for Medicines (iMed.ULisboa), Faculty of Pharmacy, Universidade de Lisboa (Portugal)

Abstract

Higher Education has been the target of enormous transformations resulting from the use of technology given that the educational context is increasingly embedded in this ecosystem. In the academy, we have seen a growing concern about teaching and learning requiring digital fluency. Indeed, it is important to reinforce teachers' and students' digital skills with strategies that make learning appealing, safe, and effective, without forgetting that digital fluency can be the basis for better teaching. However, the following questions arise: Are higher education teachers in Portugal responding and adapting to these challenges? What actions and strategies have they developed to apply technologies in classrooms and to promote digital fluency among students? And what actions should be taken, given that the young public is not only a consumer, but also a producer of online information and, at the same time, the internet has become a privileged resource for searching for easy and immediate information? This is the basis for this exploratory study, which aims to analyze the actions and strategies that higher education teachers in Portugal have developed to promote digital fluency, through digital technologies. This work seeks to observe how professors have worked on digital skills and encouraged their development in the academic community, particularly among their students. This can be observed through their pedagogical practices, namely in the creative and responsible use of information, communication strategies, content creation, and problem-solving or academic well-being promotion. To this end, a questionnaire survey is carried out among higher education teachers in Portugal, adapted from European Digital Competence Framework for Educators – DigCompEdu. The results point to a conservative view of integrating technologies in pedagogical practices, with most teachers using and encouraging general office-type software, learning platforms such as Moodle, or some applications for active learning moments, like Mentimeter, Kahoot or other apps. This reinforces the idea of previous studies that reveal that there is still some hesitation in openly embracing technologies and integrating them not just as tools, but as part of learning.

Keywords: *Digital skills, digital fluency, higher education teachers, pedagogical practices, Portugal.*

1. Introduction

Digital competence extends beyond the mere technical operation of electronic devices. It encompasses the safe and critical use of technologies in professional, personal, and social contexts, including the ability to locate, evaluate, store, produce, and exchange information, as well as participate in digital networks (Clifford et al., 2020). Mastery of these competencies is essential for workplace success and active citizenship in a digital society. The concept of digital literacy builds on foundational literacies, such as library, media, and computer skills, but extends beyond technical proficiencies to encompass knowledge, perceptions, and attitudes. As Bawden (2001) emphasizes, digital literacy integrates a spectrum of skills, understanding, and attitudes, underscoring its multifaceted nature. In the context of education, fostering digital skills has become a priority, particularly as digital resources reshape interactions with information. Educators play a pivotal role in advancing digital literacy by addressing the digital needs of diverse student populations, and fostering them to use digital devices in a fluent and proficient manner. This competency encompasses problem-solving and cognitive skills, extending beyond basic technology and internet skills. Importantly, information literacy and digital literacy are interconnected, with the latter embedding technological fluency while emphasizing ethical information use, respect for intellectual

property, and active citizenship in the digital era (Karpat, 2011). Addressing gaps in digital competence across various population groups is essential for designing effective training programs that align with the digital transition. In higher education, teachers prioritize lessons to help students effectively navigate and utilize diverse information resources. These skills are particularly critical for research-oriented students, for whom the integration of information literacy with digital fluency is vital (Allan, 2010). In this context, the development of digital literacy and fluency is foundational to equipping individuals for meaningful participation in the information society. Higher education serves as critical arena for cultivating these competencies, ensuring that individuals can effectively harness digital tools to achieve their academic, professional, and personal goals. The European Digital Competence Framework for Citizens (DigComp) is an initiative for framing digital skills policy, developing, and measuring digital competence, ultimately contributing to the Commission's priority 'A Europe fit for the Digital Age' and to Next Generation EU (European Commission, 2020). It serves multiple purposes, including designing competence assessment tools, creating training courses and materials, and identifying professional digital profiles within the realms of employment, education and training, and social inclusion. Within this framework the European Digital Competence Framework for Educators (DigCompEdu) (Ferrari, Punie, & Bre, 2013) has been adopted in Portugal (Lucas & Moreira, 2018). This framework, in particular, targets educators across various levels. It encompasses both general and vocational training, special education, and non-formal learning environments, delineated among six areas of competence: (a) Professional Engagement, (b) Digital Resources, (c) Teaching and Learning, (d) Assessment, (e) Empowering Learners, and (f) Facilitating Learners' Digital Competence. To support educators, the framework also provides a progression model that allows them to evaluate and enhance their digital competencies systematically. From these six areas, particular emphasis has been placed on Facilitating Learners' Digital Competence, recognizing its importance in equipping students with the skills necessary to thrive in a digital society. This underscores the role of educators not only as transmitters of knowledge but as facilitators of students' digital skills development. In doing so, it highlights the evolving their responsibilities in adapting to and integrating digital tools and practices into pedagogical contexts. In this context, the present study aims to analyze the actions and strategies that higher education teachers, in Portugal, have been developing to promote digital fluency through digital technologies creatively and responsibly for information, communication, content creation, well-being and problem-solving (Ferrari, Punie, & Bre, 2013; Lucas & Moreira, 2018). It further aims to observe how teachers work on digital skills and encourage their development in the academic community, particularly with their students.

2. Methods

To study the pedagogical strategies used in higher education student training across several dimensions, a survey was design based on the requirements for promoting digital competence (available in DigCompEdu), as detailed in Table 1. Surveys of a total of 30 higher education teachers were analyzed in this work. Based on their self-description, they were further divided by their age: younger than 45 years old (n=15) and between 45 and 60 years old (n=15); and by their scientific field: social sciences and humanities (SSH; n=16) and health sciences and technology (HST; n=14). All participants gave their informed consent before answering the survey and anonymity was guaranteed.

Table 1. Key areas for questions on teaching digital fluency.

Topic	Key Focus Areas
1. Differentiation and Personalization	Adapting teaching to students' individual needs, interests, and capabilities through digital technologies to ensure personalized and inclusive learning.
2. Active Involvement	Promoting student participation via interaction, collaboration, and autonomy, leveraging digital tools and innovative approaches.
3. Information and Media Literacy	Designing tasks that require students to identify, analyze, and critically evaluate information, ensuring credibility and effective processing.
4. Digital Communication & Collaboration	Encouraging responsible use of digital technologies for communication, teamwork, and civic engagement.
5. Digital Content Creation	Teaching students to create and modify digital content responsibly, applying copyright principles, referencing sources, and assigning licenses.
6. Responsible Use	Promoting safe, ethical, and healthy use of digital technologies, addressing physical, psychological, and social well-being.
7. Digital Problem Solving	Encouraging the identification and resolution of technical issues and the creative application of technological knowledge in new contexts.
8. Technological Resources; Additional Strategies; and Motivational Factors	Identifying the technological tools and platforms teachers use or recommend to students; Open-ended input on other pedagogical actions to promote digital fluency in academic contexts; Understanding what drives teachers to adopt digital pedagogical practices.

3. Results

3.1. Differentiation and personalization

More than one fourth of participants reported the use of pedagogical strategies to promote the use of digital technologies (26.7%; n=8/30). However, while the majority of younger participants followed this overall trend, none of the older participants reported doing so, albeit three promoted individual learning plans for the use of digital technologies. Most SSH (social sciences & humanities) teachers had a more rudimentary approach to digital technology differentiation, going only as far as implementing activities with digital technologies to promote different learning paths, levels and paces (62.5%; n= 10), while half HST (health sciences and technology) teachers reported promoting overall differentiated uses of digital technologies (28.6%; n=4), individual learning plans (14.3%; n=2) or even innovative formats to promote digital learning (7.1%, n=1).

3.2. Active involvement

Although more than one third of teachers encourages students to use digital technologies in motivating and engaging activities, such as games or quizzes (36.7%, n=11/30), in this parameter a significant difference was only observed between scientific fields, with most SSH teachers reporting the promotion of students' transversal skills development (43.8%; n=7), but only one uses innovative formats to actively engage students in digital technologies.

3.3. Information and/or media literacy

Enquired teachers were very heterogeneous regarding information and media literacy. Approximately one third reported the encouragement of students to use digital technologies to collect information (30%; n=9/30), but also a similar number of participants reported actively promoting information and/or media literacy (26.7%; n=8/30). This heterogenous trend was prevalent in younger teachers but not in older ones, where the majority declared to “promote information and/or media literacy” (46.7%; n=7). Once again, SSH teachers scored higher in information and/or media literacy, whereas half HST teachers declared they only “encourage students to use digital technologies to collect information”.

3.4. Digital communication and collaboration

The higher number of answers was that teachers encourage students to “use digital technologies for communication and collaboration” (30%; n=9/30) and implementing “activities to promote digital communication and collaboration” (30%; n=9/30). Likewise, when analyzing both age groups and science fields, SSH reported higher echelons of digital communication and collaboration competence than their HST counterparts.

3.5. Digital content creation

Herein, although none admitted using “innovative formats to promote digital content creation”, the majority of the teachers showed to incentive students to use or create digital content (> 50%). Importantly, there were few differences between younger and older teachers.

3.6. Responsible use

In this regard, half of the teachers assumed not going beyond encouraging “students to use digital technologies safely and responsibly” and none developed “innovative approaches to promote students' capacity to use digital technologies for their own well-being”. Moreover, older teachers reported limited involvement in safety strategies, while younger teachers were more heterogeneous as the different degrees of involvement to promote a responsible use of digital technologies were all mentioned by the same number of participants. Most HST teachers admitted having a more hands-off approach regarding responsible use than SSH teachers, as most reported only encouraging student digital safety and responsibility (42.9%; n=6).

3.7. Digital problem solving

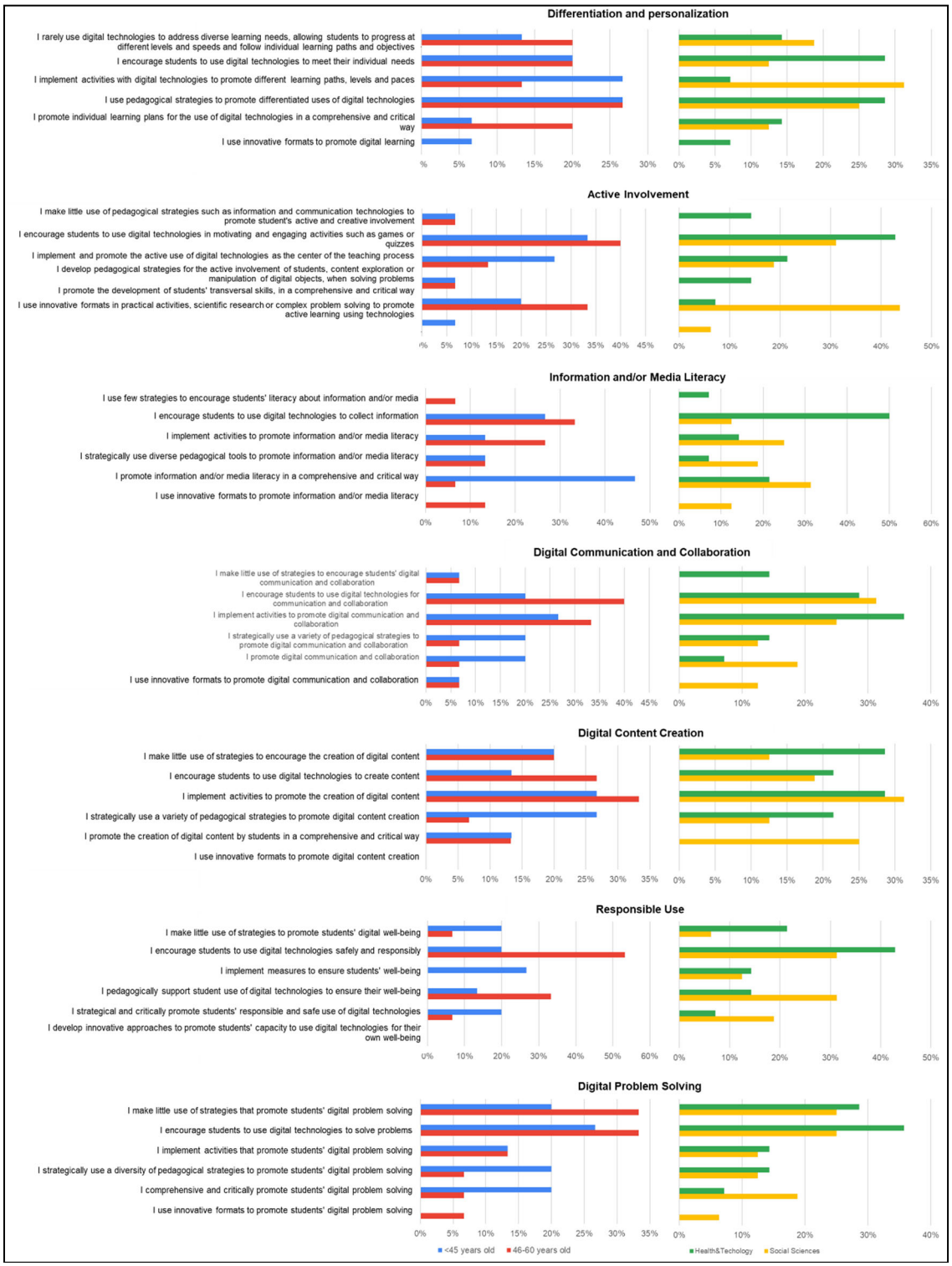
Overall, higher education teachers use little strategies to promote digital problem solving (26.7%; n=8/30) or only encourage students to use digital tools to solve problems (30%; n=9). This trend is also observed when considering both age groups and scientific fields.

3.8. Digital resources and incentives for their use

Teachers from all fields and of all age groups declared using a plethora of digital resources, namely the internet as a whole, text and tools, digital spread sheets, academic search engines, automatic reference organizer and active learning resources (such as quizzes and games), to name some examples. Of note, only

a minority admitted having made little change in their pedagogical approach (16.7%; n=5/30). In contrast, the vast majority (80%; n=24/30) considers specific courses on this subject to be the driving force to implement digital technologies and incentivize their students to do so as well and some admitted that the COVID pandemic urged this transformation (40%; n=12/30).

Figure 1. Summary of survey results considering the following parameters: (a) Professional Engagement, (b) Digital Resources, (c) Teaching and Learning, (d) Assessment, (e) Empowering Learners, and (f) Facilitating Learners' Digital Competence. n = 30. HTS-health and technology Sciences; SSH-social sciences & humanities.



4. Discussion and conclusions

In an era where technologies permeate nearly every aspect of life, digital skills are increasingly recognized as transversal, extending across various professional and personal contexts. While traditional skills remain vital, the digital age demands new competencies, including critical thinking, problem-solving, collaboration, and digital fluency. For higher education faculty, digital fluency is particularly critical, as it directly influences their ability to design and deliver authentic, technology-enhanced learning experiences (Lucas & Moreira, 2018). Miller and Bartlett (2012) highlight issues such as misinformation, filter bubbles, and the superficial consumption of online content, all of which demand sophisticated digital strategies. Professors play a pivotal role in equipping students with these strategies by fostering inquiry-based learning and integrating digital fluency into their teaching practices. Through well-designed learning activities, they can encourage students to engage critically with digital tools, enhancing their ability to navigate, evaluate, and apply information effectively. Incorporating digital fluency into higher education teaching requires a shift toward authentic learning practices, where students engage in real-world tasks that simulate professional scenarios (Méndez Gijón, 2021). This approach promotes active engagement with digital tools, allowing students to build confidence and competence in navigating digital landscapes. Authentic learning activities, designed by digitally fluent professors, prepare students not only for academic success but also for active participation in an increasingly digital workforce and society. Importantly, at a time when the advance of artificial intelligence is already a reality in the classroom, there is an urgent need for training in the sense of distinguishing between pedagogical tools that can contribute to the quality of teaching and those that can compromise and facilitate the process of creativity and reflective thinking. At a time when the advance of artificial intelligence is already a reality in the classroom, there is an urgent need for training in the sense of distinguishing between pedagogical tools that can contribute to the quality of teaching and those that can compromise and facilitate the process of creativity and reflective thinking. By integrating digital tools into pedagogical practices and modeling critical and ethical digital engagement, professors can contribute to the development of digitally competent graduates capable of meeting the demands of the digital age. In this study, it is observed that while some higher education teachers may already be implementing innovative strategies, they may not fully recognize these efforts as innovative. Nevertheless, there is evidence of an emerging awareness of these topics, as reflected in how initial concepts are being incorporated into their teaching practices. This indicates that significant progress is still needed to enhance digital fluency, enabling teachers to better equip their students with the competencies required to navigate the digital academic landscape effectively.

Acknowledgments

This work was supported by National Funds through FCT-Portuguese Foundation for Science and Technology, I.P., under UIDEF, UIDB/04107/2020, https://doi.org/10.54499/UIDB/04107/2020.

References

Allan, B. (2010). *Supporting research students*. Facet Publishing.

Bawden, D. (2001). Information and digital literacies: A review of concepts. *Journal of Documentation, 57*(2), 218-259.

Clifford, I., Kluzer, S., Troia, S., Jakobsone, M., Clifford, I., Kluzer, S., Troia, S., … Zandbergs, U. (2020). *DigCompSat: a self-reflection tool for the European digital framework for citizens*. https://doi.org/10.2760/77437

European Commission. (2020). *A Europe fit for the digital age: Empowering people with a new generation of technologies*. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age_en

Ferrari, A., Punie, Y., & Bre, B. N. (2013). *DIGCOMP : A Framework for Developing and Understanding Digital Competence in Europe.* https://doi.org/10.2788/52966

Karpat, A. (2011). Digital Literacy in Education. Policy Brief, (May). https://unesdoc.unesco.org/ark:/48223/pf0000214485/PDF/214485eng.pdf.multi

Lucas, M., & Moreira, A. (2018). DigCompEdu: Quadro Europeu de Competência Digital para Educadores. In *Centro de Investigação em Didática e Tecnologia na Formação de Formadores*. http://area.dge.mec.pt/download/DigCompEdu_2018.pdf

Méndez Gijón, F. (2021). Evaluación de competencias digitales docentes de profesores universitarios. *Revista Conrado, 18(89)*, 289-298.

Miller, C., & Bartlett, J. (2012). «Digital fluency»: towards young people's critical use of the internet. *Journal of Information Literacy*, *6*(2), 35. https://doi.org/10.11645/6.2.1714

EMPOWERING OR IMPAIRING? THE EFFECT OF GENERATIVE AI ON CLASS TEAMWORK, LEARNING AND ENGAGEMENT

Evelina Atanassova, & Diana Cabori
University of Massachusetts, Global, School of Business and Professional Studies (USA)

Abstract

Generative Artificial Intelligence (GAI) is transforming industries and daily life, prompting discussions about its implications for student learning in higher education. GAI tools support brainstorming, writing, and research processes, yet they may also lead to overreliance that undermines students' critical thinking, collaborative engagement, and independent problem-solving. This study used a quasi-experimental design to investigate the effects of AI-assisted teamwork on learning outcomes in undergraduate courses at a U.S. university. We compared students' performance on identical assignments in two course sections: one required using GAI tools in team projects, while the other restricted AI use. Results indicated that AI integration reduced team performance but enhanced creativity. These findings contribute to the ongoing discourse on AI in collaborative learning and offer guidance for institutional policies that balance innovation with meaningful educational experiences.

Keywords: *Generative Artificial Intelligence (GAI), collaborative learning, Social Interdependence Theory (SIT), Socio-Technical Systems* (STS) *Theory, andragogy.*

1. Introduction

As Generative Artificial Intelligence (GAI) reshaped industries and daily experiences, its influence on higher education became increasingly prominent and controversial. Educational institutions, educators, students, and policymakers grappled with the potential benefits and unintended consequences of integrating GAI into the classroom (Schneider & Haried, 2024). They weighed its potential advantages against concerns about reduced critical thinking, overreliance, weakened team dialogue, and diminished independent problem-solving (Schneider & Haried, 2024).

This study explored GAI's impact on teamwork, learning, and engagement in an undergraduate management course at a public university in the United States. Using a quasi-experimental design, the research compared outcomes from two, course sections taught during the spring 2025 semester. One group used GAI in team assignments, while the other did not. Both groups completed the same standardized team project with identical evaluation criteria.

The study examined seven key variables. Researchers collected data through structured surveys with Likert-scale items and through evaluations by three independent graders. They applied interrater reliability to ensure scoring consistency. Content analysis further evaluated the role and relevance of AI-generated contributions to team collaboration.

Guided by a combined theoretical framework, the study offered insights into how emerging technologies shaped collaborative learning (Mujtaba, 2024). The findings aimed to inform institutional policies and instructional strategies that integrated AI while preserving critical thinking, interpersonal collaboration, and cognitive development.

2. Theoretical framework

This study employs Social Interdependence Theory (SIT) and Socio-Technical Systems (STS) Theory to analyze the effects of Generative Artificial Intelligence (GAI) on collaborative learning in undergraduate teams. These theories, when viewed through the lens of andragogy, provide a comprehensive framework for understanding how adult learners engage with peers, technology, and the learning process. As GAI becomes increasingly integrated into educational environments, it is essential to examine its functional contributions and its more profound impact on the social and cognitive processes that underpin effective teamwork (Hu et al., 2024).

Social Interdependence Theory posits that the structure of interdependence among individuals within a group determines the nature of their interactions and their influence on one another's outcomes (Gheorghe et al., 2023). When individuals perceive their goals as positively interdependent, they are more likely to engage in promotive interaction, which includes mutual support, shared responsibility, and collaborative problem-solving. In educational contexts, such positive interdependence has been consistently associated with deeper learning, higher motivation, improved reasoning, and stronger interpersonal relationships (Johnson & Johnson, 2009; Bate et al., 2014).

SIT identifies three interrelated forms of interdependence: outcome, means, and boundary. Outcome interdependence refers to shared goals and rewards among group members. Means interdependence involves mutual reliance on resources, roles, and coordinated efforts to achieve team objectives. Boundary interdependence pertains to the delineation of team membership and the behaviors that either support or obstruct the pursuit of collective goals. These dimensions foster accountability, collaborative competence, and social cohesion, which are essential for effective team-based learning (Paradis and Whitehead, 2018).

The introduction of GAI into team-based learning environments adds new complexity to each form of interdependence. As a shared cognitive tool, GAI influences means interdependence by altering how tasks are distributed, how roles evolve, and how team members communicate. Boundary interdependence may be affected as the use of GAI challenges traditional norms of authorship and contribution, potentially diminishing individual accountability. Likewise, outcome interdependence may shift as teams recalibrate their understanding of success considering algorithmic assistance.

To further explore these dynamics, the study incorporates Socio-Technical Systems Theory, which emphasizes the interplay between a team's social and technical subsystems. According to STS Theory, team effectiveness, and creativity result from the joint optimization of both domains. The social subsystem includes interpersonal relationships, communication patterns, roles, and norms, while the technical subsystem encompasses tools, platforms, and processes such as GAI. This framework encourages investigation into how students prompt and interpret AI-generated content, develop or withhold trust in machine assistance, and maintain or relinquish creative agency. The alignment or misalignment between these subsystems may enhance or inhibit divergent thinking, coordination, and performance (Baxter & Sommerville, 2011).

These theoretical lenses are particularly relevant in andragogical contexts. Adult learners bring prior knowledge, workplace experience, intrinsic motivation, and a preference for relevant, problem-centered learning to the classroom (Knowles, Holton, & Swanson, 2015). Andragogy emphasizes autonomy, practical application, and purposeful learning. GAI can enhance task relevance, innovation, and engagement when integrated with intention. However, if instructors fail to align GAI use with adult learning principles, there is a risk of encouraging passive participation, eroding critical thinking, and undermining interpersonal development.

This study investigates whether using GAI enhances or impedes the processes of social interdependence within team learning. Specifically, it examines whether GAI improves the efficiency of collaborative tasks without diminishing meaningful peer-to-peer engagement or whether it fosters dependency and weakens the quality of team interaction. By applying SIT and STS Theory in a comparative analysis of collaborative learning environments that either permit or restrict the use of GAI, the study offers a conceptual foundation for interpreting differences in team and individual outcomes.

At the team level, the research examines variations in creativity and overall performance. At the individual level, it assesses student perceptions of interest, learning value, practicality, quality of team discussions, and accountability. Grounded in andragogical principles, the study evaluates GAI for its technological utility and alignment with adult learners' developmental needs. Through this approach, the study aims to inform instructional practices that integrate emerging technologies while preserving the essential goals of higher education: the cultivation of critical thinking, personal responsibility, and interpersonal competence.

3. Methodology

3.1. Research design and participants

This quasi-experimental study involved students enrolled in two sections of the same core course in a public U.S. university's Bachelor of Business Administration program. A quasi-experimental design was chosen due to the absence of a pretest, which is consistent with Neuman (2011). The course was taught by the same instructor using identical pacing, content, and instructional strategies across both sections. The intervention was introduced in the final team project: students in the experimental group were required to use AI prompts as part of their assignment, whereas the control group received no such requirement. Specifically, the experimental group's rubric included an additional 10-point criterion requiring students to

submit four AI prompts, the associated outputs, and explanations of how those outputs were used. Participants included 94 students enrolled in the Organizational Behavior course, evenly split between the experimental (n = 47) and control (n = 47) groups. Gender demographics were as follows: [insert breakdown once available]. Participation was voluntary, with a minor incentive of 10 extra credit points (out of 1,000 total course points). The study was approved by the university's Institutional Review Board.

3.2. Procedures

This study took place during the 16-week Spring 2025 semester. In week 2, students formed teams and stayed in those teams for the duration of the course. They completed three preliminary team assignments in weeks 4, 7, and 9. In week 10, the instructor released the final project guidelines and rubric. At that point, the instructor introduced the intervention: one section received an added rubric criterion worth 10 points that required teams to use four AI prompts to support project development. Teams documented each prompt, the AI tool used, the AI-generated output, and a brief explanation of how it informed their project. They included this section after the references but did not present it in class. In week 14, the instructor invited all students to complete a voluntary post-project survey and gave them one week to respond.

3.3. Study measures

Group-level outcomes included creativity and overall performance, assessed through content analysis of the final team projects. Three independent raters evaluated each submission using standardized rubrics. Creativity was scored on a 5-point scale (1 = minimal, 5 = exceptional) based on detailed descriptors. Performance was rated using a similar 5-point scale (1 = deficient, 5 = exceptional). In cases of scoring disagreement, raters discussed their assessments until consensus was achieved.

The individual dependent variables in the study are interest in the assignment, perceived learning value, perceived practicality, team discussion quality, and sense of accountability. Each was measured with four items on a 5-point Likert scale. Sample items used are: "The assignment topic was meaningful to me" (interest in the assignment); "This assignment helped me understand the subject matter better" (perceived learning value); "I learned new skills working on the assignment" (perceived practicality); "Team members actively shared and debated different ideas" (team discussion quality); and "I put in effort to ensure our team produced high-quality work" (sense of accountability).

The prompts submitted as part of the assignment in the experimental group were evaluated by the same reviewers for their quality and relevance. Quality was assessed as 1=basic (repeats studied content), 2=applied (related to analysis, comparison, or problem-solving linked to course concepts), and 3=innovative (related to evaluation or creation). Relevance was assessed as 1=low (prompt does not address the core objectives), 2=moderate (prompt addresses the core objectives but without nuanced search for meaning), 3=high (prompt searches for ways to address higher-order execution of the core objectives).

4. Results

We used separate exploratory factor analyses (EFAs) for each of the five measured variables using the Promax rotation option in JASP to analyze the latent structure of the survey items. Investigating the Kaiser-Meyer-Olkin (KMO), Bartlett's Test, eigenvalue, variance explained, and items loading statistics, we found that each variable demonstrated sampling adequacy, supporting single-factor solutions. Each of the five factors explained between 54.7% and 64.3% of the variance. In addition, all the loadings were above the recommended threshold of .60, which provided further evidence that each factor represents a coherent construct. Table 1 reports the results of EFAs, which support the interpretation of five latent variables, and therefore, we proceeded with the consequent analyses using each factor as a single variable.

Table 1. Exploratory Factor Analyses (EFAs) results, conducted in JASP.

Variable	*KMO*	*Bartlett's Test χ^2(df)*	*p-value*	*Eigen-value*	*Variance Explained*	*Factor Loadings (range)*	*Lowest Loading Item*
Interest	0.791	111.86 (6)	< .001	2.861	62.4%	0.727 – 0.883	Q1.3 (0.471)
Learning Value	0.774	83.40 (6)	< .001	2.609	54.7%	0.570 – 0.861	Q2.3 (0.570)
Practicality	0.691	118.09 (6)	< .001	2.853	62.0%	0.725 – 0.839	Q3.1 (0.725)
Discussion Quality	0.697	89.91 (6)	< .001	2.631	54.9%	0.626 – 0.826	Q4.1 (0.626)
Accountability	0.781	122.22 (6)	< .001	2.909	64.3%	0.680 – 0.906	Q5.1 (0.680)

We then performed two sample t-tests to compare the means of the study variables between the control and experimental groups. We found that students in the control group (M=4.24, SD=1.21, n=29) achieved significantly higher performance than the students in the experimental group (M=2.93, SD=1.48, n=30); t(57)=3.70, p<0.001, d=0.96. This result suggests that students prompted to use AI achieve lower performance than those who are not. Conversely, we found that the team creativity of the control group (M=2.28, SD=0.70, n=29) is lower than that of the experimental group (M=2.93, SD=1.14, n=30) with t(57)= -2.65, p<0.01, d=-0.69. We did not find any statistically significant differences in the means for the other variables—interest in the assignment, perceived learning value, perceived practicality, team discussion quality, and sense of accountability.

Next, we performed a correlation analysis of the study variables to determine if there were significant relationships. The results are presented in Table 2 and indicate some notable findings. It showed that team performance positively correlated with assignment interest, learning value, assignment practicality, team discussion quality, accountability, and gender, but negatively with AI use. The analysis revealed strong positive correlations among the individual-level outcomes, especially between assignment interest and learning value, team discussion quality, and accountability. Notably, AI use shows significant relationships with team performance and team creativity, but did not significantly correlate with individual-level outcomes, indicating it did not influence students' perceptions of interest, value, practicality, discussion quality, or accountability.

Table 2. Correlations between study variables.

Variable	TP	TC	AI	LV	AP	DQ	A	G	AIU
TP	_								
TC	0.221*	_							
AI	0.431***	0.168	_						
LV	0.433***	0.221*	0.857***	_					
AP	0.370**	0.087	0.780***	0.808***	_				
DQ	0.432***	0.148	0.818***	0.771***	0.648***	_			
A	0.463***	0.076	0.752***	0.704***	0.652***	0.845***	_		
G	0.277**	-0.237**	0.0490	-0.055	-0.141	0.118	0.209	_	
AIU	-0.440***	0.331*	-0.050	-0.064	-0.081	0.013	-0.154	-0.255**	_

Note: n=59; *** = p<.001; ** = p<.005; * = p. <.10; TP= team performance; TC = team creativity; AI = assignment interest; LV = learning value; AP = assignment practicality; DQ = discussion quality; A = accountability; G = gender (dummy variable, 0 = female, 1 = male); AIU = AI use.

Analyzing AI prompts for quality and relevance among the eight experimental teams revealed significant variation in how effectively students used generative AI to support their presentations. Three trained raters independently evaluated each team's prompts using a standardized rubric. The few differences in grades were addressed collaboratively until agreement was reached between the three reviewers. Only two teams consistently produced high-quality, relevant prompts that received top scores. These teams demonstrated a strong ability to craft aligned and innovative inputs, reflecting a better understanding of how to prompt AI for academic tasks that go beyond what is learned in the classroom and search for synthesis, evaluation, creation, or other higher-order actions that can inform their research in a novel way. In contrast, the majority of the teams submitted mostly low-level, repetitive, and surface-level prompts, which frequently received the lowest possible scores; an example is “What are companies that can compete with Google?” One of the teams in the experimental group did not submit prompts, so the analysis excluded them. On average, prompt quality varied widely, with only a few teams demonstrating effective use of AI and others struggling to generate purposeful inputs and consequently to receive meaningful outputs. These results highlight the need for scaffolded instruction in prompt engineering. To use AI effectively in academic settings, students must learn to write clear, strategic prompts that align with learning goals and stimulate higher-order thinking. Without structured guidance and opportunities for practice, students are unlikely to fully benefit from AI as a tool for collaborative learning and presentation development.

5. Discussion and conclusion

This study examined whether undergraduate teams using GAI in class projects experienced enhanced or diminished learning and collaboration. Teams that used AI generated more creative ideas but scored significantly lower on overall project evaluations than teams that did not use AI. Students in both

groups reported similar levels of interest, perceived learning, practicality, team discussion quality, and accountability. These findings suggest that while AI can stimulate creativity, it does not automatically improve learning outcomes or strengthen team engagement.

Using Social Interdependence Theory, we found that AI can disrupt the cooperative structures that support effective teamwork. It may reduce outcome interdependence when students rely on AI instead of each other to accomplish goals. It can shift means interdependence by moving responsibilities away from shared tasks toward passive tool use. It may also weaken boundary interdependence when AI-generated content blurs individual contributions. From a Socio-Technical Systems Theory perspective, this misalignment between the technical tool and team dynamics helps explain why creativity improved while overall performance declined.

These results also raise essential considerations through the lens of adult learning theory. Adult learners depend on relevance, autonomy, and collaboration. When instructors introduce AI without thoughtful design, the tool can lower engagement and reduce the benefits of active learning. Although AI offers valuable support, educators must help students use it in ways that enrich rather than replace critical thinking, participation, and team collaboration. Therefore, educators should consider fostering both technical proficiency and collaborative interdependence to help students harness AI as a complement to deeper and meaningful learning.

In conclusion, GAI can empower students by expanding creative possibilities, but it can also impair learning and teamwork when students use it as a substitute for meaningful interaction. Its impact depends on how intentionally instructors integrate it into team-based learning environments. The findings highlight the need for a balanced approach to prioritizing active collaboration alongside technological innovation. To realize AI's potential as an empowering force, students must also learn how to write effective prompts that guide the tool toward thoughtful and relevant contributions. Future research should explore whether structured AI guidelines, prompt-writing education, and scaffolded team tasks can mitigate the challenges we outlined.

Acknowledgments

The authors gratefully acknowledge Tanya Rodriguez for serving as a rater.

References

Bate, E., Hommes, J., Duvivier, R., & Taylor, D. C. M. (2014). Problem-based learning (PBL): Getting the most out of your students - Their roles and responsibilities: AMEE Guide No. 84. *Medical Teacher, 36*(1), 1-12.

Baxter, G., & Sommerville, I. (2011). Socio-technical systems: From design methods to systems engineering. *Interacting with Computers*, *23*(1), 4-17.

Gheorghe, A., Fodor, O. C., Curșeu, P. L., Trif, S., & Cirebea, L. (2023). The effect of humor and perceived social interdependence on teamwork engagement in student groups. *Current Psychology*, *42*(27), 23830–23841.

Hu, L., Xiao, W., Zhu,W., Zhu, L., & Hu, Y. (2024). Impact of artificial intelligence, smart learning and belief about future on academic performance & moderating effect of desire for knowledge. *El Profesional de La Información*, *33*(4), 1-15.

Johnson, D. W., & Johnson, R. T. (2009). An educational psychology success story*:* Social Interdependence Theory and Cooperative Learning. *Educational Researcher*, *38*(5), 365-379.

Knowles, M. S., Holton, E. F., & Swanson, R. A. (2015). *The adult learner: The definitive classic in adult education and human resource development* (8th ed.). London and New York: Routledge.

Mujtaba, B. (2024). Clarifying ethical dilemmas in sharpening students' artificial intelligence proficiency: Dispelling myths about using AI tools in higher education. *Business Ethics & Leadership (BEL), 8*(2), 107-127.

Neuman, W. L. (2011). *Social Research Methods*. Boston: Pearson Education Inc.

Paradis, E., & Whitehead, C. R. (2018). Louder than words: Power and conflict in interprofessional education articles, 1954–2013. *Medical Education*, *52*(4), 422-437.

Schneider, S., & Haried, P. (2024). Use of Artificial Intelligence in Higher Education with Particular Reference to Automated Content Generation, Trust and Anxiety. *Journal of Business & Educational Leadership, 14*(1), 4-21.

Sihi, D., & Ryan, A. (2024). Crafting and evaluating Generative AI prompts: Insights from students, educators, and marketers. *Marketing Education Review*, 1-7.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

THE ROLE OF GENERATIVE AI IN TRANSFORMING EDUCATIONAL PRACTICES

Nora Gavira-Duron[1], Ana Lorena Jiménez Preciado[2], Angélica Alonso-Rivera[1], & Claudia M. Ramirez-Culebro[1]
[1]Universidad de las América Puebla (Mexico)
[2]Instituto Politécnico Nacional CDMX (Mexico)

Abstract

The rapid advancement of artificial intelligence (AI) technologies, particularly generative AI and Natural Language Processing (NLP) tools is transforming higher education. This study investigates the integration of AI in tertiary educational settings, focusing on its impact on teaching practices and learning outcomes. Our corpus analysis highlights the prominence of AI in education, with frequent references to AI applications such as ChatGPT and large language models. These technologies offer innovative solutions for personalized learning, intelligent tutoring systems, and enhanced pedagogical methods. The analysis reveals a significant focus on practical implementations of AI, emphasizing the transformation of traditional teaching methodologies. The study also addresses critical issues such as the technological infrastructure required for AI integration and the ethical considerations of AI use in education. The findings suggest that while AI holds promise for revolutionizing education, there is a need for a balanced approach that includes developing critical thinking skills and addressing ethical implications. This research contributes to the growing body of literature on AI in education by providing a detailed exploration of current trends, challenges, and future directions in the field.

Keywords: *Generative AI, natural language processing (NLP), higher education, innovative pedagogy.*

1. Introduction

Artificial Intelligence (AI) has emerged as an overarching change force in all levels of learning, transforming pedagogical practice from pre-school classes to vocational training centers and college classrooms. While early implementation of AI was predominantly restricted to the tertiary education sphere, generative applications like ChatGPT (OpenAI, 2023) currently permeate different learning spaces, including schools and colleges in K-12 (Kindergarten to 12th grade), corporate training modules, and non-formal lifelong learning settings. Bahroun, et al. (2023), situate this democratization of technology in the context of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), analyzing 207 studies to identify such major gaps in fields such as medical and engineering education, where intelligent tutoring systems and adaptive learning driven by generative AI (GAI) are transforming pedagogical standards.

The AI is transforming the educational field in terms of improving pedagogical practices, raising students' engagement, and reducing administrative workload (Villamil, et al. 2024). Generative AI, such as Natural Language Processing (NLP) tools like ChatGPT, has been demonstrated to be largely promising in facilitating personalized learning experiences, intelligent tutoring systems, and tailored evaluation (Quezada and Urbina, 2025) and (Gavira, 2023). These technologies underpin learning theories like constructivism, connectivism, and adaptive learning, promoting student-centered, adaptive, and data-driven learning (Pineda, et al. 2024). However, the use of AI in education also has ethical effects on equity, digital literacy, and institutional readiness (Gómez, Fuentes and Castro, 2024). This model discusses how generative AI reconfigures teaching methods and learning processes and resolves these significant concerns.

Building on these foundations, Katonane (2024) extends this ground by illustrating how AI adaptive learning systems improve learning outcomes as far as they raise ethical issues regarding their scalability, particularly in resource-scarce environments, the voracious expansion of large language models (LLMs) has hastened such shifts. Teachers at all levels have grappled with its meaning since ChatGPT came into public view in November 2022. Saariluoma and Karvonen (2024) investigate the languages of AI construction at the back of which rests underlying theory restrictions in educational technology

construction. Formal, computational, and natural language are distinguished as formal languages (mathematics and logic) not having semantics relevant to the world, computational languages having domain-limited references, and natural language with dynamic creative expression. These distinctions clarify the perennial debate between strong AI (human-like cognition) and weak AI (task-specific solutions), revealing how design choices in theory languages shape AI's pedagogical potential and limitations.

From high school teachers redesigning writing assignments to medical schools incorporating AI diagnostics simulations (Lund and Wang 2023). López-Chila, et al. (2024) quantify this trend through bibliometric analysis of 870 articles, which indicate the prevalence of computer science and education journals for AI research. Their focus on higher education nevertheless points to a significant omission: only 12% of the publications reviewed focused on primary or vocational contexts despite growing evidence of AI adoption in these sectors. Papadogiannis, Wallace and Karountzou (2024) justify these facts based on educational data mining (EDM), demonstrating that algorithms such as classification, natural language processing (NLP), and regression analysis enable customized learning experience on a global level but with concern about algorithmic bias in the case of non-rigorous ethical frameworks.

Democratization of AI technologies carry special meanings in developing countries where technological leapfrogging crosses over with limited resources. These programs are compatible with Bahroun, et al. (2023) calls for multidisciplinary directions in considering explainable GAI models capable of mitigating cultural bias. The issue should be addressed in educator preparation Adekunle, et al. (2024) point to the importance of AI literacy for pre-service teachers, who will turn out to be constructors of learning institutions. This study challenges such multifaceted changes in terms of cross contextualism. By synthesizing evidence from peer-reviewed studies, industry case studies, and policy documents, we aim to map concrete AI deployments across education levels (K-12, vocational, higher), analyze competing pedagogical and ethical concerns by institutional context, and propose equity-focused frameworks for responsible AI deployment.

2. Literature review

Constructivist theories, explained by Jean Piaget (1969) and Lev Vygotsky (1926), focus on the construction of knowledge through active learning and social interaction. Recent studies show that AI technologies support these theories by personalizing learning experiences. For example, AI adaptive learning systems in early childhood improve understanding and recall by modifying content to fit individual needs (Veces, et al. 2024). Interactive content, like AI-backed simulations, allows students to discover and actively participate in constructing knowledge (Quezada and Urbina, 2025). In addition, AI-generated content supports independent learning, where students connect information based on their own comprehension (Solis, Huerta and Hernández, 2024). Vygotsky's sociocultural theory (1926) is also supported by AI, which aids in learning. AI systems allow for the easier delivery of personalized content and improving student-teacher interaction to fill gaps in understanding (Arango, et al., 2024). AI offers guided models within the Zone of Proximal Development (ZPD) and improves how students interact with technology, improving collaborative learning (Benavides, et al. 2024). Digital constructivism emphasizes the capability of teachers and students to be technologically competent. Such competency is essential for AI to effectively facilitate autonomous learning (Villamil, et al. 2024).

AI fits well with Adaptive Learning Theory and Gardner's Multiple Intelligences, showing that it can cater to different learning styles. By modifying lessons based on students' performance, AI renders the learning process individualized (Prince, 2022), these systems recognize strengths and weaknesses in different intelligences, like language, spatial capacity, and math personalizing activities to stimulate students. For example, adaptive platforms convert difficulties to fit all learners, enhancing inclusivity and academic success (Veces, et al., 2024). This not only boosts motivation but also guarantees equal access to education for all people, catering to different learning styles and needs. Siemens (2005) connectivism argues that knowledge develops through networked interactions, which is a model fostered by AI. AI is supported by technologies such as dynamic content generators and collaborative platforms that enable peer-to-peer co-construction of knowledge, unlike static curricula, AI continuously analyzes students' progress, enabling real-time content adjustment and personalized feedback (Flores and Nuñez, 2024). Learning analytics allows educators to detect gaps using data, whereas computerized exams enhance self-regulation and computer literacy readiness (Gómez, Fuentes and Castro, 2024).

AI enhances teaching by stimulating students to inquire and discover. Interactive simulations and virtual tutors enable students to learn through real-world issues (Villamil, et al., 2024). In flipped classrooms, AI personalizes the content that students learn prior to class, enabling them to devote more class time to critical thinking and collaboration (Montenegro-Rueda and Fernández-Cerero, 2022). Educators move from simply presenting information to facilitating student learning, utilizing AI to assist

and promote in-depth comprehension (Villamil, et al., 2024). AI applications bring up essential ethical issues. We need to reduce algorithms' bias and data privacy (Gómez, Fuentes and Castro, 2024). Students need to study AI so that they can critically evaluate AI-generated materials (Solis, Huerta and Hernández 2024). We need to focus on equity and inclusiveness so that no one is excluded. Training teachers on the ethics of AI will facilitate the responsible usage of AI (Gómez, Fuentes and Castro, 2024). These steps are crucial towards fostering positive behavior online in AI-based education.

This study employs a mixed-methods design to analyze generative AI's role in education, combining natural language processing (NLP) of academic literature with qualitative case studies. This approach ensures methodological triangulation, balancing broad thematic trends with granular insights into real-world applications. A purposive sample of 52 peer-reviewed articles (2024) was extracted from Emerald Publishing Limited, focusing on AI in education. This sample aligns with NLP research conventions, where corpora of 50–60 articles suffice to identify disciplinary discourse patterns (Xu and Ouyang 2022); (Mousavinasab, et al. 2018). Articles were filtered using keywords (generative AI, pedagogical innovation, educational transformation), supplemented by industry case studies and policy documents to contextualize findings.

The text preprocessing begins with the cleaning and tokenization of the data, non-alphabetic characters and words that do not provide results were eliminated (for example, "the", "and") and the texts were reduced to lowercase. Tokenization was then carried out with which texts were segmented into word-level units following white space boundaries (Webster and Kit, 1992), structuring data for computational analysis. After cleaning the data, lemmatization was performed, using NLTK's WordNetLemmatizer (Bird, Klein and Loper 2009), the inflected words (e.g., "learn" → "learn") were assigned to their canonical form (Plisson, Lavrac and Mladenić 2004). This ensured terminological coherence, which is essential for analyzing conceptual constructions in academic texts (Korenius, et al. 2004); (Sproat, et al. 2001). To then carry out the quantitative analysis in two parts:

1. *N-Gram Models:* Markov chain-based n-gram analysis identified recurring phrases (e.g., "adaptive learning systems," "ethical implications"), revealing dominant pedagogical and technological trends.
2. *Topic Modeling:* Latent Dirichlet Allocation (LDA) algorithms clustered the 316,687-word corpus into themes (e.g., AI ethics, personalized learning), highlighting scholarly priorities.

3. Results analysis

The n-gram analysis revealed key clusters shaping the current discourse on AI in education, aligning with the study's focus on pedagogical transformation and institutional adoption. Below, we synthesize the findings at the n-gram levels, emphasizing their theoretical and practical implications. In the *1-gram analysis*, the corpus prioritized *AI* (5,827 occurrences) and *education* (4,327), reflecting the field's central focus on technological integration. The high frequencies of *student* (3,723) and *learning* (3,473) underscored a student-centered orientation, consistent with the constructivist principles highlighted in the literature review (Veces, et al. 2024). In particular, *ChatGPT* (3466) emerged as the most cited tool, pointing to its disruptive impact on pedagogical practices. The prominence of *research* (2,421) and *technology* (2,212) reinforced the dual emphasis on empirical research and applied innovation, reflecting the mixed methods design of this study.

The *analysis of 2-grams* emphasizes AI's central role in the corpus. Its high frequency (1193 occurrences) indicates that it is a fundamental concept around which much of the research revolves, aligning with the growing integration of AI technologies in educational settings and the increasing academic interest in this intersection. Showing the contextualization of AI applications, *higher education* predominated (824), suggesting an emphasis on university student research compared to K-12 or vocational contexts, a gap observed in the literature review (López-Chila, et al., 2024). On the other hand, there is a rise in *generative AI* (444) and *AI tools* (340) highlighted the rapid adoption of technologies such as ChatGPT, aligning with studies on personalized learning (Quezada and Urbina, 2025). Regarding practical implementation, phrases such as *use ChatGPT* (257) and *AI technology* (270) dominated the theoretical terms, emphasizing a pragmatic shift towards tool implementation. Regarding dual pedagogical objectives, *AI education* (319) and *teaching-learning* (226) revealed parallel interests in both teaching about AI and improving pedagogy with AI, echoing the literature's emphasis on AI literacy (Gómez, Fuentes and Castro, 2024).

The 3-gram analysis shows us the emerging frontiers, *AI higher education* (106) and *higher education institutions* (63) reaffirmed the tertiary bias of the field, while *educational information technology* (60) highlighted critical infrastructural concerns for scaling AI (Papadogiannis, Wallace and Karountzou, 2024) Regarding technical and pedagogical innovation, *natural language processing* (88) and *generative artificial intelligence* (84) highlighted cutting-edge methodologies, while *research in innovative teaching* (55) linked AI with pedagogical experimentation, in resonance with connectivist frameworks

(Siemens, 2005). The analysis confirms the transformative role of AI in higher education, particularly through generative tools like ChatGPT, but reveals three critical points:

1. *Equity gaps:* The tertiary focus of the corpus contrasts with the emphasis on the democratizing potential of AI, suggesting underexplored opportunities in K-12 and vocational training.
2. *Ethical ambiguity:* Although ethical implications appeared in 2 grams (165), their lower frequency compared to technical terms (e.g., artificial intelligence tool) indicates the need for deeper ethical scrutiny, as noted by (Gómez, Fuentes and Castro, 2024).
3. *Theory-practice balance:* The predominance of applied terms (use ChatGPT) over pedagogical theories (e.g., constructivism) suggests a risk of tool-centric discourse, requiring a stronger theoretical foundation.

These findings validate the literature's emphasis on adaptive learning and student-centered design, but challenge assumptions about the equitable reach of AI across educational levels.

4. Conclusion

Generative AI is redefining educational paradigms by putting constructivist, adaptive and connectivism theories into practice, enabling personalized learning experiences and institutional innovation, particularly in higher education, as demonstrated by the predominance in the corpus of terms such as *higher education AI* (106 trigrams) and *generative AI* (444 bigrams). This study's focus on 2024 articles from Emerald-indexed sources, while methodologically rigorous, may overlook regional perspectives and non-tertiary contexts, reinforcing a bias toward underrepresentation of vocational and K-12 applications, a gap underscored by limited mentions of *educational information technology* (60 trigrams) in broader ecosystems. The ethical tensions highlighted by Gómez, Fuentes and Castro (2024), such as algorithmic bias and data privacy, remain unexplored in tool-centric discourse, indicating the need for frameworks that prioritize equity alongside innovation. Future research should expand through longitudinal and cross-contextual analyzes (comparing AI adoption in early childhood, vocational, and Global South settings) while integrating participatory methodologies to co-design ethical AI systems with educators and students. Furthermore, professional development models should bridge technical literacy in AI with critical pedagogy, as noted by Adekunle, et al. (2024), ensuring that educators are equipped to navigate the sociotechnical complexities of AI. By centering equity, collaboration, and ethical oversight, the field can harness the potential of AI without replicating existing inequalities, fostering learning ecosystems that are as inclusive as they are innovative.

References

Adekunle, A, M., Adelana O. P., Molefi R. R., Olalekan A., & Ishola A. M.. (2024). Examining artificial intelligence literacy among pre-service teachers for future classrooms. *Computers and Education Open*, *6*, 100179. https://doi.org/10.1016/j.caeo.2024.100179

Arango, P. R., Sagrado A. L., González E. O., & de Bedout, L. F. (2024). Implicaciones filosóficas, éticas y pedagógicas del uso de la Inteligencia Artificial en educación. *Digital Education Review, 45,* 29-36. https://doi.org/10.1344/der.2024.45.29-36

Bahroun, Z, Anane C., Ahmed V, & Zacca A. (2023). Transforming Education: A Comprehensive Review of Generative Artificial Intelligence in Educational Settings through Bibliometric and Content Analysis. *Sustainability, 15*(17). https://doi.org/10.3390/su151712983

Benavides, L M. A., Cazales V. J. R., Lovera M. D. L. Á. G., & Mendiola, M. S. (2024). Formación para el uso de la inteligencia artificial generativa en el profesorado de la UNAM: primeros pasos. *DIDAC, 84*, 7-20. https://doi.org/10.48102/didac.2024.84_JUL-DIC.208

Bird, S., Klein E., & Loper E. (2009). *Natural language processing with Python: analyzing text with the natural language toolkit*. O'Reilly Media, Inc.

Flores J. D., & Olivera N. R. N. (2024). Aplicación de Inteligencia Artificial en la Educación de América Latina: Tendencias, Beneficios y Desafíos. *Revista Veritas De Difusão Científica, 5*(1), 1-22. https://doi.org/10.61616/rvdc.v5i1.52

Gavira-Duron. N. (2023). Cómo potenciar las habilidades matemáticas con ChatGPT. R*evista Mexicana de Bachillerato a Distancia*, *15*(30). https://doi.org/10.22201/cuaieed.20074751e.2023.30.86525

Gómez, C. R., Penna A. F., & Rascón A. C. (2024). El Uso Ético y Moral de la Inteligencia Artificial en Educación e Investigación. *Ciencia Latina: Revista Multidisciplinar, 8*(5), 3243-3261. https://doi.org/10.37811/cl_rcm.v8i5.13801

Katonane, G. I. (2024). The Role of AI-based Adaptive Learning Systems in Digital Education. *Journal of Applied Technical and Educational Sciences, 14*(2), 1-12. https://doi.org/10.24368/jates380

Korenius, T., Laurikkala, J., Järvelin, K., & Juhola, M. (2004). Stemming and lemmatization in the clustering of finnish text documents. *ACM international conference on Information and knowledge management. Association for Computing Machinery*, 625-633. https://doi.org/10.1145/1031171.1031285

López-Chila, R., Llerena-Izquierdo J., Sumba-Nacipucha N., & Cueva-Estrada J. (2024). Artificial Intelligence in Higher Education: An Analysis of Existing Bibliometrics. *Education Sciences. 14*(1). https://doi.org/10.3390/educsci14010047

Lund, B. D., & Wang, T. (2023). Chatting about ChatGPT: how may AI and GPT impact academia and libraries? *Library Hi Tech News, 40*(3), 26-29. https://doi.org/10.1108/LHTN-01-2023-0009

Montenegro-Rueda, M., & Fernández-Cerero J. (2022). Realidad aumentada en la educación superior: posibilidades y desafíos. *Tecnología, Ciencia y Educación, 23*, 95-114. https://doi.org/10.51302/tce.2022.858

Mousavinasab, E, Zarifsanaiey, N., K. Niakan S., Rakhshan, M., Keikha L., & Ghazi, S, M.. (2018). Intelligent tutoring systems: a systematic review of characteristics, applications, and evaluation methods. *Interactive Learning Environments, 29*(1) https://doi.org/10.1080/10494820.2018.1558257

OpenAI. (2023). *GPT-4 Technical Report.* openai.com/research/gpt-4

Papadogiannis, I., Wallace, M., & Karountzou, G. (2024). Educational Data Mining: A Foundational Overview. *Encyclopedia, 4*(4), 1644-1664. https://doi.org/10.3390/encyclopedia4040108

Piaget, J. (1969) *Psicología y pedagogía*. Crítica, Barcelona.

Pineda, V. R. E., Brito, E. Y. C., Morales, A. G. S., & Simancas, J. M. C. (2024). Inteligencia artificial desde una concepción de las metodologías activas de la enseñanza-aprendizaje en Educación Superior. *Revista Científica Multidisciplinaria SAPIENTIAE, 7*(14), 140-159. https://doi.org/10.56124/sapientiae.v7i14.0010

Plisson, J., Lavrac, N., & Mladenic, D. (2004, October). A rule based approach to word lemmatization. In Proceedings of IS (Vol. 3, pp. 83-86). sn. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=5319539616e81b02637b1bf90fb667ca2066cf14

Prince Torres, Á.C. (2022). El aprendizaje inmersivo como alternativa educativa en contextos de emergencia. *PODIUM, 42,* 19-38. https://orcid.org/0000-0002-0059-7797

Quezada, V. C., & Velasco C. J. U. (2025). Inteligencia Artificial en la educación del siglo XXI: una exploración a su implementación, beneficios, desafíos y consecuencias éticas. *Yachana, 14*(1) https://doi.org/10.62325/10.62325/yachana.v14.n1.2025.932

Saariluoma, P., & Karvonen, A. (2024). Theory languages in designing artificial intelligence. *AI & Society, 39*, 2249-2258. https://doi.org/10.1007/s00146-023-01716-y

Siemens, G. (2005). Connectivism: A Learning Theory for the Digital Age. *International Journal of Instructional Technology and Distance Learning (ITDL)* http://www.itdl.org/Journal/Jan_05/article01.htm

Solis, P. F. M., Patraca G. A. H., & Martínez C. E. H. (2024). Inteligencia Artificial en Educación: La opinión de estudiantes universitarios sobre el uso del ChatGPT. *Revista Paraguaya de Educación a Distancia (REPED)*, 55-71. https://doi.org/10.56152/reped2024-dossierIA2-art6

Sproat, R., Black, A. W., Chen, S., Kumar, S., Ostendorf, M., & Richards, C. D. (2001). Normalization of non-standard words. *Computer speech & language, 15*(3), 287-333. https://doi.org/10.1006/csla.2001.0169

Veces, A., De León, M., Dutary, Y., Almanza, N., Swaby, H., & Rojas, N. (2024). El uso de la inteligencia artificial en la educación preescolar. Una revisión bibliográfica de la experiencia exitosa en México. *Revista Semilla Científica, 1*(6)*,* 438-445. https://doi.org/10.37594/sc.v1i6.1592

Vygotsky, L. S. (1926) *Psicología pedagógica*. Traducción de Guillermo Blanck. Buenos Aires, Febrero de 2000.

Villamil, C. C. J., Cavagnaro J. R. R., Tenorio A. L. M., Mendoza, K. V. G., & Moreno M. I. G. (2024). La transformación educativa con el uso de Inteligencia artificial: Apoyo a los educadores en el siglo XXI. *Retos y Avances en la Ciencia Contemporanea, 5*(1), 651-667. https://doi.org/10.55813/gaea/ccri/v5/n1/402

Webster, J. J., & Kit, C. (1992). Tokenization as the initial phase in NLP. *The 14th international conference on computational linguistics*, 1106-1110. Retrieved from https://aclanthology.org/C92-4173.pdf

Xu, W., & Ouyang F. (2022). The application of AI technologies in STEM education: a systematic review from 2011 to 2021. *International Journal of STEM Education, 9*(59). https://doi.org/10.1186/s40594-022-00377-5

CREATING EDUCATIONAL PATHS FOR UNIVERSITY STUDENTS TO ADDRESS SOCIETAL PROBLEMS

Les M. Sztandera
Jefferson School of Business, Thomas Jefferson University (USA)

Abstract

It has been noted in literature that creating educational paths for University students to address societal problems are multifaceted undertakings. They are often driven by federal, state, and local government grant sponsors on one hand, and foundations as well as well non-profit entities, on the other hand. Faculty members write proposals to these sponsors to obtain funding for their research projects with students. Universities typically have offices dedicated to managing these sponsored projects, ensuring compliance with sponsor requirements and University policies. Faculty must meet educational and learning outcomes in their courses through those projects. Project learning has five key characteristics: Project outcomes are tied to curriculum and learning goals; Driving questions and problems lead students to the central concepts or principles of the topic or subject area; Students' investigations and research involve enquiry and knowledge building; Students are responsible for designing and managing much of their learning; and Projects are based on authentic real-world problems proposed by sponsors. Sponsored projects are ideal instructional approaches for addressing societal problems, because they employ the 4Cs: Critical thinking, Communication, Collaboration and Creativity with learning structured in real world contexts. In this paper we present one of those student research projects that focused on approaches from Genetic Algorithms (GA) research to establish an extensive structure-property correlation database library. The collection of recommendations was used to design a range of novel polymers and fibers with improved characteristics such as exceptional stretch, recovery, strength, increased bulk, easy to dye, as well as improved hand and comfort properties. These technically advanced fibers of commercial importance to the U.S. textile industry combined the best properties of nylon and polyester, all through students' research.

Keywords: *Higher education, industry sponsored student projects, social and community impact.*

1. Project selection

Based on END 2025 Conference reviewers' input, a student project that helped to solve community and social challenges nationally and globally, was selected. However, it is essential to stress that human empathy, derived and coming from communities experiencing the issues, served as a guide for students in solving that very problem (Sztandera, 2023). Through the project, students at Jefferson were able to learn and see the applications of Genetic Algorithms (GA) in daily activities and things they interacted with, like the clothes they wear, for example (Sztandera, 2012). The goal of this project was ambitious. Initially, we addressed the issues of monomer design and polymerization in order to demonstrate proof of concept. Subsequently, the project expanded to fiber spinning, yarns and fabrics. With help of Genetic Algorithms (GA), we were able to create and examine extremely large virtual databases of polymer molecular structures. The project was theoretical in concept, but highly practical in both, its aims, implementation and eventual applications. We planned to design fibers that offered increased bulk, improved softness and were easy-dye. Such fabrics were ideally suited for the apparel, home furnishings and automotive markets, and offered cost-effective, high-performance alternatives to existing commercial textile products.

2. Background

Genetic Algorithms (GA) have been increasingly incorporated into industrial design and development projects, and we believed that the textiles of the future should include new materials produced using these advanced computational chemistry-based approaches. Production of fibers, yarns and fabrics represented a promising field for such computationally advanced processes; thus, this project laid the

groundwork for applying Genetic Algorithm approaches to the production of new materials. This project was profoundly relevant to the mission of National Textile Center (NTC), a Consortium of Universities, supported by the U.S. Department of Commerce, to spur the development of new materials and innovative manufacturing processes.

Genetic algorithms (GAs) seek to solve optimization problems using the methods of evolution, specifically survival of the fittest. In a typical optimization problem, there are a number of variables which control the process, and a formula or algorithm which combines the variables to fully model the process. The problem is then to find the values of the variables which optimize the model in some way. If the model is a formula, then we will usually be seeking the maximum or minimum value of the formula. There are many mathematical methods which can optimize problems of this nature (and very quickly) for fairly "well-behaved" problems. These traditional methods tend to break down when the problem is not so "well-behaved."

Genetic Algorithms (GAs) are intelligent computer techniques based on the biological concepts of natural selection and genetics. In this approach, the variables that define the solution to a scientific problem are represented as genes on a chromosome. GAs features a group of candidate solutions (a “population” of solutions) on the response surface. Through a form of natural selection and the genetic operations of mutation and recombination, chromosomes with better fitness are found. Natural selection guarantees that chromosomes with the best fitness will propagate into future populations. Using the recombination operator, a GA combines genes from two parent chromosomes to form two new chromosomes with a high probability of superior fitness. Mutation allows new areas of the response surface to be explored. GAs offers a generational improvement in the fitness of the chromosomes and, after many generations, will create chromosomes containing optimized variable settings.

3. Approach

There are 6 basic steps in the manufacture of textile products (Chen et. al., 2008). They are design and synthesis of monomers, polymerization of monomers, fiber spinning (melt vs. solution spinning), yarn preparation from fibers, weaving or knitting of yarns into textiles, and finally dyeing/finishing. Our initial aim was to address the issues of monomer design and polymerization in order to demonstrate proof of concept. The project eventually expanded into fiber spinning, yarns and fabrics after a demonstration of concept.

The number of potential polymeric materials is enormously large: numerous different types of monomers exist, they can be combined with one another in varying proportions, and in a wide range of molecular stereochemistry. Each factor – monomeric identities, stoichiometry, and stereochemistry – may profoundly influence the physical properties of the resulting polymer. Because of the enormous number of different polymers possible to synthesize, it is not viable to attempt to identify those polymers with desirable properties by synthesizing every conceivable polymer in order to test its properties. Some means of intelligent search through the range of potential products is therefore required. In view of the magnitude of the problem, Genetic Algorithms, which are ideally suited to this kind of large-scale multidimensional search, were used. The Genetic Algorithms made use of industrial and scientific data on the properties and performance of commercial textiles, and combined those data as appropriate with molecular quantum mechanical calculations on new species of potential interest. Thus, an extensive structure-property correlation repository could be developed. That repository was used both to evaluate the feasibility of Genetic Algorithms in the developmental phase of the project, and to aid it in the search for novel materials in the exploitation phase. The GA databases included:

- relationship between monomer parameters (chemical structure) and physical, thermal, mechanical properties of their resulting polymers;
- relationship between fundamental characteristics of polymers (molecular weight, level of crystallinity, orientation) and their physical, thermal, mechanical properties of polymers;
- relationship between reaction parameters (temperature, concentration, time, catalyst etc.) of monomers during polymerization of monomers into polymers and the fundamental characteristics of the resulting polymers;
- relationship between fiber spinning parameters (molecular weight of polymers, temperature, pressure, flow rate, draw ratio, annealing condition etc.) and fiber properties (level of crystallinity, degree of orientation, mechanical strength, etc.);
- relationship between fiber parameters (size, mono vs. multifilament etc.) and yarn processing (twist);

- relationship among fiber and yarn parameters, weaving/knitting of fabrics and fabric properties (air permeability, abrasion, tear, tensile, bursting, stiffness, comfort, dyeability).

Our approach to designing novel fibers made from polymers was to allow a GA search over monomer space to find polymers that possess a specified set of physical and chemical properties. GAs outperformed other optimization methods in a search of monomer space because the space was large and discontinuous. The representation used in the project was in the form of GA programming language strings that represented backbones and side chain groups. The graphical user-interface made that transparent to a user, which was critical for applications. The new GA which we proposed in this project, encompassed four important steps:

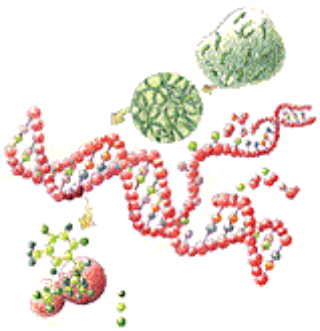
- The initial population of chromosomes was created either randomly or by perturbing an input chromosome (a sequence of physicochemical properties)
- In the evaluation step, fitness was computed using either a function derived from a summation of the properties of individual genes, or the more sophisticated Bohachevsky function
- The third step was the exploitation or natural selection step. Chromosomes with the largest fitness scores were placed semi-stochastically into a mating subset. Chromosomes with low fitness scores were removed from the population. Thus, we proposed a binary tournament mating subset selection method
- The fourth step, exploration, involved use of recombination and mutation operators. Two chromosomes from the mating subset were randomly selected and, using the uniform crossover method, recombination was applied to the individual genes in the chromosome. After the exploration step, the population was full of newly created chromosomes, and steps two through four were repeated for a predetermined number of generations.

The unique proposed operators used with polymers were:

1) *Asymmetric Crossover*: monomers could be of a variable length, so there is no advantage in choosing the same crossover point for the two parents. However, the crossover operator must leave realizable offspring, so a crossover point in the backbone was always chosen;
2) *Blending*: this operator concatenates two parents to produce one offspring whose length was the sum of those of the two parents;
3) *Mutation*: the mutation operator can act on either the backbone or the side chains;
4) *Insertion and Deletion*: backbone and side chain units can be deleted or inserted;
5) *Hopping*: the hop operator switches positions of the two backbone units.

The fitness function used was also novel in that it required the properties of the designed polymer to lie within a specified tolerance of the desired value.

Figure 1. A sample DNA sequence used in Genetic Algorithm approach.



After the establishment of the GA derived structure-property correlation database repository, a few model polymers were synthesized and their properties were evaluated for determining the feasibility of the proposed concept in designing novel polymers and fibers.

4. Conclusions

Commercially available monomers, polymers, and chemical reagents were used in the highlighted project to facilitate industry sponsored student project that led eventually to the technology transfer. Close relationships between academia and industry were established through exchange of ideas and the feedback

of information on the production and performance of new products. Consultation with personnel from related chemical and fiber industries were sought to explore product and market possibilities and to provide feedback on industrial needs in this area of research. In the three years of this project, we demonstrated that utilizing Genetic Algorithms technology could overcome the design limitations of existing polymers and fibers, thus paving the way to production of yarns and textiles with novel functionality (Chen et. al. 2014).

Educational and learning outcomes in the course project were achieved through students pursuing their research challenge. The highlighted project learning had all required five key characteristics: Outcomes were tied to curriculum and learning goals; Driving questions and problems led students to the central concepts or principles of the topic or subject area; Students' investigations and research involved enquiry and knowledge building; Students were responsible for designing and managing much of their learning; and Project was based on authentic real-world problem proposed by the sponsor.

Industry sponsored student projects are ideal instructional approaches for addressing societal problems, because they employ the 4Cs: Critical thinking, Communication, Collaboration and Creativity with learning structured in real world contexts.

References

Chen X., Sztandera L. M., & Cartwright H. M. (2008). Genetic Algorithms in Molecular Design of Novel Fibers. *International Journal of Intelligent Systems, 23*(1), 22-32.

Chen X., Sztandera L. M., Cartwright H. M., & Granger-Bevan S. (2014). The Use of Computational Intelligence in the Design of Polymers and in Property Prediction. *Lecture Notes of the Institute for Computer Sciences, Social Informatics, and Telecommunications Engineering (LNICST).*

Sztandera, L. M. (2012), Industry Sponsored Projects and Teamwork in Innovative Curriculum Design and Development, *Int. Journal of Wireless Information Networks and Business Information Systems, 5*, 138-146.

Sztandera, L. M. (2023). Data Science and Changing Economic Landscape as Driving Factors in Higher Education. In M. Carmo (Ed.), *Education and New Developments* (Vol. II, pp. 154-157).

THE USE OF AI IN TEACHING MATHEMATICS IN TEACHER TRAINING COLLEGES WITH BILINGUAL STUDENTS

Nader Hilf, & Leonid Kugel
Kaye Academic College of Education (Israel)

Abstract

With the development of the Internet and the ability to obtain information quickly, including professional and educational information, students have developed the skill of fast reading. Along with the advantages of such skills in learning mathematics, we would like to point out some disadvantages. With the skill of fast reading, it is easy to lose small details when parsing data in the proposed tasks. Such problems arise not only when reading about the problems themselves, but also when solving the problems offered in seminars. We want to look at some ways to fill these gaps in students' knowledge with the help of students' access to artificial intelligence chat rooms. There is no need to fear the fact that the student can get additional help in the subject, it is necessary to take control of this possibility. We will consider the issue of analyzing the initial data and the results obtained on the example of a subject (a subject of our choice, for example: Geometry), but if desired, this methodology can be extended to other subjects. The possibilities of AI are very broad, from finding answers to general questions to finding solutions to specific problems. For the instructor, the main difficulty in using AI is that today's systems do not use friendly forms of recording mathematical formulas but accept them in LaTeX format. Colleges typically do not take the time to learn the scientific language of formulas and thus must find additional applications to translate the familiar "math language" into a scientific format. However, ChatGPT can now recognize mathematical handwritten text, although it requires additional verification of the correctness of the translation (the correctness of reading the handwritten text). We use this feature for additional explanation of the material to Arabic-speaking students. After explaining the new material after the first examples, we suggest that students write a request to ChatGPT in their native language and get a second explanation, but in their native language. One of the disadvantages of the ChatGPT is the inability to draw geometric shapes, which will cause difficulties for students in understanding the proposed solution.

Keywords: *ChatGPT, geometry, AI, prompts.*

1. Introduction

In recent years, technology has developed rapidly and being used increasingly in learning and teaching. In the broad field of technology, artificial intelligence has recently gained special importance and attention because it helps to get information immediately. The capabilities of artificial intelligence today are very wide, from finding answers to general questions to finding solutions to specific problems. In addition, it is language-based. Considering these features of artificial intelligence, students have developed and still developing the ability to read quickly. It is important to note that an immediate barrier to this type of reading is a lack of attention to minute detail (NCTM, 2014). This means that the ability to process and analyze data as required from the user is limited. Therefore, it is very important to understand this technology and use it wisely, both in teaching and learning, by considering its weaknesses and limitations (Tashtoush et al., 2023), not only global but also adapted to the discipline.

2. Review

In the light of progress, the introduction of new technologies, including artificial intelligence, is also of great importance in the teaching of mathematics. Combining the teaching of a profession with artificial intelligence can increase its appeal by providing immediate feedback, helping to increase motivation, reduce anxiety and providing experiential learning processes (NCTM, 2014). Nevertheless, one major difficulty arises when using artificial intelligence in teaching mathematics, is that today's systems do not use known mathematical formulas because they are language-based, as mentioned above. They obtained

in LaTeX format. This is why teacher-training colleges are usually reticent to teach math using artificial intelligence, because math is a scientific language of formulation.

The conversation model developed using artificial intelligence calls ChatGPT. Currently, this model is beginning to show a potential as a methodology for teaching and learning mathematics (Baidoo-Anu & Ansah, 2023) as it can recognize mathematical text from a manuscript. However, it is worth noting that this ability, even today, requires additional verification of the correctness of the AI translation. However, we did not limit the students to only using ChatGPT; they also used Google (Gemini) and Microsoft (Copilot) environments. The results are the same. Each has advantages, such as the ability to write from right to left, combined with math formulas, and disadvantages, such as not everyone can read handwriting and then first need to translate it into printed text.

In this paper, we focus on the ability to use artificial intelligence in teaching mathematics in complex groups in terms of students' native language and proficiency levels. We thought that the use of artificial intelligence chat could help with two problems specific to learning mathematics in such groups: first, the comprehension of material in a second language (not the native language), and second, the different proficiency levels of the students. With the first difficulty, the material subjected to double processing at the student level: first, performed the translation of the learning material into the native language; Second, the process of mastering the theoretical material or solving the tasks begins. We realize that artificial intelligence can help by explaining the material studied in the native language. This is not a technical translation of a lecture or direct problem solving in class, but a result based on learning from many sources. Regarding the second difficulty, when solving problems, artificial intelligence can use for understand the steps of the solution as well as to further verify the correctness of the solution. Checking the correctness of the solution and detecting errors, if necessary, develops students' skills of self-quality control and analyzing solutions. It is worth noting that most chat rooms based on artificial intelligence who knows as a potential of many errors.

3. Research

To investigate the contribution of artificial intelligence in teaching math in touchy-feely classrooms, we use it to explain new material to Arabic-speaking students in a college for teachers from southern countries. During the study, students received explanations of new material in the Hebrew classroom, knowing that students from the Bedouin sector in the study group were discussing Hebrew with language difficulties. They then received their first sample solutions to the exercises. At the end of the tutorial, students invited to write a request to ChatGPT in their native language for further clarification. Prior to this, we invited an Arabic team member to go to the chat room and get the solutions in Arabic. We did the same with Russian-speaking students, offering them a Russian query. To see if this step is enough to understand the material and the solution paths in relation to it, we want to offer a solution to the exercise we showed.

Many students find it difficult to find a solution to a problem and do not know where to start. Here too, a chatbot based on artificial intelligence can help by showing different solution options without immediately revealing the solution.

-- To solve the given problem about the trapezoid ABCD, let us outline multiple possible approaches:

As a result, we got four ideas for solving our problem.

Figure 1.

-- 1. Using Proportionality in Similar Figures

Since $\boldsymbol{FE} \parallel \boldsymbol{CD}$ and lies between two parallel lines in the trapezoid, it forms a smaller, similar trapezoid within $\boldsymbol{ABCD}$. This similarity can be used to determine segment ratios:

We use the midsegment theorem for directly compute $\boldsymbol{EF}$ in relation with $\boldsymbol{AB}$.

The same similarity applies to the segment relationships between $\boldsymbol{M}, \boldsymbol{C}$ and $\boldsymbol{F}$.

-- 2. Using Coordinate Geometry

Assign coordinates to the vertices:

Let $\boldsymbol{A}(\boldsymbol{0}, \boldsymbol{h})$, $\boldsymbol{B}(\boldsymbol{a}, \boldsymbol{h})$, $\boldsymbol{C}(\boldsymbol{2a}, \boldsymbol{0})$, $\boldsymbol{D}(\boldsymbol{0}, \boldsymbol{0})$.

Use the midpoint formula to locate points like $\boldsymbol{E, F, ME}$.

Compute segment lengths using the distance formula and verify the required ratios.

-- 3. Using Vector Algebra

Assign vectors to points based on known ratios.

Express $\vec{\boldsymbol{E}}, \vec{\boldsymbol{F}}$, and $\vec{\boldsymbol{M}}$ in terms of known points.

Use vector properties to prove given segment relationships.

-- 4. Using Mass Points

Assign mass values proportional to segment divisions (e.g., if $\boldsymbol{BC = 3 \cdot BE}$, assign mass 3 at C and 1 at B).

Use the mass balance method to find the exact location of E, F, M.

Compute the required segment ratios.

We also decided to conduct the solution in two stages: the teacher's solution in the classroom and then analyzing and/or understanding the solution in the students' native language using artificial intelligence. After discussing and building possible models of our problem, we asked students to ask ChatGPT to suggest its solution.

At this stage, we considered additional tasks, as understanding the solution in their native language and analyzing the correctness of the solution. When teaching mathematics in schools, it is important to develop in future teachers the habit of analyzing not only their own solutions, but also the solutions of future students.

Figure 2.

-- Solve the problem step by step:

Step 1: Find $\frac{\boldsymbol{EF}}{\boldsymbol{AB}}$

Since $\boldsymbol{FE \parallel CD}$ and lies between the parallel lines, it acts as a segment proportional to the bases of the trapezoid.

Using the trapezoidal midsegment theorem, the ratio between corresponding parallel segments follows the same ratio as that of the bases:

$$\frac{\boldsymbol{EF}}{\boldsymbol{AB}} = \frac{\boldsymbol{CD}}{\boldsymbol{AB}}$$

Given that $\boldsymbol{CD = 2AB}$, we get:

$\frac{\boldsymbol{EF}}{\boldsymbol{AB}} = \frac{\mathbf{1}}{\mathbf{2}} \Rightarrow \frac{\boldsymbol{E}}{\boldsymbol{F}} = \frac{\mathbf{1}}{\mathbf{2}}\boldsymbol{CD}$

Thus, the required ratio is:

$$\frac{\boldsymbol{EF}}{\boldsymbol{AB}} = \frac{\mathbf{1}}{\mathbf{2}}$$

Step 2: Prove $\mathbf{MC = 3FM}$:

From the given data, $\mathbf{BC = 3BE}$. This suggests that point $\mathbf{E}$ divides segment $\mathbf{BC}$ in the ratio:

$$\mathbf{BE : EC = 1 : 2}$$

Since M is the midpoint of DE, it follows that segment M divides line DE in a 1:31:31:3 ratio, meaning:

$$\mathbf{MC = 3FM}$$

Thus, the statement has been proved.

Step 3: Find $\frac{\mathbf{AM}}{\mathbf{MC}}$

From the previous step, we established:

$$\mathbf{MC = 3FM}$$

Since $\mathbf{AM = FM}$, we conclude:

$$\frac{\boldsymbol{AM}}{\boldsymbol{MC}} = \frac{\mathbf{1}}{\mathbf{3}}$$

Final Answers:

A. $\frac{\boldsymbol{EF}}{\boldsymbol{AB}} = \frac{\mathbf{1}}{\mathbf{2}}$
B. $\boldsymbol{MC = 3FM}$
C. $\frac{\boldsymbol{AM}}{\boldsymbol{MC}} = \frac{\mathbf{1}}{\mathbf{3}}$

We found that artificial intelligence helps and promotes data analysis by students who learn a language that is not their native language and understanding of the methods of solving the set tasks, but there are disadvantages in its use. In the process of research, we have identified that the first is the language problem, the problem of reading and understanding; the second is that students do not always conduct a complete data analysis (immediately start building a model: calculate, find, prove, etc.); the third is the verification of the correctness of the solution. We instill in students the skills that in each solution the student needs to perform four stages of the solution: data analysis, search for a solution, actually solving the problem and checking the correctness of the solution. In practice, we find that students, who often fail to find a solution, stop working, and in most cases, using artificial intelligence, and after receiving the results do not check them.

The study concludes that using artificial intelligence in groups with different proficiency levels to teach math requires instructors to ensure that students are accustomed to a safe environment of use in which the process of visualizing the material ingrained at every stage of learning the material and in practice. In addition, the use of artificial intelligence does not happen overnight. After using artificial intelligence to understand, the material and exercises are must until the material will learned at the native language level.

References

Baidoo-Anu, D., & Ansah, L. O. (2023). *Education in the Era of Generative Artificial Intelligence (AI): Understanding the Potential Benefits of ChatGPT in Promoting Teaching and Learning.* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4337484

National Council of Teachers of Mathematics (NCTM). (2014). *Principles to Actions: Ensuring Mathematics Success for All. National Council of Teachers of Mathematics*.

Tashtoush, M., Wardat, Y., & Elsayed, A. (2023). Mathematics distance learning and learning loss during COVID-19 pandemic: Teachers' perspectives. *Journal of Higher Education Theory and Practice, 23*(5), 162-174.

ARTIFICIAL INTELLIGENCE AND CHILDREN'S MENTAL HEALTH: THE TWO SIDES OF THE COIN

Eva N. Patrikakou
Department of Counseling and Special Education, DePaul University (USA)

Abstract

The World Health Organization estimates that 8% of children and 15% of adolescents worldwide experience a mental issue, with suicide being the third leading cause of death for 15–29-year-olds. Importantly, WHO notes that the majority of children and youth do not seek help or receive care, thus these percentages likely underestimate the extent of these issues. Given that early diagnosis and intervention is key for the prognosis of mental health, utilizing Artificial Intelligence (AI) advances, including Machine Learning and Deep Learning can assist clinicians with the identification and individualization of therapy sessions in order to provide quality mental health services to a wider sector of the population. The use of AI in mental health holds promising applications that can detect mental health issues and neuroatypical signs earlier, provide ongoing monitoring of indicators, offer personalized treatment, and easy, 24-hour support to distressed individuals. At the same time, AI use has raised questions about the ethical use of sensitive patient data, the unpredictability of AI derivation, and algorithmic bias which may produce false positive or false negative results. AI's use especially for the diagnosis and treatment of mental health disorders and other disabilities in children and youth, expands services to areas of the globe with less access to mental health providers, while minimizing the stigma with which such services may be associated in certain social contexts. When referring to AI and the well-being of children and adolescents, one cannot overlook the pervasive and expansive influence that social media have on this part of the population. At the same time, merely being dismissive of AI and its increasing influence, instead of focusing efforts on harnessing AI's power in an ethical manner, is to the detriment of future, beneficial applications that can best serve humanity.

Keywords: *Artificial Intelligence, mental health, children, adolescents, diagnosis, treatment.*

1. Introduction

Childhood and adolescence are critical stages in human development as they represent a time of rapid growth and brain development. Mental health in children encompasses their ability to process and analyze information, cope with emotions, build relationships, and learn. Good mental health in children and teens is essential for their overall well-being, enabling them to develop cognitively, emotionally, socially, and also for building capacity and resilience which will impact their future success and quality of life.

Children can have the same mental health conditions as adults, but they may display different symptoms. Mental health problems in children can manifest as delays or disruptions in thinking, behaviors, social skills, or emotional regulation. These can cause distress and interfere with a child's ability to function at home, school, or in social settings (Mayo Clinic, 2024), with one third of mental health conditions emerging before the age of 14 and half before the age of 18 (United Nations, 2024).

When we consider (a) that 90% of the world's 1.2 billion adolescents live in low- to middle-income countries and are particularly vulnerable to adverse conditions and trauma which can trigger mental health issues ("Closing the Global Gap," 2024), and (b) the dearth of trained mental health care providers worldwide (Moitra, 2023), does taking advantage of various, fast-developing AI technologies offer a solution to address the gap in access to mental health services and become a transformative force in the field of mental health?

2. Statistics on children's and adolescents' mental health

According to the National Survey of Children's Health, about one in five adolescents 12-17 years old have been diagnosed with a mental health or behavioral condition. Between 2016 and 2023 the prevalence of mental and behavioral health, including anxiety, depression, and behavioral issues increased by 35%. It is important to note that this upward trend was observed prior to the COVID pandemic, and has continued since (Maternal and Child Health Bureau, 2024). Anxiety, depression, and behavior disorders were the most commonly-diagnosed mental health disorders. While percentages vary by age group, the prevalence of these three conditions were observed in all three group clusters (i.e., 3–5-year-olds, 6–11-year-olds, and 12–17-year-olds; Centers for Decease Control, 2024a). Additionally, concerning trends indicate that 40% of high school students had pervasive feelings of sadness or hopelessness, and 20% reported having seriously considered attempting suicide (Centers for Decease Control, 2024b).

The World Health Organization (WHO; 2024) estimates that 8% of children and 15% of adolescents worldwide experience a mental issue, with suicide being the third leading cause of death in 15–29-year-olds. Importantly, WHO notes that the majority of children and youth do not seek help or receive care, thus these percentages likely underestimate the extent of these issues. Data from the Global Burden of Disease study indicate the following mental health disorder prevalence percentages per age group: 6.80% for 5–9-year-olds, 12.40% for 10–14-year-olds, and 13.96% for those aged 15-19 years (Kieling et al., 2024).

3. Artificial Intelligence

Artificial Intelligence refers to the ability of machines to perform tasks that typically require human intelligence, such as learning, problem-solving, and decision-making. Current AI applications are designed to perform specific tasks with high efficiency but lack general intelligence or the ability to adapt to new situations outside their training. Applications include voice assistants, facial recognition security systems, virtual chatbots, and self-driving cars (IBM, 2023). There are various AI forms contributing to diagnostics and treatment such as Machine Learning (including generative AI systems), and its subset of Deep Learning, (extracts patterns from data without explicit programming; Natural Language Processing (NLP; understand, interpret, and generate human language); Rule-based Expert Systems (use knowledge and rules to solve specific problems); and Robotics (creating robots that can perform tasks autonomously).

4. AI and mental health

In a policy statement, the American Psychological Association acknowledged that AI technologies are changing clinical and research practices in psychological science (2024). Use of AI applications in the field of mental health has expanded diagnostic and therapy capacities, from early detection to personalized treatment plans. At the same time, concerns over ethical issues and algorithmic bias have also emerged along with these advancements.

5. The promises

Specifically, the role of AI in diagnosis, includes analyzing extensive and expansive patient data to identify patterns of health or mental health conditions. Exploring such vast amounts of information can lead to better overall diagnostics and prevention approaches, with NLP techniques being able to identify early signs of mental and emotional changes. AI has significantly impacted personalized mental health treatment by factoring in multiple sources of information from genetic predispositions, existing conditions, and specific patient characteristics, strengths and challenges. AI applications in treatment extend further than personalized plans, and have the capacity to reach a wider audience with a minimized social stigma which, unfortunately, is associated with mental health services in communities around the world. Specifically, AI-driven therapy includes virtual therapists and chatbots, real-time teletherapy assistance, ongoing monitoring, and evidence-based, progress decision making, (Olawade, et al., 2024). For example, AI-powered chatbots such as *Woebot* and *Wysa* are designed by therapists and AI developers to provide mental health support and therapeutic guidance through conversational interactions. *Woebot* is a chatbot which is available through a free app which prompts users to share their moods and experiences, and then suggests tools, skills, and strategies based on the principles of cognitive-behavioral therapy. It is important to note that such AI tools like chatbots are not designed to address psychiatric crises, but they can provide an alternative, much-needed access to mental health to communities around the world with limited access to traditional psychotherapy (Zhang, 2024).

6. The challenges

While the rapid adoption of AI use in mental health has enhanced mental health services, it has also brought about concerns regarding privacy risks, algorithmic bias, and human isolation. AI tools require access to personal and sensitive patient data. Specifically, safeguarding confidentiality and preventing unauthorized access to such data is of paramount importance, and has posed challenges in medical systems which have been compromised by cyberattacks. In addition, the accuracy of AI algorithms depends on the quantity and quality (including the multidimensionality) of data on which they are trained. If the AI-training data provided are incomplete or lack multidimensionality, then algorithmic bias is introduced, and AI can produce erroneous conclusions leading to false positive or false negative diagnoses. Exacerbating this possibility is the fact that available data may reflect biases for demographic groups that are underrepresented, therefore, overgeneralizing conclusions drawn based on such data. Lastly, several mental health conditions have overlapping symptoms which adds to the complexity of making an accurate diagnosis and suggesting targeted treatment (Thakkar, et al., 2024). Scientists have also raised the "black box" issue for cases where even if the best set of data is provided to an AI system, the AI's process and derivation is unpredictable (Abrams, 2024). While identifying potential sources of AI bias, this should not serve as justification for dismissing AI use. It is important to note that biases are not a new phenomenon introduced by AI; humans have been generating biases for millennia, in many cases without acknowledging or addressing them.

7. AI and the mental health of children and adolescents: An overview of opportunities and challenges

AI already impacts many parts of daily life for both adults and children, and AI technologies exponentially continue to extend to even more aspects of life. In terms of overall technology use, generative AI tools such as ChatGPT are the fasted-growing applications in consumer history, reaching a million users in just five days after its launch. Existing studies indicate that children and youth are using these tools more than adults, and such use poses opportunities and risks for children's development, education, diagnosis, and treatment (UNICEF, 2024).

In recent years, some studies have identified a weak but significant correlation between AI-generated, screen media use and internalizing and externalizing behavioral problems (Eirich et al., 2022). Many flags have been raised regarding the potential risks of social media use by children and adolescents who display a fear of missing out if they don't systematically engage in these online interactions. Cybervictimization, social comparison and exclusion, heightened negative peer influences, and displacement[1] are just a few of the issues associated with the use of social media and youth's mental health (Nesi, 2020). At the same time, the other side of the same coin includes various benefits such as social connection, identity exploration, creative expression and entertainment. One should keep in mind that media-use by children and adolescents does not happen in isolation. Often, parents model behaviors that they then criticize in their kids. If we would like to maximize the benefits of media use while minimizing its risks, we need to realize that it is not just a matter of changing children's online behaviors, but most crucially, parents should be leading the way establishing healthier media-use habits themselves. Studies have underlined this by indicating that if entire families (including both adults and children in the same household) reduce their overall screen time, there is a positive impact on children and adolescents' behavior (Schmidt-Pesson et al., 2024).

The role of AI in diagnosis. Ongoing monitoring of children and adolescents' development is key in early detection and intervention. With varying access to preventative pediatric health services around the world, AI can play a crucial role in providing much needed access. Only few longitudinal studies exist that investigate the outcomes of AI use in diagnostics, and overall, most such AI tools have not been evaluated in clinical practice. Overall, AI has been used to detect delays and disorders in language acquisition, cognitive development and mental health, socioemotional development and disorders, and motor and physical growth (Reinhart et al., 2024). The focus of AI studies in diagnostics has primarily been on diagnosing autism. For example, the role of AI has been crucial in developing shortened assessments which allow clinicians to decrease the age of autism diagnosis, creating earlier interventions and treatment, as well as decreasing the cost of the diagnostic process, and thus have the potential to make such diagnostics more affordable to more people around the world (Patrikakou, 2024).

[1] The issue of displacement encompasses the question of what other activities important to the healthy development of children and adolescents have been replaced by the time spent on social media.

The role of AI in treatment. Various AI-powered applications have been used in mental health treatment and in addressing the needs of neuroatypical children and adolescents. For example, the use of wearable sensors can collect detailed biological and physiological data which are also markers of mental health issues. This information can be used to monitor and customize therapy addressing specific individual needs through virtual reality applications and assistive robots to enhance emotional recognition, regulation, and social skills development (Alt, et al., 2024; Patrikakou, 2024). In addition, studies have indicated that AI can successfully support young people with language and communication skills, literacy, and other subject-areas basic learning skills (Rice & Dunn, 2023). AI applications have been primarily investigated in their use with neuroatypical children such as those diagnosed with Autism Spectrum Disorder, Attention Deficit Hyperactivity Disorder, Learning Disabilities, Cognitive Impairments, and Cerebral Palsy. One example is the use of AI-generated platforms which can detect and analyze errors students with Down Syndrome made in math problems and then provide personalized feedback and practice opportunities (Ojha, 2022). Socially Assistive Robots, are also used to enhance interpersonal interactions for students with autism, applying adapting difficulty of activities based on user needs while encouraging sustained engagement (Scassellati et al., 2018).

8. Conclusion

Advances in the use of AI in daily life and in the diagnosis and treatment of mental health issues have opened up tremendous opportunities but also challenges that need to be addressed. With the rapidly increasing demand for mental health services for younger people, the lack of access around the globe, and the dearth of trained professionals to address these increasing needs, AI can provide much-needed support to clinicians, educators, and parents alike to best support healthy children and adolescent development. AI is a tool and given its exponential permeation in so many facets of our daily lives, it is not good or bad per se, but rather its use by humans can serve "good" or "bad" purposes. Merely being dismissive of it instead of ethically harnessing its power, constitutes ostrichism[2], a cognitive bias in itself.

References

Abrams, Z. (2024, April 1). Addressing equity and ethics in artificial intelligence. *Monitor on Psychology*, *55*(3). Retrieved from https://www.apa.org/monitor/2024/04/addressing-equity-ethics-artificial-intelligence

Alt, A. K, Pascher, A., Seizer, L., von Fraunberg, M., Conzelmann, A., & Renner, T. J. (2024). Psychotherapy 2.0. Application context and effectiveness of sensor technology in psychotherapy with children and adolescents: A systematic review. *Internet Interventions, 38*. doi: 10.1016/j.invent.2024.100785.

American Psychological Association (2024). *Artificial Intelligence and the Field of Psychology* https://www.apa.org/about/policy/statement-artificial-intelligence.pdf

Centers for Decease Control (2024a). *Data and Statistics on Children's Mental Health* (August 2024). Centers for Decease Control. Retrieved from https://www.cdc.gov/children-mental-health/data-research/index.html

Centers for Decease Control (2024b). *Adolescent and School Health* (November, 2024). Centers for Decease Control. Retrieved from https://www.cdc.gov/healthy-youth/mental-health/index.html

Closing the Global Gap in Adolescent Mental Health (2024, February). *Nature Medicine, 30*, 309-310. https://doi.org/10.1038/s41591-024-02846-6

Eirich, R., McArthur, B. A., Anhorn, C., McGuinness, C., Christakis, D. A., & Madigan, S. (2022). Association of screen time with internalizing and externalizing behavior problems in children 12 years or younger: A systematic review and meta-analysis. *JAMA Psychiatry*, *79*(5), 393-405. doi: 10.1001/jamapsychiatry.2022.0155.

IBM (2023, October). *Understanding the different types of artificial intelligence*. IBM. Retrieved from https://www.ibm.com/think/topics/artificial-intelligence-types

Kieling C, Buchweitz C, Caye A., Silvani, J., Ameis, S. H., Brunoni, Cost, K. T., Courtney, D. B., Georgiades, K., Merikangas, K. R., Henderson, J. L., Polanczyk, G. V., Rohde, L. A., Giovanni A. Salum, G. A., & Szatmari, P. (2024). Worldwide prevalence and disability from mental disorders across childhood and adolescence: Evidence from the Global Burden of Disease study. *JAMA Psychiatry, 81*(4), 347-356. https://doi:10.1001/jamapsychiatry.2023.5051

[2] The deliberate avoidance or ignorance of conditions as they exist; self-delusion (Merriam-Webster, nd).

Maternal and Child Health Bureau (2024). *National Survey of Children's Health* (Data Brief October 2024). Health Resources and Services Administration. Retrieved from https://mchb.hrsa.gov/sites/default/files/mchb/data-research/nsch-data-brief-adolescent-mental-behavioral-health-2023.pdf

Mayo Clinic. (2024, January 27). *Mental Illness in Children: Know the Signs.* https://www.mayoclinic.org/healthy-lifestyle/childrens-health/in-depth/mental-illness-in-children/art-20046577

Merriam-Webster. (n.d.). Ostrichism. In *Merriam-Webster.com dictionary*. Retrieved March 29, 2025, from https://www.merriam-webster.com/dictionary/ostrichism

Moitra, M., Owens, S., Hailemariam, M., Wilson, K. S., Mensa-Kwao, A., Gonese, G., Kamamia, C., White, B., Young, D., & Collins, P. Y. (2023). Global mental health: Where we are and where we are going. *Current Psychiatry Reports, 25*(7), 301-311. doi: 10.1007/s11920-023-01426-8.

Nesi, J. (2020). The Impact of social media on youth mental health: Challenges and opportunities. *North Carolina Medical Journal, 81*(2), 116-121. doi: 10.18043/ncm.81.2.116

Ojha, S.T. (2022). Artificial intelligence in special education. *Journal of Positive School Psychology*, *6*(6), 8341-8345. https://journalppw.com/index.php/jpsp/article/view/9109/5928

Olawade, D., Wada, O., Odetayo, A., David-Olawade, A., Asaolu, F., & Eberhardt, J. (2024). Enhancing mental health with Artificial Intelligence: Current trends and future prospects. *Journal of Medicine, Surgery, and Public Health, 3*. https://doi.org/10.1016/j.glmedi.2024.10009

Patrikakou, E. N. (2024). Autism spectrum disorders and AI: Applications and areas of promise. In M. Carmo (Ed.), *Education and New Developments* (Vol. 2, pp. 42-46). Portugal: inScience Press.

Reinhart, L., Biscops, A. C., Kerth, J. L., Hagemeister, M., Heinrichs, B., Eickhoff, S. B., Dukart, J., Konrad, K., Mayatepek, E., & Meisser, T. (2024). Artificial Intelligence in child development monitoring: A systematic review on usage, outcomes and acceptance. *Intelligence-Based Medicine*, *9*. https://doi.org/10.1016/j.ibmed.2024.100134

Rice, M. F., & Dunn, S. (2023). The use of artificial intelligence with students with identified disabilities: A systematic review with critique. *Computers in Schools, 40*(4), 370-390. https://doi.org/10.1080/07380569.2023.2244935

Scassellati. B., Boccanfuso, L., Huang, C. M., Mademtzi, M., Qin, M., Salomons, N., Ventola, P., & Shic, F. (2018). Improving social skills in children with ASD using a long-term, in-home social robot. *Science Robotics, 3*(21). doi: 10.1126/scirobotics.aat7544

Schmidt-Persson, J., Rasmussen, M. G. B., Sørensen, S. O., Mortensen, S., Olesen, L., Brage, S., Kristensen, L., Bilenberg, N., & Grøntved, A. (2024). Screen Media Use and Mental Health of Children and Adolescents: A Secondary Analysis of a Randomized Clinical Trial. *JAMA Network Open, 7*. doi:10.1001/jamanetworkopen.2024.19881

Thakkar, A., Gupta, An, & De Sousa, A. (2024). Artificial intelligence in positive mental health: A narrative review. *Frontiers in Digital Health, 6*. doi: 10.3389/fdgth.2024.1280235.

United Nations. (2024, October 9). *1 in 7 children and teens impacted by mental health conditions*. https://news.un.org/en/story/2024/10/1155536

UNICEF (2024, May 7). *Generative AI: Risks and opportunities for children*. https://www.unicef.org/innocenti/generative-ai-risks-and-opportunities-children

World Health Organization. (2024). *Mental Health of Adolescents* [Fact sheet]. https://www.who.int/news-room/fact-sheets/detail/adolescent-mental-health

Zhang, A. (2021). "Hey There, {{YOUR NAME}}": How mental health chatbots can address psychotherapy's current distributive system. *Intersect, 14*(3). https://ojs.stanford.edu/ojs/index.php/intersect/article/view/1926

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

PROMOTING EQUAL OPPORTUNITIES THROUGH TEXTBOOKS

Paola Nicolini, Greta Mancini, Evelyn Manoni, & Veronica Guardabassi
Department of Humanities, Macerata University (Italy)

Abstract

Every child, regardless of gender, socio-cultural background and geographical provenience, the type of family in which they are born, religious background, disability and so on, has the right to develop to their full potential. However, the presence of inequalities in their own lives and in the lives of their caregivers creates significant barriers to achieving this goal (Unicef, 2019). In line with the United Nations 2030 Agenda, which serves as the overarching reference point for global commitments at national and international levels to identify shared solutions to the pressing challenges confronting the planet, the promotion of equality and overall the empowerment of girls and women worldwide has been identified as a key objective. In this regard, there is a consensus among international policymakers on the necessity to advocate for interventions within the domains of culture and education. Education and culture are the primary instruments through which the promotion of gender equality can be achieved, and schools have a pivotal role in this regard. In alignment with this perspective, the majority of school textbook publishers have directed their efforts towards the valorization of the female universe, thereby fostering the free construction of the imagination for both girls and boys. The significance of textbooks is further underscored by their pervasive use across the national territory, particularly in Italy, and the fact that they are utilised by individuals across the age spectrum. A substantial proportion of the population uses textbooks for at least 80% of their school time (Sadker & Zittleman, 2007). The notion that human development is significantly influenced by imitation and modelling (Bandura & Walters, 1977; Bandura, 2003) further reinforces the notion that textbooks, as a cultural authority (Blumberg, 2008; Kalmus, 2004; Witt, 2001), wield considerable influence over the mental representations of the world that children develop about gender roles (Stromquist, Lee, & Brock-Utne, 1998), encompassing lifestyle, employment, and career aspirations, even impacting their self-image (Britton & Lumpkin, 1977; Crawford & English, 1984; Macaulay & Brice, 1997; Witt, 2001; Heslop, 2016). In the event of the planning of cultural and educational support with the intention of maintaining equal opportunities in different situations, children are presented with the chance to encounter multiple situations, multiple people, multiple places, and multiple developmental trajectories within which to identify and build their own identity representation. In Italy, guidelines for publishers have been drawn up to bridge the gap (Progetto Polite, 2011). However, it still exists and is damaging the new generations. In the light of a collaboration with an Italian company that wanted to ensure equal opportunities in its own projects, a research was developed with two main objectives: the drafting of guidelines covering a wide range of considerations, including the gender of the textbook authors, the linguistic nuances used, the diversity of human representation and the presence of stereotypes; the revision of the textbooks published in order to close the gap in the new series.

Keywords: *Equal opportunities, textbook, school, education, children, gender.*

1. Introduction

A definition of gender refers to qualities, roles and responsibilities associated with women or men (Brugeilles & Cromer, 2009). It is a social concept determined by values and cultural beliefs (United Nations Educational, Scientific and Cultural Organisation, 2014). The construction of the concept is influenced by parents, teachers, school, peers and mass media (Bronfenbrenner, 1979). Every single child, male or female, has the right to develop his/her own full potential, but gender inequality in their own lives and in the lives of their caregivers makes it difficult to achieve this goal (Unicef 2019). Similarly, the UN 2030 Agenda, includes among its goals gender equality and the empowerment of girls and women around the world. In this area, there is agreement among international policy-makers on the need to promote interventions at the level of culture and education.

School has an important role to play in this promotion and, being an cultural authority (Blumberg, 2008; Kalmus, 2004; Witt, 2001), it represents an important source for the development of education and

culture. One of the main instruments of education adopted by schools is the textbook. Children use them at school for 80% of their learning time (Sadker & Zittleman, 2007). Textbooks may serve as a model for imitation (Bandura, 2003), and their content can influence students' development. Indeed, they influence beliefs about gender roles, such as lifestyle, job and career choices, and can even affect self-image (Britton & Lumpkin, 1977; Crawford & English, 1984; Macaulay & Brice, 1997; Witt, 2001; Heslop, 2016). Thus, textbooks strongly influence children's mental representations of the world.

In the Italian context, Biemmi's (2010) study, which analysed 13 publishing houses and 1,084 passages between 2008 and 2014, showed that parity had not yet been achieved. This violation of equal opportunities is also confirmed by Pizzolato's (2020) most recent publications. An analysis of three anthology series used in the fifth year of primary school, totalling five volumes, revealed disparities in both the linguistic content and the representation of male and female protagonists. Women are underrepresented, depicted primarily as housewives and mothers, and rarely engaged in activities outside the home. A similar result was found by Scaglioso and Del Chierico (2022), who analysed six Italian second language textbooks intended for children aged seven to eleven. Both the analysis of the written text and the visual content show a polarised representation of gender, suggesting the need to rethink school education with books free of cultural preconceptions.

Considering that textbooks are widely used throughout the Italian national territory, their power is clear, especially taking into account the age of the population that use them and the freshness of their mental schemes. If this kind of cultural and educational support is planned to maintain equal opportunities in different situations, children have the opportunity to encounter multiple situations, multiple people, multiple places, multiple developmental trajectories within which to identify and build their own identity representation. Textbooks can broaden the proposals and offer greater diversification of models, images and contents.

2. Design

Taking into account the results of the researches, most textbook publishers have turned their attention to offering the valorisation of the female universe in order to support the free construction of the imaginary for both girls and boys. The Italian company Eli, committed to equal opportunities policy, wanted to develop a collaboration to improve the quality of its production, not limited to gender inequality. An extensive analysis of its textbooks was carried out in order to have a broad representation of the presence of all the differences that humanity can bring into reality. The analysis were about different aspects of the books: the index, the language, the images, the actions and the locations of the characters presented, the kind of families, the presence/absence of people with disabilities and other kind of fragility, the presence/absence of people coming from different parts of the world, and so on.

3. Objectives

Two outcomes were expected from the research: (1) the production of a vademecum on gender equal opportunity that would be useful in the design of textbooks for all the people with different backgrounds and expertise involved in their design and production; (2) the improvement of the quality of the publishing house's production by identifying Eli's best practices and proposing an exhibition to showcase them. Through the synergy between the University of Macerata and the publishing house Eli, the research group also explored the theme of inclusion analyzing school textbooks and assessing how well they represent a reality as multifaceted as possible.

4. Method

Several meetings were organised between Eli and the expert team from the University of Macerata in order to share a common background and vocabulary. In the meantime, desk research was carried out to deepen the knowledge of the subject. The results were also shared and discussed, with the aim of applying them to the Italian landscape, as well as widening the competences of all the participants in the research team, allowing them to have a common framework for working together. The current production of textbooks published by Eli was also analyzed, under different perspective.

5. Results

As the aim of the research was to produce both a vademecum for publishers and an improvement to the textbooks published by Eli, in order to achieve full equality in its cultural and educational products, the team worked together to reach both the outcomes.

5.1. The vademecum

Based on the previous analysis, in order to overcome gender stereotypes and offer produce gender-sensitive textbooks and teaching materials, research was conducted and a vademecum was produced aimed at summarise the good practices identified, and at suggest practices that authors and illustrators can adopt when creating their products. The vademecum for authors is divided in three thematic areas (see Table 1). The first is dedicated to language and provide guidance on the use of masculine/feminine and no-stigmatizing language. The second deals with representativeness, i.e., the quantitative number of people belonging to a particular social group, and focuses on gender issues as well as other minority groups. The third section provides advice on how to overcome social stereotypes.

Table 1. Vademecum for authors.

Language	
Use of masculine and feminine	Include and alternate the feminine with the masculine Avoid using the masculine plural as including the feminine as well Choose expressions that refer to collectives, e.g., 'il genere umano' or 'la gente' instead of 'gli uomini', 'la classe' instead of "gli alunni" Choose expressions that refer to both male and female without distinction, e.g. 'docente/insegnante' instead of 'maestro' or 'professore', 'adolescenti' instead of 'I ragazzi' Declining professional and institutional positions for both men and women Balanced and careful use of qualifications, behaviours, characteristics and interests attributed to the characters or proposed in the texts (e.g. determined, courageous, sensitive, ambitious, rebellious, etc.)
Non-stigmatising language	Use the terms considered most appropriate by the scientific community or stakeholders and proposed debates on open issues (e.g., person with disabilities) Respect the indications also in the creation of titles, from which book indexes are derived
Representativeness	
Gender issues	Balancing the presence of male and female protagonists in stories and narratives Formulating dialogues by male and female characters, paying attention to equal turns and length of speech
Differences	Considering families in a broader sense (e.g. including adoption and fostering, reassembled families, single-parent families, etc.) Representing society in a realistic way, as diverse and composite as it is in terms of gender, disabilities, cultures, traditions, customs, religions, etc.
Stereotypes	
Gender stereotypes	Including the emotional dimension in male characters Presenting men and women with interchangeable roles and reciprocal relationships, focusing on situations of mutual cooperation Treating female characters with the same attention as male characters
Other types of stereotypes	Dealing with disability as an opportunity to be in the world with one's differences, weaknesses and strengths Inclusion of human differences as an element of learning In general, to represent and recognise all kinds of difference, avoiding stereotypical attitudes and expressions.

The vademecum for illustrators (see Table 2) included a section on representativeness and one on stereotypes. As in the other author vademecum, these sections contain various suggestion for promoting not only gender equality, but also minorities' equal opportunities.

Table 2. Vademecum for illustrators.

Representativeness	
Gender issues	Equal representation of male and female characters Representing the same image with male and female characters (e.g. teacher)
Differences	Include people of different ages, ethnicities, religions, abilities, intelligences, family types and represent society in many different ways. Representing a variety of characters in different roles, actions, contexts, gender, work and professional perspectives Considering families in a broad sense with interchangeable roles, reciprocity of relationships, situations of mutual cooperation Valuing human bodies in all shapes (e.g. tall and short) and characteristics (e.g. young and old) Including situations of disagreement and conflict as everyday occurrences that provide opportunities for mutual learning and negotiation.
Stereotypes	
Gender stereotypes	Choose from a wide range of colours, clothes and accessories to represent gender identities Represent people in different stages and situations of life with interchangeable roles and reciprocal relationships with special emphasis on situations of mutual cooperation Exchangeable roles and reciprocity of relationships with special emphasis on situations of mutual cooperation mutual cooperation Representation of men and women in indoor and outdoor spaces^
Other types of stereotypes	Representing people with physical and mental disabilities as active, dynamic people with strengths and weaknesses, embedded in a relational and social context

	Referring to differences as an enrichment and opportunity for learning, rather than including the issue of differences as an element of learning Represent and acknowledge all kinds of differences, avoiding stereotypical attitudes and expressions.

5.2. An exhibition

With regard to the second objective, the EquiLibri exhibition has been created with the help of the examples of non-stereotypical representation on display, which propose new models and use iconography, characters, language and content that pay attention to gender differences, but not only. The exhibition is the result of the work on the improvement of Eli's textbooks, which was carried out as a result of the research collaboration.

5.2.1. The images. Since images possess a strong expressive power and convey messages that can be of an explicit or implicit nature, the communicative attention that has been paid to them concerns both form and content. Characters of both genders are present in the pages and the development possibilities for both are expanded, going beyond the traditional division between "male things and female things" with respect to the roles and tasks performed, emotions, adjectives and character attributions, interests and sports, hobbies and professions practiced as well as the presence and ability to act of the characters themselves in public and private spaces and places. Objects, accessories and clothing are not gendered, and presented in a wide range of colours and possibilities. For example, colours such as green or yellow are suggested to break away from the traditional pink and blue scheme. The illustrations are rich in detail and include both able-bodied characters and those with different types of disability. The characters have a non-stereotypical aesthetic and a wide variety of somatic features and body morphologies. Domestic and family care tasks are performed by both genders, and generally all members are represented while contributing in different situations in a collaborative and interchangeable manner. Male characters express emotions and thoughts about their inner world in the same way that usually pertains to the female gender. The strategies adopted offer children different opportunities to identify themselves, thanks to a wide range of representations and characters that are more responsive to the reality that is by its very nature multifaceted, rich in variations, differences and alternatives.

5.2.2. The inclusion. Researching and promoting gender equality representation in school textbooks also means, on a broader level, examining the concrete possibility of establishing new balances within the editorial context. The aim is to describe reality in its complexity and thus to reflect the possible disparities present in the social context, that textbooks can play a role in reducing. Images of physical disability are presented within contexts of play and social interaction. Similarly, the story of a pilot who continues to practice sports after losing his legs promotes the development of a representation of disability considered as one of many possible expressions of human life. Portraits are inserted of children of different ethnicities playing and engaging in activities together, living within the same environments, creating a rich and varied community. In addition, the representation of the family as formed by biological, adoptive or foster parents and children, single-parent households or reconstituted after divorce has been enlivened. To portray society realistically, as diverse and varied in cultures, traditions, customs, religions and points of view was the effort.

6. Discussion and conclusions

Textbooks can promote equal opportunity also without explicit contents about inclusion. Semantic choices of words (nuns and adjectives), types of images, representativeness characters in stories and their personal characteristics can implicitly suggest and shape children' representation of women, men and all the minorities. In this sense, textbook can be defined as resilient tools. With this purpose, based on the example by the Italian Association of Publishers (AIE) and the self-regulatory code of the project "Equal Opportunities in Textbooks" (Polite, 1998), the present work reported the results of a collaborative research activity between the ELi publishing group and University of Macerata. The project developed not only a gender perspective but also a minority perspective, i.e. textbooks able to reflect the current development of society towards multiculturalism and multiethnicity, taking into account all minorities.

Future studies could further explore the role and the presence of equal opportunities in textbooks (Guardabassi et al. 2024) as well as find new way to promote an equal representation in books and other educational materials (Biemmi, 2024). In addition, the Vademecum elaborated as a result of the research, should be taken into account by other editors and publishers when preparing textbooks, being supported by appropriate training to ensure consistent implementation in different contexts.

Acknowledgements

The ELi Publishing Group and the research team from the University of Macerata collaborated closely to develop the vademecum and the entire research. Ninfa Contigiani, Liviya Kazantseva and Donatella Pagliacci took part in the activities as members of the University of Macerata research team.
In a further step of the research, this work has been funded by the European Union - NextGenerationEU under the Italian Ministry of University and Research (MUR) National Innovation Ecosystem grant ECS00000041 - VITALITY - CUP D83C22000710005.

References

Bandura, A. (2003). Social cognitive theory for personal and social change by enabling media. In A. Singhal, M. J. Cody, E. M. Rogers, & M. Sabido (Eds.), *Entertainment-education and social change* (pp. 97-118). Routledge.

Bandura, A., & Walters, R. H. (1977). *Social learning theory* (Vol. 1, pp. 141-154). Prentice Hall.

Biemmi, I. (2010). *Stereotipi di genere nei libri di testo. Il caso italiano*. FrancoAngeli.

Biemmi, I. (2024). Obiettivo parità. Linee guida per implementare il principio dell'uguaglianza di genere nei libri di testo della scuola primaria. *Lifelong Lifewide Learning, 21*(44), 164-175.

Blumberg, R. L. (2008). The invisible obstacle to educational equality: Gender bias in textbooks. *Prospects*, *38*, 345-361. https://doi.org/10.1007/s11125-009-9086-1

Britton, G. E., & Lumpkin, M. C. (1977). For sale: Subliminal bias in textbooks. *The Reading Teacher*, *31*(1), 40-45.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard University Press.

Brugeilles, C., & Cromer, S. (2009). *Promoting gender equality through textbooks: A methodological guide*. UNESCO.

Crawford, M., & English, L. (1984). Generic versus specific inclusion of women in language: Effects on recall. *Journal of Psycholinguistic Research, 13*(5), 373-381. https://doi.org/10.1007/BF01068140

Guardabassi, V., Manoni, E., & Nicolini, P. (2024). *Le (im)pari opportunità nei libri di testo scolastici* (forthcoming publication).

Heslop, J. (2016). *Engaging communities in dialogue on gender norms to tackle sexual violence in and around schools* (Technical Brief). University College London, Institute of Education.

Kalmus, V. (2004). What do pupils and textbooks do with each other? Methodological problems of research on socialization through educational media. *Journal of Curriculum Studies*, *36*(4), 469-485. https://doi.org/10.1080/00220270310001630600

Luthar, S. S., & Cicchetti, D. (2000). The construct of resilience: Implications for interventions and social policies. *Development and Psychopathology*, *12*(4), 857-885. https://doi.org/10.1017/S0954579400004156

Macaulay, M., & Brice, C. (1997). Don't touch my projectile: Gender bias and stereotyping in syntactic examples. *Language*, *73*(4), 798-825. https://doi.org/10.1353/lan.1997.0048

Pizzolato, M. (2020). *Ancora stereotipi di genere nei libri di scuola. Analisi di testi di narrativa per la scuola primaria*. Milano: FrancoAngeli.

Polite. (1998). *Equal Opportunities in Textbooks: Self-regulatory code*. Italian Publishers Association (AIE).

Sadker, D. M., & Zittleman, K. (2007). Practical strategies for detecting and correcting gender bias in your classroom. In D. Sadker & E. Silber (Eds.), *Gender in the classroom: Foundations, skills, methods, and strategies across the curriculum* (pp. 259-275). Lawrence Erlbaum Associates.

Scaglioso, A., & Del Chierico, A. (2022). Gender stereotypes in second language textbooks for primary school: An analysis of written and visual content. *Italian Journal of Educational Research, 29*(2), 145-168.

Stromquist, N. P., Lee, M., & Brock-Utne, B. (1998). The explicit and the hidden school curriculum. In N. P. Stromquist (Ed.), *Women in the third world: An encyclopedia of contemporary issues* (pp. 397-407). Garland Publishing.

UNICEF. (2019). *For every child, every right: The Convention on the Rights of the Child at a crossroads*. New York: UNICEF.

UNICEF Italia. (2023, November 14). *Posso essere quello che voglio: La campagna UNICEF per l'8 marzo delle bambine*. Retrieved from https://www.unicef.it/media/posso-essere-quello-che-voglio-campagna-unicef-8-marzo/Codice_gen2011

United Nations Educational, Scientific and Cultural Organization (UNESCO). (2014). *Teaching and learning: Achieving quality for all; EFA global monitoring report, 2013–2014*. UNESCO.

Witt, S. D. (2001). The influence of school texts on children's gender role socialization. *Curriculum and Teaching, 16*(1), 25-43.

EXPLORING TINKER TOYS AS A TOOL FOR REDUCING ANXIETY AND ENHANCING GROUP DYNAMICS IN COLLEGE STUDENTS

Tricia Hudson Matthew, & Harvey Bowden II
Department of Human Services and Counseling, MSU Denver (USA)
Department of Clinical Mental Health, MSU Denver (USA)

Abstract

This study examines the effectiveness of Tinker Toys as a tool for reducing anxiety and fostering positive group dynamics among graduate and undergraduate students. Tinker Toys, traditionally a children's construction set, provide sensory, fine motor, and cognitive benefits that may translate into meaningful experiential learning in therapeutic and classroom settings. By engaging in hands-on, collaborative activities, students can improve their comfort levels, enhance communication, and build trust within diverse group environments. The research utilizes a mixed-methods approach, incorporating qualitative observations and quantitative surveys. Participants include 17 graduate students from a clinical supervision course and 40 undergraduate students from a small group dynamics counseling course. In structured group activities, students first construct a designated object using Tinker Toys, then repeat the task while blindfolded, relying solely on memory, verbal communication, and tactile feedback. Observers document interactions, noting changes in anxiety levels, teamwork, and overall group cohesion. Post-activity reflections and surveys assess the impact on students' emotional resilience and interpersonal skills. Preliminary findings suggest that hands-on experiential learning with Tinker Toys can significantly enhance students' ability to manage anxiety and collaborate effectively, regardless of demographic factors such as race, gender, or ethnicity. The study contributes to counseling education and group therapy by demonstrating how structured, interactive exercises can improve emotional regulation, communication, and teamwork. These insights may inform future pedagogical strategies and therapeutic interventions aimed at fostering resilience and cooperation in diverse academic and professional settings.

Keywords: *Experiential learning, group dynamics, anxiety reduction, communication skills, hands-on activities.*

---

1. Introduction

Group dynamics and anxiety management are critical competencies in counseling education. Experiential learning activities provide students with opportunities to practice communication, leadership, and teamwork in real-time. This study examines how Tinker Toys, a simple construction set, can be leveraged as an effective learning tool in academic settings to promote group cohesion and reduce student anxiety.

2. Design and objectives

The project aimed to:

- Assess whether anxiety levels decrease during hands-on, collaborative learning.
- Evaluate group dynamics such as communication, leadership, and problem-solving.
- Compare Tinker Toys to other experiential tools.
- Document the long-term impact on participants' interpersonal and professional development.

3. Methods

A total of 57 students (17 graduate and 40 undergraduate) participated. The activity consisted of two phases: building a structure using Tinker Toys (Phase 1), and repeating the task blindfolded (Phase 2). Observers documented behaviors, and participants completed pre- and post-activity surveys on anxiety and group interactions. Follow-up reflections and interviews provided qualitative insight.

4. Procedure

Participants were grouped into teams of 3-4 and tasked with building an object using Tinker Toys. Five minutes in, they disassembled their models, donned blindfolds, and attempted to recreate the design using only memory, touch, and verbal cues. This transition simulated clinical conditions where verbal communication becomes critical. Observers noted changes in roles, communication styles, and stress management. Afterward, students debriefed and reflected on their experiences.

5. Results and discussion

5.1. Communication and collaboration

Clear communication was pivotal. During blindfolded tasks, students developed verbal precision and active listening.

5.2. Leadership and role distribution

Leadership emerged naturally in some groups. Those with defined leaders generally performed better and adapted faster.

5.3. Problem-Solving and decision-making

Conflict resolution was key. Groups who resolved disagreements respectfully completed tasks more efficiently.

5.4. Emotional impact and anxiety

Anxiety declined as group trust increased. Humor and shared success helped reframe stress positively. Students with higher initial anxiety reported the most notable improvements.

5.5. Personal reflections

Participants described the activity as revealing and transformative.

6. Comparison with other experiential tools

Compared to traditional experiential tools, Tinker Toys stand out as an inclusive, low-stakes method for fostering communication and teamwork. Unlike role-playing, which can be emotionally intense and anxiety-inducing, Tinker Toys reduce social pressure while still promoting collaboration. Team-building activities often emphasize competition or performance, which may deter introverted or anxious students. Art-based therapies, while useful for emotional processing, often lack the interaction necessary to foster strong group dynamics. In contrast, Tinker Toys provide a relaxed, tactile, and interactive experience that combines sensory engagement with communication, helping students practice trust, memory, and empathy under mild stress.

7. Long-Term impact

Follow-up data collected 1 to 6 months post-intervention show that students retained many of the interpersonal skills developed during the Tinker Toys activity. Participants reported using improved communication and conflict-resolution strategies in clinical settings. Some described applying the activity's lessons particularly trust-building and patience to internships and real-life group work. Pre/post anxiety and stress surveys, as well as reflections, revealed enduring gains in emotional regulation and group leadership. These outcomes were especially significant among students who initially identified as having moderate-to-high social anxiety.

8. Conclusions

Tinker Toys provide a low-cost, accessible, and effective tool for reducing anxiety and strengthening group dynamics. The hands-on, non-threatening format supports skill development in communication, trust, and leadership. These outcomes support its continued use in counseling and supervision education.

Additional survey feedback highlighted those students felt more comfortable contributing their ideas after the blindfolded activity. Several noted how the absence of visual cues led to increased empathy and improved listening. These reflections support the idea that Tinker Toys offer more than a physical task. They provide emotional insight and trust-building.

Observers reported specific examples of how students negotiated roles, adapted to group feedback, and acknowledged individual strengths. In one case, a quieter participant became the most vocal during the blindfolded phase, guiding peers with remarkable clarity. This shift illustrates how the activity revealed hidden leadership and adaptive problem-solving.

9. Key takeaways

Key takeaways from facilitators included the importance of debriefing to link hands-on work with clinical supervision principles. They emphasized how moments of frustration, confusion, or success paralleled dynamics students would face in real counseling teams. Thus, the Tinker Toy activity becomes not just experiential but transformational.

From a pedagogical standpoint, this activity offered a direct simulation of clinical supervision scenarios where communication, patience, and role negotiation are critical. These soft skills are difficult to teach through lecture alone but were consistently observed and practiced during this project.

Comparatively, traditional team building often forces vulnerability too quickly or under pressure. With Tinker Toys, students felt the challenge was both engaging and achievable. In one undergraduate group, laughter and collaboration replaced early frustration, and students began associating group work with shared success rather than individual evaluation. Observers also commented on the natural emergence of leaders who had not previously taken initiative in classroom settings. For example, one facilitator remarked, *"It was striking to see the quieter students suddenly become the clearest communicators when the group had to work blind. That reversal of dynamic taught us a lot about hidden strengths."*

Participants noted that trust became a central theme, especially when vision was removed during the blindfolded task. As one student reflected, *"I had to rely on my group more than I ever thought I would. It made me realize how much I tend to take control when I can see, and how letting go felt both scary and freeing"*.

Acknowledgments

We would like to thank the students of MSU Denver who participated in this project and provided thoughtful reflections that made this study possible.

References

Carpenter, J. (2012). *Tinker Toy Exercise/Builderific*. *Carpenter Strategy Toolbox*. https://carpenterstrategytoolbox.com/2012/07/20/tinkertoy

Christensen, R., & Anderson, M. (2014). Tinkering in class: Using the Tinker Toy exercise to teach first-mover advantages. *International Journal of Strategic Management, 8*(1), 53-66.

Galea, J., Sanabria, G., Greene, K., et al. (2023). MSW students' perspectives on learning and delivering a protocolized, low-intensity transdiagnostic psychological intervention: Implications for experiential learning. *Community Mental Health Journal, 59*, 812-817.

Johnson, L. M., & Davis, P. K. (2019). Effectiveness of cognitive-behavioral group play therapy on anxiety. *Psychological Science & Education, 26*(2), 112-126.

Murphy, M. A., & Miller, K. S. (2018). The influence of active learning practices on student anxiety. *Journal of Education and Learning, 12*(4), 87-99.

Peeples, L. B., Thompson, B. C., Tucker, J. B., et al. (2024). Growing empathy through art therapy, life story, and relationships: Experiential learning in adult day services. *Frontiers in Psychology, 15*, 1489344.

Walker, L. G., & Schmidt, T. E. (2017). Effect of play therapy on reduction of social anxiety and increasing social skills in preschool children in Omidiyeh. *Research in Behavioral Therapy, 22*(1), 40-52.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

TROLLING IN VIRTUAL LEARNING SPACES: A PROPOSAL FOR ANALYSIS FROM COLLECTIVE LEARNING

Sonia Valero-Tapia[1], Pablo Bautista[2], & Santos Orejudo[1]
[1]Department of Psychology and Sociology, University of Zaragoza (Spain)
[2]Department of Educational Sciences, University of Zaragoza (Spain)

Abstract

The emergence and evolution of the internet has brought about many changes in society, including in the educational paradigm. With the rise of Learning and Communication Technologies (LCT), the way students learn has changed. One example of this is online collaboration tools, such as the Collective Learning platform, which allows hundreds of students to group together anonymously and synchronously to solve activities on any subject. The aim of the platform is to reach consensus, make decisions and establish learning processes around different topics. However, despite the fact that students interact and communicate indirectly on the platform during the tasks, its purpose is far from that of the social networks in use. Despite this, it has been detected that on Collective Learning, as on other digital leisure platforms on the Internet, trolling behaviour can appear, i.e. behaviour initiated by anonymous users on digital platforms to annoy other users and hinder online communication. In Collective Learning, this behaviour is seen through trolling responses that some students make while doing activities on the platform. These types of responses hinder the development of tasks in Collective Learning and jeopardise the learning processes during them, and should therefore be analysed. In this study, we report on an experiment in which 265 students aged 12-16 collaborated online to solve a case about extreme popularity seeking on social networks. The aim is to detect the troll responses elaborated by the students during the task and to establish common characteristics among them. Our work shows how troll answers can appear in a task on socioemotional development on the Internet with students of Compulsory Secondary Education. These types of responses may reach a certain popularity within the platform, but their general tendency is to disappear as the activity progresses. Finally, with the study presented, it has been possible to establish a set of common characteristics among the troll responses on the platform that has allowed the development of a definition for them and thus open a more favourable path for their detection and mitigation in future activities carried out with Collective Learning.

Keywords: *Collective learning, trolling, collective intelligence, learning.*

1. Introduction

Over the last decade, the emergence of the Internet has transformed educational contexts to a large extent, especially for the very young (Du et al., 2024). In digital spaces, adolescents find numerous opportunities for social interaction (Cebollero-Salinas et al., 2022), both from platforms for leisure and social networks (Volkova and Bachrach, 2015) or even in online collaboration and learning platforms (Faraj et al., 2010; Malone et al., 2010), one of the latter being Collective Learning. Collective Learning is a platform based on the construct of collective intelligence, which assumes that a group of individuals performing a task will perform better than a single individual (Wolley et al., 2010). Collective Learning offers the opportunity to generate spaces for interaction in which hundreds of people can collaborate synchronously and anonymously to solve tasks on any topic through consensus building. With the activities created on the platform, learners work through seven phases. Participants answer certain questions about the activity posed and can see what answers their classmates give, copying from them partially or in full or keeping their initial answers. The phases are developed as follows:

- Phase 1. Students answer the questions in the solo activity.
- Phases 2, 3 ,4 and 5. Students can see what their peers have answered and copy from other users' productions if they wish. In these phases the platform considers the most copied answers as the most popular and starts discarding the least copied ones.
- Phase 6. The most popular answers for each question are presented in a top 10, from which students can copy in part or in full if they wish.

- Phase 7. A final top 10 is presented for each question, students can only keep their answers or fully copy answers from the top.

Under this premise, several researchers (Bautista et al., 2022; Orejudo et al., 2022; Orejudo et al., 2024) have used Collective Learning as a platform on which to propose to hundreds of students the resolution of different activities related to socioemotional development and the prevention of digital risks on the Internet through the case methodology (Orejudo et al., 2008). These studies show positive results in terms of socioemotional development; however, it has been detected that while students perform these types of tasks on the platform, trolling behaviours may appear in the answers that students offer to solve the activities (Orejudo et al., 2022; Bautista et al., 2022; Valero-Tapia and Orejudo et al., 2024), these types of answers on the platform have been called troll answers.

Users who engage in trolling behaviour on the internet are called trolls, whose aim is to annoy and provoke other users (Bishop, 2012; Hardaker, 2010; Keita, 2023), hindering online interactions, in this case in Collective Learning. Troll responses in Collective Learning, which not only distance themselves from the objective of the proposed tasks, affecting interaction and cooperation between participants in the activities, but also pose a risk to collective learning (Denoni Buján and Casanova, 2024). In order to protect the learning processes in Collective Learning, studying troll responses in Collective Learning becomes a necessity. Therefore, the following research study is proposed, which aims to detect troll responses and their common characteristics elaborated by a group of 265 students during a task based on the case methodology on socio-emotional development in Collective Learning.

2. Objectives

The aim of this paper is to detect troll responses and their common characteristics elaborated by a group of 265 students during a task based on the case methodology on socioemotional development in Collective Learning. The hypothesis that accompanies this objective focuses on the fact that although troll responses can be detected on the basis of common characteristics, they may contain different content and present differential characteristics.

3. Method

3.1. Participants

The work presented here involved 265 Spanish students from the first to the fourth year of Compulsory Secondary Education (ESO), from four schools located in the Autonomous Community of Aragon. In Spain, ESO students range in age from 12 to 16 years old.

3.2. Instruments: The case

The study participants faced an activity designed from the case methodology (Orejudo et al., 2008) and developed in the Collective Learning platform. The case told a story about Tania, a teenager facing a contentious divorce between her parents and being bullied at school. At a critical moment, she posted images of herself self-harming on Twitter, threatening suicide if her classmates did not stop the bullying. Although initially the bullying diminishes, Tania repeatedly resorts to threats to blackmail her classmates, which eventually leads to a resumption of the bullying. This situation aggravates her emotional state, leading her to self-harm again and hospitalisation. The case was accompanied by five open-ended questions with no predetermined character limit, which alluded to Tania's possible motivations, the importance of the context, the sensitive content uploaded to social networks and the search for solutions to the protagonist's situation.

3.3. Procedure

Prior to the activity, all Secondary Education and Vocational Training schools in the Autonomous Community of Aragon were invited to participate. This session was part of a complete research program, which offered more sessions related to cyber coexistence and digital risk prevention, approved and validated by the Research Ethics Committee of the Autonomous Community of Aragon (CEICA: Comité de Ética de la Investigación de la Comunidad Autónoma de Aragón). The interested centers accepted the conditions of participation, which were to have the necessary time to carry out the activity and that each participating student had an electronic device with Internet access. Prior to the activity, both the participating students and their families were informed of the purpose of the study and the procedure through a letter of informed consent. This letter also explained the voluntary nature of participation and guaranteed the anonymity of the students. To carry out the activity, prior to the session, all the schools from which the participating students came were sent a password and user name for each student with which they could access the activity on the date and time set.

3.4. Data analysis

First, all the answers that the students proposed to solve the activity in the Collective Learning platform were extracted and ordered taking into account their time of appearance and the phase to which they corresponded. Once ordered and taking the conceptualization of trolling by Bishop (2012), Hardaker (2010) and Keita (2023), we proceeded to detect the responses considered as trolling responses by the students, i.e., those that did not respond to the context of the activity and that intentionally deviated from the objective of the activity. After detecting which responses met this identification criterion, an ad hoc empirical categorization system was designed to divide the responses that had initially been categorized as troll responses into more specific categories. The categorization system consisted of the following categories (table 1):

Table 1. System of categorization of troll responses developed.

Category	*Name*	*Definition*	*Example extracted from the base*
1	*Absurd troll responses*	*They do not respond to the question or relate to the theme of the activity*	*"Salami"*
2	*Aggressive troll responses*	*They do not answer the question, express aggressiveness outside the context of the activity*	*"nerf to the purple dot. Fat girls with blue hair=bad"*
3	*Troll responses that allude to the face-to-face context*	*They do not answer the question, they establish a communication channel with the rest of the users alluding to known topics or people*	*"klk_guillermo is looking for a girlfriend to play with him"*
4	*Sarcastic troll responses*	*They do not respond to the objective of the activity, but answer the question sarcastically*	*"The opinion of the fat women"*
5	*Troll responses with viral elements*	*They do not respond to the objective of the activity, their main objective is to allude to songs, video games, memes or viral gossip on social networks*	*"I want to play fornite"*
6	*Popularity-seeking troll responses*	*They do not respond to the objective of the activity, they allude to their own profiles or channels on social networks seeking popularity or followers*	*"rrrubenn_010 follow me gpas'"*
7	*Incoherent troll responses*	*They do not respond to the activity, they are meaningless.*	*"ðđħ¶ŧ←↓↓ĴЄ¬ß¶ŋŧЄ ¶đð"đß"*

4. Results

In the proposed activity, 4950 responses elaborated by the students were recorded. Of the 4950 responses recorded, 404 of them (8.2%) were found to be troll responses, being more frequent in phase 7 and between phases 3 and 5 (table 2).

Table 2. Distribution of troll responses by phase.

	NO TROL			*TROL*			*Total*
Phase	*N*	*%*	*Waste*	*N*	*%*	*Waste*	*N*
1,00	*1239*	*96.9%*	*7.6*	*40*	*3.1%*	*-7.6*	*1279*
2,00	*429*	*95.5%*	*3.0*	*20*	*4.5%*	*-3.0*	*449*
3,00	*285*	*86.6%*	*-3.6*	*44*	*13.4%*	*3.6*	*329*
4,00	*511*	*88.9%*	*-2.8*	*64*	*11.1%*	*2.8*	*575*
5,00	*1193*	*89.2%*	*-4.1*	*144*	*10.8%*	*4.1*	*1337*
6,00	*756*	*94.1%*	*2.6*	*47*	*5.9%*	*-2.6*	*803*
7,00	*133*	*74.7%*	*-8.5*	*45*	*25.3%*	*8.5*	*178*
Total	*4546*	*91.8%*		*404*		*8.2%*	*4950*

Once the category system was applied, it was found that the category of troll responses with the highest frequency of occurrence was category 5, related to troll responses with viral elements (3.4%). Regarding the rest of the categories, the troll responses were evenly distributed among them (Table 3).

Table 3. Distribution of troll responses by category.

Number of category	*Name of category*	*N*	*%*
1	*Absurd troll responses*	*39*	*0.8%*
2	*Aggressive troll responses*	*48*	*1.0%*
3	*Troll responses that allude to the face-to-face context*	*33*	*0.7%*
4	*Sarcastic troll responses*	*46*	*0.9%*
5	*Troll responses with viral elements*	*170*	*3.4%*
6	*Popularity-seeking troll responses*	*19*	*0.4%*
7	*Incoherent troll responses*	*49*	*1.0%*
	Total	*404*	*8.2%*

5. Discussion and conclusion

The aim of this work was to detect the troll responses and their common characteristics elaborated by a group of 265 students during a task based on the case methodology on socioemotional development in Collective Learning. The hypothesis was that troll responses could be detected through common characteristics but that there were differential elements among them. In the case developed, 4950 responses were recorded, 404 of them being troll responses, which had a greater representation in the final phase of the activity and between phases 3 and 5. To determine what common characteristics the 404 detected troll responses shared, an empirical categorisation system created ad hoc was designed, which allowed categorising all the detected troll responses, allowing them to be grouped into subgroups of greater concreteness.

In this way, the detection and categorisation of troll responses allows us to establish a definition for them, and it can be pointed out that this type of response would be those that do not respond to the context of the activity, intentionally deviating from its objective and whose content contains absurd, aggressive elements, allusive to the classroom context, sarcastic, allusive to viral elements, aimed at seeking popularity and/or incoherent. Therefore, it has been possible to corroborate the hypothesis put forward at the beginning of this study. Finally, trolling behaviours, or in this case troll responses, are not only likely to appear in online leisure environments such as forums (Phillips, 2015), video games (Thacker & Griffths, 2012) or social networks (Fichman, P., & Rathi, M., 2023), but can also appear in online learning contexts such as Collective Learning (Denoni Buján & Casanova, 2024). These responses break the dynamics of the activity, however the knowledge generated so far about trolling in learning platforms is limited to understand aspects such as the motivation of users or the profile of users who engage in these behaviours, being Collective Learning an environment with potential to deepen these aspects in future research such as the one presented in this paper.

Acknowledgments

This study was funded by Department of Science, University and Knowledge Society, Government of Aragon (Ref. PROY_S14_24. CONVIVEN-CI-IA. Aprendizaje de competencias socioemocionales para la ciberconvivencia a través de la integración de herramientas de Inteligencia Artificial (IA) + Inteligencia colectiva (IC) en centros educativos). Project financed by: FEDER Aragón Operational Program 2014-2020. Building Europe from Aragon.

References

Bautista, P. Cano-Escoriaza, J., Sánchez, E., Cebollero-Salinas, A., & Orejudo, S. (2022). Improving adolescent moral reasoning versus cyberbullying: An online big group experiment by means of collective intelligence. *Computers & Education, 189.* https://doi.org/10.1016/j.compedu.2022.104594

Bishop, J. (2012). The psychology of trolling and lurking: The role of defriending and gamification for increasing participation in online communities using seductive narratives. In H. Li (Ed.), *Virtual community participation and motivation: Cross-disciplinary theories* (pp. 160-176). Hershey: IGI Global.

Cebollero Salinas, A., Bautista, P., Cano, J., & Orejudo, S. (2022) E-competencias socioemocionales e inteligencia colectiva. Propuestas para el desarrollo emocional en las interacciones en línea. *Revista Internacional de Educación Emocional y Bienestar*, *2*(1), 13-32. Retrieved from https://rieeb.ibero.mx/index.php/rieeb/article/view/21

Denoni Buján, M., & Casanova, O. (2024) Characteristics of Troll Responses Created by Primary School Students on The Collective Learning Platform. *INTED2024 Proceedings*, 6928-6933.

Du, W., Fan, Z., Li, D., & Wu, M. (2024). Internet use behavior and adolescent mental health: The mediating effects of self-education expectations and parental support. *Psychology Research and Behavior Management*, 1163-1176. https://doi.org/10.2147/PRBM.S449353

Faraj, S., Jarvenpaa, S. L., & Majchrzak, A. (2011). Knowledge Collaboration in Online Communities. *Organization Science*, *22*(5), 1224-1239. Retrieved from http://www.jstor.org/stable/41303115

Fichman, P., & Rathi, M. (2023). Trolling CNN and Fox News on Facebook, Instagram, and Twitter. *Journal of the Association for Information Science and Technology*, *74*(5), 493-505.

Hardaker, C. (2010). Trolling in asynchronous computer-mediated communication: From user discussions to academic definitions. *Journal of Politeness Research*, *6*, 215-242. https://doi.org/10.1515/jplr.2010.011

Keita, M. (2023). Interactional effects of adverse childhood experiences, psychopathy and everyday sadism on Internet trolling. *Personality and Individual Differences*, *214*, 3112327. https://doi.org/10.1016/j.paid.2023.112327

Orejudo Hernández, S., Fernández Turrado, T., & Garrido Laparte, M. Á. (2008). Elaboración y trabajo con casos y otras metodologías activas. Cuatro experiencias de un grupo de profesores de la Facultad de Educación de Zaragoza. *Revista Interuniversitaria de Formación del Profesorado*, *22*(3), 21-45.

Orejudo, S., Cano-Escoriaza, J., Cebollero-Salinas, A., Bautista, P., Clemente-Gallardo, J., Rivero, A., Rivero, P., Tarancón, A. (2022). Evolutionary emergence of collective intelligence in large groups of students. *Frontiers in Psychology*, *13*, 848048. https://doi.org/10.3389/fpsyg.2022.848048

Orejudo, S., Lozano-Blasco, R., Bautista, P., & Aiger, M. (2024). Interaction among participants in a collective intelligence experiment: an emotional approach. *Frontiers in Psycholo*gy, *15*, 1383134. https://doi.org/10.3389/fpsyg.2024.1383134

Phillips, W. (2015). *This is why we can't have nice things: Mapping the relationship between online trolling and mainstream culture*. MIT.

Malone, T., Laubacher, R., & Dellarocas, C. (2010). The Collective Intelligence Genome. *IEEE Engineering Management Review*, *38*, 38-52. https://doi.org/10.1109/EMR.2010.5559142

Thacker, S., & Griffiths, M.D. (2012). An exploratory study of trolling in online video gaming. *International Journal of Cyber Behavior, Psychology and Learning (IJCBPL), 2*, 17-33. https://doi.org/10.4018/ijcbpl.2012100102

Valero-Tapia, S., & Orejudo, S. (2024) Evolution of Digital Stereotypes of Secondary School Students on The Collective Learning Platform. *INTED2024 Proceedings*, 6790-6797. https://doi.org/10.21125/inted.2024.1783

Volkova, S., & Bachrach, Y. (2015). On predicting sociodemographic traits and emotions from communications in social networks and their implications to online self-disclosure. *Cyberpsychology, Behavior, and Social Networking*, *18*(12), 726-736.

Woolley, A. W., Chabris, C. F., Pentland, A., Hashmi, N., & Malone, T. W. (2010). Evidence for a collective intelligence factor in the performance of human groups. *Science*, *330*, 686-688.

TRANSFORMING ELECTRONICS EDUCATION WITH AI: A CHALLENGE-BASED LEARNING APPROACH

José Manuel Bravo-Pacheco, Sergio Esteban-Romero, Iván Martín-Fernández, Manuel Gil-Martín, & Fernando Fernández-Martínez
Grupo de Tecnología del Habla y Aprendizaje Automático (THAU Group),
Grupo de Innovación Docente en Ingeniería y Sistemas Electrónicos (GRIDS),
Departamento de Ingeniería Electrónica, Information Processing and Telecommunications Center,
E.T.S.I. de Telecomunicación, Universidad Politécnica de Madrid (Spain)

Abstract

The integration of Artificial Intelligence (AI) into electronics and computer science education offers new opportunities to enhance student engagement and learning outcomes. This paper presents a comprehensive approach to embedding AI-driven tools in laboratory-based courses, making complex concepts more tangible through hands-on experimentation. Developed by the GRIDS educational innovation group, this initiative leverages challenge-based learning and emerging technologies to create an interactive and adaptive learning environment. Three key AI applications serve as the foundation of this approach: Facial Emotion Recognition (FER), Human Activity Recognition (HAR), and Embedded Speech Technologies. These domains provide students with an opportunity to explore AI beyond theoretical concepts, engaging directly with machine learning models and real-world datasets. The Facial Emotion Recognition module enables students to experiment with deep learning for affective computing, using Convolutional Neural Networks (CNNs) and facial landmark detection to analyze emotions from video feeds. Through platforms like Google Colab and Raspberry Pi, students can train models with existing datasets (e.g., RAVDESS) or collect their own, gaining practical experience in AI model deployment. The Human Activity Recognition component introduces AI-powered gestures and movement analysis. By utilizing both inertial sensor data and image-based hand pose recognition, students implement deep learning architectures, such as Long Short-Term Memory (LSTM) networks and CNNs. This hands-on approach enhances their understanding of real-time AI applications in fields like robotics, healthcare, and human-computer interaction. The Embedded Speech Technologies module focuses on voice-driven interfaces, employing the Picovoice platform for speech recognition and intent detection. Using tools such as Porcupine Wake Word and Rhino Speech-to-Intent, students develop low-cost, voice-controlled systems that showcase the potential of AI for embedded applications. Across these projects, students engage in design, implementation, and optimization of AI models within resource-constrained environments, reinforcing problem-solving and critical thinking skills. The combination of service learning, design thinking, and adaptive learning methodologies, supported by platforms like Moodle, YouTube, and GitHub, ensures a scalable and accessible experience. Qualitative feedback highlights increased student motivation, deeper conceptual understanding, and stronger engagement with AI-based tools. The findings suggest that incorporating AI into laboratory settings not only enhances learning outcomes but also better prepares students for the evolving demands of AI-driven industries.

Keywords: *Artificial Intelligence, electronics education, hands-on learning, challenge-based learning, AI applications.*

1. Introduction

The rapid evolution of Artificial Intelligence (AI) is reshaping industries and redefining the skillsets demanded of future professionals. As this happens, new students must be prepared with not only theoretical concepts but also solid practical experience in AI technologies. Traditional methods, based on theoretical lectures and textbooks, often struggle to engage the students. To address this, there is a growing interest in project-based approaches that encourage active learning and real-world problem solving. In this context, the integration of AI-based tools into laboratory sessions is emerging as a powerful strategy to increase the student engagement and stimulate their curiosity, which is important for their academic achievement and enjoyment (Steinmayr et al., 2019).

To accomplish that, the implementation of three AI-based applications is proposed: Facial Emotion Recognition (FER), Human Activity Recognition (HAR), and Embedded Speech Technologies. The first one involves analyzing facial features such as eyes, mouth, and facial muscles to determine emotions like happiness, sadness, anger, etc. The second one focuses on determining the activity performed by an individual, like running, through inertial sensors, and recognizing hand poses, like letters of Sign Language, from images. The last one shows the implementation of speech recognition libraries on low-cost platforms such as STM32.

Along this paper, the implementation of the three systems in laboratories sessions is explained, showing their possible applications in education. In addition, the response from a set of students that used the proposed resources is described.

2. Description of the proposed resources

This section deeps into the implementation of the proposed systems, including different modules of an AI project lifecycle, such as data acquisition, image or signal processing, training and analysis of the results, and deployment.

2.1. Face emotion recognition (FER)

As mentioned previously, this system is focused on identifying and interpreting human emotions based on facial expressions. To achieve this, it analyses a set of landmarks extracted from relevant face points. These systems have wide application fields such as education (tracking the attention of the students), public safety (lie detectors), or employment (helping recruiters).

The final system can detect the facial emotion that a user is expressing in real time, showing the prediction on screen. It has different stages: data acquisition, image processing to acquire 478 landmarks, artificial intelligence-based model training, and system deployment for real-time testing.

Concerning data acquisition, the project allows the students to work both with existing datasets found on the internet or custom ones recorded by them. In this sense, they can play with the changes between using large datasets, which are usually less accurate to a specific desired functionality, and small datasets, which are usually more focused on the task, or even combining them, leading to more robust systems.

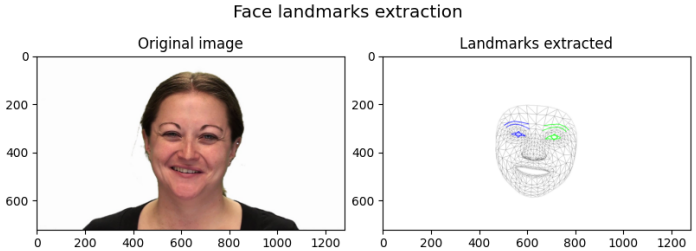
The RAVDESS dataset (Livingstone & Russo, 2018) is proposed as a baseline. The dataset includes recordings of 24 actors expressing emotions in both audio and video formats, with video frames labeled by emotion. Specifically, seven emotions are recorded: calm, happy, sad, angry, fearful, surprise, and disgust.

On the other hand, the students are allowed to record their own dataset for training the systems. In this sense, they can decide the number of classes to record, their class names and the number of images to save at each class. This personalization of the process allows them to test different combinations and to see their effect in the model. This recording is done using a Raspberry Pi equipped with a camera module.

Regarding the image processing, the system extracts a set of face landmarks for doing the classification. This reduces the amount of irrelevant information provided to the model, resulting in a smaller and easier approach to train models. The landmarks are extracted from the images using the MediaPipe library (Google, n.d.). Specifically, it takes an image in RGB format and returns an array with 478 points, normalized between 0 and 1 with respect to the size of the input image. The landmark extraction process can be seen in Figure 1.

While the landmarks are normalized with respect to the image size, they still include biases that can interfere in the classification such as the position of the face in the image or the distance from the camera. By normalizing this data, students can observe the impact of these techniques in the result of the system, learning interactively its importance. As a baseline, a normalization for these two cases is also proposed.

Figure 1. Landmark extraction process. The image is extracted from the RAVDESS dataset.



Once the data is loaded and preprocessed, the training starts. In this phase, the students iterate the data through a model and, by reducing the loss between the predictions dropped by the model and the real classes, it finds characteristic patterns in the landmarks. Since the process is very demanding on computer resources, a Google Colab (Google, n.d.) notebook is used. Two different models are proposed as initial options: one Convolutional Neural Network (CNN) (LeCun et al., 1998) and one Visual Transformer (ViT) (Dosovitskiy et al., 2020). Once the training is finished, the models obtained can be compared and downloaded. The comparison is made with the accuracy metric and 95% confidence interval. Students can experience comparing their different approaches and selecting the best solution found for their application.

Finally, the students can easily implement their recently trained models to make a real-time demo of the task. A Raspberry Pi 5 with 4GB of RAM is used for the deployment of the demo. Once the model is loaded, the deployment script can be run. This script enables the camera of the device and shows the recording on the screen. With every frame, the landmarks of the face are extracted, and a square is drawn around the detected user, informing about the detected emotion. A demonstration of the system is available online at: https://youtu.be/HEggPs9-L8M

2.2. Human activity recognition (HAR)

Commonly recognized daily activities in the literature include walking, running, sitting, and standing. However, it is also possible to recognize activities directly related to sport such as performing squats or steps. In parallel, HAR also covers the detection of specific hand poses, which can enhance the development of human-computer interaction systems, thereby improving user experiences across diverse domains. Hence, two systems are proposed for HAR: Human Activity Recognition from acceleration signals and Hand Pose Recognition from images. As in the previous system, these applications include four stages: data acquisition, signal processing, model training and demo deployment. Moreover, it also relies on combining both a Raspberry PI and Google Colab for a balance in low-resource devices and high-power computation.

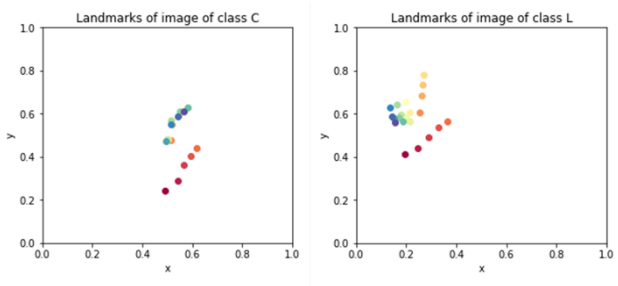
A Raspberry PI platform is used for recording data for both systems. This platform is equipped with a camera and a Sense HAT add-on board (with an LSM9DS1 IMU that contains an accelerometer).

For the recording of the physical activity signals, the subjects used a hip belt to attach the Raspberry Pi at the lumbar during the data collection. Though the system is flexible to capture acceleration data from the activities the students are interested in, the default configuration invited the students to capture data from four activities related to sport: running, step, squat and circles. The recording of the hand poses is done using the camera. The subjects located the Raspberry Pi in front of them while performing different hand poses. For this system, the students were invited to perform hand poses related to some letters from the Sign Language Alphabet.

The acceleration signals captured from the sensor were segmented into windows. The default configuration asked the students to capture enough time to obtain 50 examples of 4-second windows with a 1-second overlap per class, which were directly used as input to the model.

Regarding the hand pose system, a set of 21 hand landmarks are extracted from the images using the MediaPipe library. Figure 2 shows the points that were obtained after processing the images for two hand poses (“C” and “L”).

Figure 2. Hand poses for the Sign Language Alphabet.



For the physical activity system, the processed acceleration signals were used as an input of a simple Long Short-Term Memory (LSTM) (Hochreiter & Schmidhuber, 1997) network to model the motion pattern in the time domain. This model is designed to process sequential data consisting of three acceleration axes. In case of the hand pose system, the x and y coordinates of the 21 landmarks were used as an input of a simple CNN. The models’ performance was evaluated using the accuracy metric with 95% confidence intervals. As the training process of these systems is resource-demanding, the stage is also performed through Google Colab platform.

For both applications, the trained model is loaded in the Raspberry Pi to offer the possibility for real-time testing. This way, the students can observe how the system performs in real life examples. The students can observe the predicted class in a terminal connected to the Raspberry Pi. However, the 8x8 RGB LED matrix can also be used to display a different letter and color depending on the predicted class. A demonstration of the system is available online at: https://youtu.be/yy-fC5ERWAs

For the second system, students could witness how the system accurately classifies the hand poses they had chosen beforehand. As the students executed the hand poses, they could view the predicted class on a screen simultaneously. A demonstration of the system is available online at: https://youtu.be/URrn2O6BPt4

2.3. Embedded speech technologies

Enabling speech recognition on low-cost platforms like STM32 microprocessors opens up a wide range of practical applications in various domains and can revolutionize user interactions, making them more intuitive, hands-free, and efficient. However, it also presents challenges due to limited computational resources and memory constraints. To address this, we explore the technologies provided by Picovoice (Picovoice Inc., n.d.).

Picovoice is a platform designed with developers in mind, empowering you to create voice-related applications according to your preferences. Diverging from Amazon or Google, Picovoice's AI operates solely on the device, offering enhanced accuracy. Specifically, the way Picovoice works is by listening until the configured wake-word is said. When this happens, the library processes the following phrase to decode the intention of the message based on a set of predefined actions. In this case, the full interface consists of three different steps: audio recording, sample processing and intention processing. The deployment of the system is done in a STM32-F411E-DISCO platform.

The interface uses the Integrated Interchip Sound (I2S) peripheral to connect the board with a MEMS microphone. This microphone records samples in PDM format. Since Picovoice requires PCM samples, the audio is converted from PDM to PCM.

We also want to ensure that the software is processing the samples at the same time as we keep recording. To make this possible the system implements a double buffer, one for reading and one for writing, and, by alternating them, both tasks can be performed at the same time.

For processing the obtained samples, Picovoice library makes two principal actions. First, it keeps checking if the wake-word has been said. If it is the case, the library automatically processes the following phrase and returns the intention of the voice command. The intention's parameters are returned as a set of previously configured options which is highly customizable from its web.

Finally, when the intention has been decoded, the system must process it as a normal programming flow to implement the desired functionalities. As a demo, a system was built to control a set of LED lights, however, the possibilities are endless. A demonstration of the system is available online at: https://youtu.be/4zYQlVsk_SM

3. Teaching methodology and results

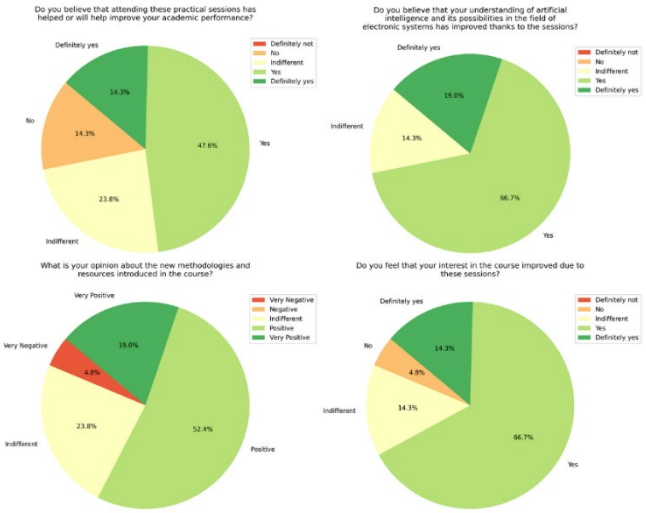
To assess the students' acceptance, motivation, and involvement, we followed a methodology based on qualitative interviews with a select group of students that experienced the integration of the systems, and observations during the laboratory sessions.

For example, the students' response of the new HAR resources showed great acceptance. Students shared that they were afraid at the beginning when the resources were presented. However, the novelty of the technology and its application over a real system sparked their curiosity to achieve their own systems based on artificial intelligence. Furthermore, the students expressed their delight about having the opportunity to put theoretical concepts to practical use.

Professors noted that students' body language and expressions evolved positively while using the resources when they observed that the systems correctly classified their own activities or hand poses. Moreover, professors observed that students actively engaged in problem-solving when using different deep learning approaches to solve the recognition challenges. In addition, students engaged in collaborative efforts with their peers throughout the practical lessons.

Figure 3 shows the feedback given by students after using the HAR project in laboratories. As can be seen, the students' interest improved using these projects, also helping them to achieve a higher understanding of AI systems. Moreover, survey results suggest that these practical sessions and resources helped to improve their academic performance.

Figure 3. Results of polls taken to students about the proposed methodology.



4. Conclusions

Our initiative of incorporating practical sessions based on AI systems as tools to enhance students' academic performance in electronics education appears advantageous. These experiences suggest that it is possible to boost the students' problem-solving skills in an enjoyable environment with a interactive and engaging systems related to Facial Emotion Recognition, Human Activity Recognition or Embedded Speech Technologies.

While we acknowledge the limitations of a smaller sample size, the qualitative findings provide a rich narrative that complements and enriches our understanding of the educational impact of these technologies. Further research, with larger samples or diverse student groups, can continue to explore the qualitative dimensions of this innovative approach to learning.

Acknowledgements

This work was funded by Project ASTOUND (101071191 — HORIZON-EIC-2021-PATHFINDERCHALLENGES-01) of the European Commission and by the Spanish Ministry of Science and Innovation through the projects GOMINOLA (PID2020-118112RB-C22), TRUSTBOOST (PID2023-150584OB-C21) and BeWord (PID2021-126061OB-C43), funded by MCIN/AEI/10.13039/501100011033 and by the European Union "NextGenerationEU/PRTR". Sergio Esteban-Romero research was supported by the Spanish Ministry of Education (FPI grant PRE2022-105516). Iván Martín-Fernández research was supported by the Universidad Politécnica de Madrid (Programa Propio I+D+i).

References

Dosovitskiy, A., Beyer, L., Kolesnikov, A., Weissenborn, D., Zhai, X., Unterthiner, T., … Houlsby, N. (2020). An image is worth 16x16 words: Transformers for image recognition at scale. *arXiv preprint arXiv:2010.11929*. Retrieved April 24, 2025, from https://arxiv.org/abs/2010.11929

Google. (n.d.). *Google Colaboratory*. Retrieved April 24, 2025, from https://colab.research.google.com/

Google. (n.d.). *MediaPipe*. Retrieved April 24, 2025, from https://mediapipe.dev/

Hochreiter, S., & Schmidhuber, J. (1997). Long short-term memory. *Neural Computation, 9*(8), 1735-1780.

LeCun, Y., Bottou, L., Bengio, Y., & Haffner, P. (1998). Gradient-based learning applied to document recognition. *Proceedings of the IEEE, 86*(11), 2278-2324. https://doi.org/10.1109/5.726791

Livingstone, S. R., & Russo, F. A. (2018). *The Ryerson Audio-Visual Database of Emotional Speech and Song (RAVDESS)*. Retrieved April 24, 2025, from https://zenodo.org/record/1188976

Picovoice Inc. (n.d.). *Picovoice Platform Documentation*. Retrieved April 24, 2025, from https://picovoice.ai/

Steinmayr, R., Weidinger, A. F., Schwinger, M., & Spinath, B. (2019). The importance of students' motivation for their academic achievement – Replicating and extending previous findings. *Frontiers in Psychology, 10*, 1730. https://doi.org/10.3389/fpsyg.2019.01730

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

ARTIFICIAL INTELLIGENCE AND EDUCATIONAL MANAGEMENT: THREAT OR CHALLENGE FOR SCHOOL LEADERS

Paraskevi Chatzipanagiotou*
Dr., Department of Education Sciences, European University Cyprus,
Associate Professor of Educational Management & Leadership (Cyprus)

Abstract

Artificial Intelligence (AI) is rapidly transforming various industries, and is increasingly applied across numerous areas of human activity, offering both significant benefits and unique challenges. Educational management is no exception. AI is being used to improve the learning experience for students and to streamline administrative processes at reduced costs. While the potential of AI in education is vast, its integration into school leadership and management raises critical ethical and practical issues. Key concerns include "What are the benefits and risks of implementing AI in schools" and "What competencies do school leaders need to use AI effectively in their roles". This paper highlights the transformative potential of AI in educational management, arguing that AI should be seen as a valuable tool that enables school leaders to delegate routine management tasks and refocus their attention on creative problem solving and complex interpersonal challenges that require human insight and emotional intelligence. A small survey was conducted among Greek primary school principals to explore their perceptions of AI, their readiness to adopt AI-driven tools, and the challenges they face in integrating AI into their daily practice. The results of the survey provide valuable insights into the practical implications of AI for school leadership and the professional development needs of educators. This study adopted a quantitative methodological design and data were collected through an electronic questionnaire created using Microsoft Forms software. Convenience sampling was used; the electronic questionnaire was administered to participants in 2024 and was anonymous. The findings show that the majority of school leaders are sceptical about the use of AI, perceiving it more as a threat, but are aware that it is a necessity of the times and that training is required. The paper also argues that while AI can augment certain leadership tasks, it cannot replace the core human elements of educational leadership - building deep, authentic connections and demonstrating compassion, empathy and ethical decision-making. As Harris and Jones (2023) argue, leadership is fundamentally about these human qualities, which are beyond the current capabilities of AI. The study concludes by advocating for targeted professional development to help school leaders acquire the necessary skills to work effectively with AI technologies. By doing so, school leaders can improve outcomes while maintaining the human-centred essence of education.

Keywords: *School leadership, Artificial Intelligence, administrative tasks, competences, CPD.*

1. Introduction

Artificial Intelligence (hereafter AI) is reshaping a multitude of human activity sectors, including education, introducing new tools that enhance the effectiveness of both educators, teachers and school leaders. However, its integration raises ethical and practical dilemmas, especially for school leaders who are tasked with managing its impact on school practice. The emerging question is whether AI constitutes a threat to traditional leadership roles or, conversely, a catalyst for transformation. This paper explores the implications of AI for school leadership, focusing on the benefits, risks, and required skills for principals. Research conducted with the participation of principals from Greek primary schools provides insights into their perceptions of AI and their readiness to adopt related tools.

*Correspondence: p.chatzipanagiotou@euc.ac.cy

2. The challenge of Artificial Intelligence for school leaders

Schools operate as open and complex systems, characterized by dynamic interactions among stakeholders (administration, teachers, administrative and support staff, students, parents, local and national authorities). School functioning can be understood across two institutional levels:

- The micro-level, focusing on the core processes of teaching, learning, assessment, and socialization, and
- The meso-level, concerning the organizational and administrative dimensions of school education, such as human resource management, financial planning, infrastructure and strategy development (Chatzipanagiotou, 2010, p.49).

At the heart of these interconnected levels works the school principal, whose leadership plays a critical role in shaping organizational performance, achieving learning outcomes, and striving for the continuous improvement of the school. This role is rapidly evolving in light of international trends promoting school autonomy and accountability. These trends simultaneously offer leaders greater decision-making power but also increase their responsibilities and pressure (West et al., 2014). Thus, principals are increasingly required to manage (medium to high) risk decisions often under conditions of uncertainty. In this context, data-informed decision-making emerges as a strategic approach to enhance leadership capacity. Although the theoretical value of data usage is recognized for diagnosing problems and planning evidence-based interventions, in practice, many principals face obstacles such as lack of time, insufficient training in data analysis, and the absence of reliable and timely information systems (Marsh & Farrell, 2014). Consequently, the quality and availability of data directly influence the principals' ability to lead effectively.

Artificial intelligence technologies (AI & GenAI) offer new opportunities to support school units. Their applications range from intelligent tutoring systems and robotic tools to adaptive learning platforms, automated assessments, and learning analytics dashboards. These tools promise personalized teaching, support for differentiated approaches, streamlining of administrative procedures, and overall improved educational experiences (Chen et al., 2020). Cooper (2023) describes this shift as a "seismic transformation" of global educational ecosystems. However, their widespread application raises ethical, regulatory, and pedagogical questions. Currently, there is a significant gap in research, frameworks, and ethical guidelines specifically concerning the application of GenAI in educational settings. Educators and policymakers struggle with uncertainty as AI's rapid advancement outpaces the development of clear standards and responsible practices. A recent OECD report (2023) highlights that AI is likely to surpass humans in linguistic and numerical literacy in the near future. This technological leap could render many current skills obsolete. Therefore, education systems must actively adapt, enhancing AI-related competencies among pupils, students, educators, and school leaders, preparing them to collaborate with AI rather than be replaced by it.

This urgent call for adaptation is echoed in the US Department of Education's (2023) report examining the future of teaching and learning in the AI era. The report concludes that traditional approaches to homework, teaching, and assessment may soon become outdated. A radical redesign of educational practices and systems is needed, with AI serving as a catalyst for renewal and transformation. Central to this reconfiguration is the re-evaluation of the role of school leaders, who must now navigate uncharted waters while fostering innovation. Indeed, school leaders (principals and educators) worldwide are already rethinking their roles, responsibilities, and professional practices. As noted by Azorín and Fullan (2022), some longstanding practices are no longer sustainable or effective in the emerging educational paradigm. AI can relieve principals from significant administrative and managerial burdens—freeing time and mental energy for visionary leadership, strategic planning, and community building. While recognizing the significant potential of AI, they are also aware of its risks to teaching and learning. As Van Quaquebeke and Gerpott (2023, p. 272) point out: "The question is no longer whether AI will play a role in leadership, but whether school leaders will continue to have a role. And if so, what that role will be..."

Until today literature on the emerging impact of AI on school leadership remains limited (Hejres, 2022). However, available research indicates that AI can support school leaders by taking over repetitive and routine administrative tasks, freeing time and cognitive space for more strategic, human-centered activities that require creativity, empathy, and social intelligence. At its core, leadership is about building meaningful human relationships and demonstrating compassion (Harris & Jones, 2023)—deeply human dimensions that are difficult, if not impossible, to replicate with artificial systems. Nevertheless, the introduction of AI in schools is expected to transform both the nature and practice of leadership. Principals will need to continually update their technological skills to keep pace with AI's rapid evolution. The COVID-19 pandemic experience marked the emergence of new leadership forms (Harris & Jones, 2022). Therefore, it can be argued that school principals are now better equipped than ever to face the uncertainties

and demands brought by AI, having already managed a form of global disruption (Harris, 2020), an experience that might aid them in approaching the next one.

According to the American Federation of School Administrators (2023), AI is expected to reshape school leadership roles through data analysis, automation of administrative processes, support of student interventions, and facilitation of communication with staff, pupils, and the broader school community. However, the choices school leaders face concerning AI are complex and often overwhelming. Therefore, it is vital for principals to develop a long-term, values-based vision for the ethical and purposeful integration of AI into education. Despite the excitement surrounding this new AI world, principals must keep the learning needs of children and youth at the centre of every decision. This technology could ultimately prove either a valuable educational tool or a threat to professional roles. What is certain is that school leaders are at the forefront of responding to both the opportunities and the challenges brought by AI. To understand technological changes and manage increasing complexity, they will need strong professional networks, collaborative relationships, and mutual support more than ever. The key question is not merely how AI can be integrated into existing educational systems, but how these systems can be redesigned and improved in response to challenges such as:

- Ethical dilemmas: The lack of transparency in AI decision-making may undermine leadership accountability and ethical responsibility.
- Loss of meaningful role: Automation could reduce principals' roles to merely administrative tasks, diminishing their pedagogical and strategic contribution.
- Inequities in access: Unequal availability of AI tools may exacerbate educational disparities among schools and students.

3. Methodology

A quantitative research design was adopted, and data collection was conducted via an electronic questionnaire created using Microsoft Forms. The questionnaire was deemed the most suitable tool as it ensures anonymity, fast distribution (Cohen, Manion & Morrison, 2007), low cost, and easy data collection. Convenience sampling was used, with the sample consisting of 48 members of the Panhellenic Scientific Association of Primary School Principals in December 2024. Of the 48 participants, 30 were women (62.5%) and 18 were men (37.5%). While the study offers important findings, it is recognized that the results reflect the views of a specific sample and cannot be generalized to all Greek school principals. The anonymous questionnaire included demographic questions and closed-ended and Likert-scale questions focusing on three main thematic areas: (a) benefits and risks of using AI in schools, (b) readiness to adopt AI tools, and (c) professional development needs regarding AI. A pilot test of the online questionnaire was conducted with two primary school principals, who provided feedback on completion time, structure, and clarity, ensuring the questionnaire's reliability and validity (Cohen et al., 2008). Coding and descriptive data analysis were performed using Microsoft Excel.

4. Presentation of key findings

The main findings are presented below, based on descriptive data analysis. 65% of participants expressed concern that AI might pose a threat, mainly regarding job security and emerging ethical issues. However, the majority (78%) recognized AI’s significant contribution to enhancing the efficiency of administrative processes.

Table 1. Perceptions of AI in Schools.

Question / Theme	Agreement (%)	Comment
AI enhances administrative efficiency	78%	Positive stance on functional uses
AI poses a threat to role security	65%	Strong concern about professional safety
Need for professional development	72%	Urgent need for training investment

Most participants (72%) stated there is an urgent need for training, particularly in digital literacy, ethical AI usage, and change/innovation management.

Table 2. Professional Development Needs.

Training Area	Mention Rate
Digital Competence	High (>70%)
Ethical Use of AI	High
Change & Innovation Management	Medium - High

5. Discussion and recommendations

The findings of this study provide insights into the current attitudes, concerns, and professional needs of Greek primary school principals regarding the integration of Artificial Intelligence (AI) into education. The data sketch a realistic profile of leaders who recognize both the potential and the risks accompanying this technological innovation. A significant proportion of participants view AI as a potential threat, primarily due to concerns about job security. This finding reflects the broader dialogue in the field of educational leadership, where AI is often seen as a double-edged sword—capable of improving efficiency but also of threatening the human-centred nature of leadership.

Despite these concerns, an even larger proportion recognizes AI as an inevitable reality, highlighting its clear advantages in streamlining administrative procedures and reducing everyday burdens. This indicates that principals are not rejecting technology but are seeking its strategic integration into school operations. Moreover, three-quarters of participants expressed a strong need for professional development, particularly in areas such as digital competence, ethical use of AI, and change management. This is a crucial finding, as it shows that school leaders are willing to innovate but do not yet feel sufficiently prepared to lead this transition.

Overall, the results reveal that principals approach AI with a blend of caution and optimism. They maintain a strong ethical responsibility to safeguard the educational interests of children while preserving the human character of school leadership. The pandemic appears to have prepared them to a large extent for the new technological challenge, as they have already experienced the need to adapt their leadership styles. Thus, the main challenge will be to strike a balance between innovation and ethics, technology and pedagogy. Building professional networks and designing targeted professional development programs are essential to ensure that AI becomes a tool for empowerment rather than marginalization.

References

American Federation of School Administrators. (2023). *Artificial Intelligence and Education.* https://www.theschoolleader.org/news/artificial-intelligence-and-education

Azorín, C., & Fullan, M. (2022). Leading New, Deeper Forms of Collaborative Cultures: Questions and Pathways. *Journal of Educational Change*, *23*(1), 131-143. https://doi.org/10.1007/s10833-021- 09448-w

Chatzipanagiotou, P. (2010). *School Management and teachers' participation in decision making*, Thessaloniki: Kyriakides (in Greek).

Chen, X., Xie, H., Zou, D., & Hwang, G. J. (2020). Application and Theory Gaps during the Rise of Artificial Intelligence in Education. *Computers & Education: Artificial Intelligence, 1*, 100002. https://doi.org/10.1016j.caeai.2020.100002

Cohen, L., Manion, L. & Morrison, K. (2007). *Research Methods in Education*. London: Routledge.

Cooper, G. (2023). Examining Science Education in ChatGPT: An Exploratory Study of Generative Artificial Intelligence. *Journal of Science Education and Technology, 32*(3), 444-452. https://doi.org/10.1007s10956-023-10039-y

Harris, A. (2020). COVID-19–School Leadership in Crisis?. *Journal of Professional Capital and Community*, *5*(3/4), 321-326. https://doi.org/10.1108/JPCC-06-2020-0045

Harris, A., & Jones, M. (2022). Leading during a Pandemic–What the Evidence tells Us. *School Leadership & Management*, *42*(2), 105-109. https://doi.org/10.1080/13632434.2022.2064626

Harris, A., & Jones, M. (2023). Compassionate Leadership. *School Leadership & Management*, *43*(3), 185-188. https://doi.org/10.1080/13632434.2023.2235540

Hejres, S. (2022). The Impact of Artificial Intelligence on Instructional Leadership. In A. Hamdan, A. E. Hassanien, T. Mescon, & B. Alareeni (Eds.) *Technologies, Artificial Intelligence and the Future of Learning Post-COVID-19. Studies in Computational Intelligence* (Vol. 1019, pp. 691-711). Cham: Springer. https://doi.org/10.1007/978-3-030-93921-2_36

Marsh, J. A., & Farrell, C. C. (2014). How leaders can support teachers with data-driven decision-making A framework for understanding capacity building. *Educational Management Administration & Leadership*, 1–21.

OECD. (2023). *Is Education Losing the Race with Technology?: AI's Progress in Maths and Reading*, Educational Research and Innovation, Paris: OECD Publishing. https://doi.org/10.1787/73105f99-en

United States Department of Education, Office of Educational Technology. (2023). *Artificial Intelligence and Future of Teaching and Learning: Insights and Recommendations*. Washington, DC: United States Department of Education, Office of Educational Technology.

Van Quaquebeke, N., & F. H. Gerpott (2023). The Now, New, and Next of Digital Leadership: How Artificial Intelligence (AI) will Take Over and Change Leadership as We Know It. *Journal of Leadership & Organizational Studies, 30*(3), 265-275. https://doi.org/10.1177/15480518231181731

West, D. L., Peck, C. M., Reitzug, U. C., & Crane, E. A. (2014). Accountability, autonomy and stress: principal responses to superintendent change in a large US urban school district. *School Leadership & Management, 34*(4), 372-391.

BUTTERFLY-PIANO: A DIFFERENTIATED LEARNING PROPOSAL, BASED ON THE AMERICAN GROUP PIANO METHODOLOGY, FOR CHILDREN WITH AUTISM SPECTRUM DISORDER

Priscila Gambary
Associate Professor, Departamento de Música, Universidade Federal de Sergipe (Brazil)
Visiting Professor (Post-Doctoral Course), Dipartimento di Studi Umanistici, Università di Macerata (Italy)

Abstract

This study aims to suggest new creative possibilities for using the piano – considered one of the most traditional musical instruments – through the application of a non-conventional graphic element. This approach involves not only a playful and diversified design, but also a therapeutic association between musical notes and colors, which may effectively complement treatments for Autism Spectrum Disorder (ASD). It is hoped that this "new instrument" may provide various benefits and serve as a support tool for children who experience difficulties with verbal communication, visual interaction, affection, and social engagement.

Keywords: *Autism Spectrum Disorder, learning proposal, American methodology, group piano, butterfly-piano.*

1. Introduction

It is not surprising to state that a teacher must always be open to different educational approaches and methodologies. The world is constantly changing, and as part of that context, we must be increasingly receptive to new tools that help us positively transform the reality in which we live.

In the field of music, pedagogical approaches often remain quite conservative, particularly when addressing students with specific potentials and limitations. Clearly, every human being is unique. We all have strengths in some areas and challenges in others, but we all deserve access to knowledge.

Educators who believe that an instrument is only suitable for those with “musical intelligence” fail to acknowledge the truth that music is a democratic language. They also miss the premise that, as art and music educators, we can help change a person's life – since all humans are musical beings with lived experiences, capable of being inspired to achieve positive and meaningful encounters in the world of sound and silence.

2. Autism Spectrum Disorder and music

The piano has increasingly been used as a complementary therapeutic tool for individuals with autism. According to Alvim and Warwick (1991, p.13), children on the spectrum tend to interact more effectively with objects than with people. When it comes to music, they may form a strong bond with a specific instrument for several reasons – its shape, for instance – and this object can serve as a bridge for interaction between their internal world and the external environment. Thus, the piano, as both a musical instrument and a tangible object, can play a significant role in their development.

As noted by Neves, Parizzi, Freire et al. (2022, p.4, our translation), “Ockelford (2018) emphasized that children with ASD... are often fascinated and motivated by music... the piano is often the first instrument of choice... especially for those with absolute pitch—because it offers immediacy... in sound.” Additionally, the same authors point out that the instrument’s shape or design allows for interactive experimentation with others (a core principle of the American group piano methodology). The size and materiality of the piano foster interaction through shared attention activities. Another factor is its organized key system, which by itself provides a pattern-based stimulus that appeals naturally to individuals with autism.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

Several studies support the claim that people with ASD are three times more likely to have absolute pitch than neurotypical individuals. This characteristic must be acknowledged to help them achieve greater developmental outcomes. Considering these essential factors from a music educator's perspective, and using an adaptation of the group piano methodology, this article introduces not only a new playful design for the instrument, but also a practical and functional approach.

3. Objectives

The objective of this research is to propose new creative ways to use the piano – one of the most traditional musical instruments – for individuals with Autism Spectrum Disorder. Based on the group piano methodology, the goal is to promote a better quality of life for children with ASD, particularly non-verbal individuals or those with low social interaction. This last point is the primary learning objective of piano instruction through the group methodology.

4. Methods

This research is grounded in the analysis and adaptation of the principles of the group piano methodology, applied to a bibliographic study. Developed in the United States many years ago, the group piano methodology was designed to provide musical literacy to beginner students of any age. Group piano methods – regardless of whether they are intended for children or adult beginners – encourage creativity, improvisation, and ensemble interaction. Having worked with both *Piano 101* and *Alfred's Group Piano for Adults*, which serve as the foundation for the Butterfly Piano's sheet music configuration, we can affirm that there is no more stimulating way to introduce children and adults to the instrument than through group piano, as it is rooted in social collaboration.

Scientifically, it is known that "creative learning is an approach that goes beyond the simple assimilation of subjects and content, as it stimulates imagination, curiosity, and the ability to solve problems in original ways" (Tiburski, 2024, our translation). The proposal of a soundless keyboard, inspired by the silent pianos of the past – which are still in use today – offers the child a way to work on cognitive interaction with their fingers. With this creative strategy, students are encouraged to develop their internal hearing, since imagining and trying to trigger musical notes while speaking or singing melodies helps optimize the integration and functioning of both brain hemispheres. Rhythm is typically controlled by the left side of the brain. However, speech and logical reasoning (attributed in the past to the left side of the brain), as well as image recognition and musical ability (attributed in the past to the right side of the brain) are now known to involve both hemispheres.

Therefore, the silent, playful pianos proposed here are likely to be useful in complementary or alternative therapies for individuals with autism – not only to support specific challenges, but also to promote cognitive and neural integration. Parizzi, Freire et al. (2022, p. 3, our translation) emphasize "the use of the piano... as a powerful tool to provide children with ASD a multisensory experience early in their musical development. In this context, the piano should also be used... percussively…"

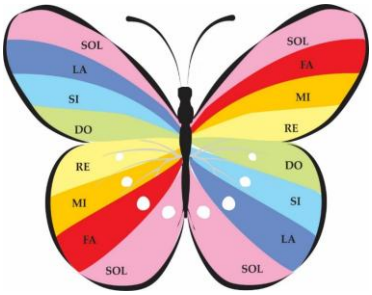
In the case of the Butterfly Piano, which produces no sound and only features a keyboard with note names from parts of universal songs—combined with chromotherapy principles—it is expected that some form of verbal communication will occur, supported by other therapies. Gradually, children can be encouraged to interact with conventional keyboards or pianos and to play what they have imagined and expressed through their frequent contact with this playful instrument.

The proposed design for the Butterfly Piano, which can be made from cardboard, would be represented as follows:

Figure 1. Butterfly-Piano Design.

Support network member's Butterfly-Piano

Piano 2



Autist's Butterfly-Piano

Piano 1

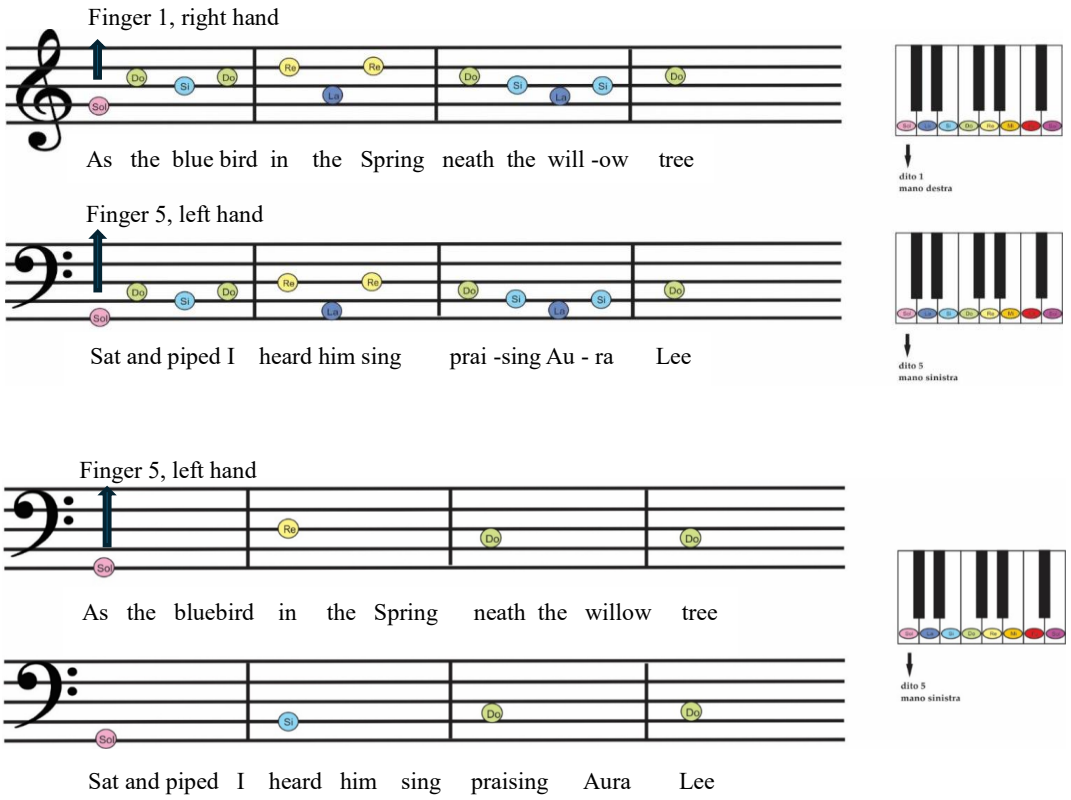
5. Discussion

Many children with autism have specific interests. However, the chosen symbolic design had to involve at least two interconnected parts to align with the traditional group piano methodology. Thus, the Butterfly Piano is intended for initial exploration between an autistic child and a partner, whether a family member or not.

As previously stated, every human being is unique. A person with a limitation in one area may not be able to respond quickly or predictably based on imitation. And how comforting it is to feel supported by another person. We only truly accept others' differences when we first recognize and accept our own flaws and limitations. This relationship is what changes the world – it transforms lives, families, communities, and cultures.

The adapted sheet music is based on a songbook passed down through generations and widely distributed across different media. This is expected to generate familiarity and emotional resonance in children with autism.

Figura 2. Aura-Lee – Gerge Poulton/William Whiteman – arranged by Priscila Gambary - Piano 1 e 2.

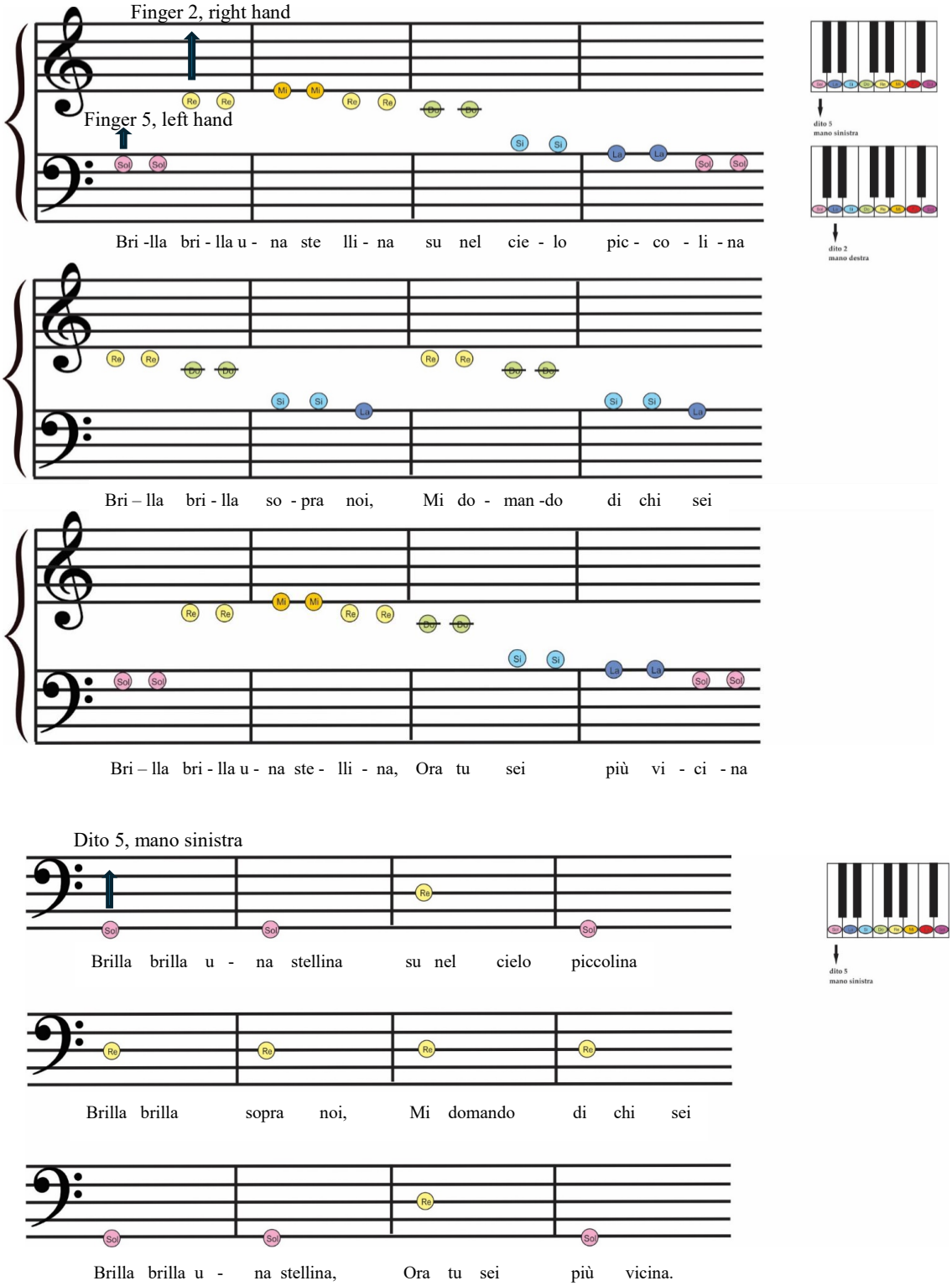


According to Rissato (2024, our translation), “bilingualism in autism can enhance adaptability to new situations... while promoting cognitive stimulation, communication skills... and cultural and social inclusion…”

All the “works” referenced here feature melodies that are universally recognized across many cultures. Language does not prevent the "performer" from translating them into their native tongue, although many children begin verbalizing in different languages.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

Figure 3. Brilla, brilla una stellina – adaptation by Priscila Gambary – Piano 1 and 2.



For many educators, affection is an essential component for developing intelligence and fostering interest and motivation in any individual, whether neurodivergent or not. If the person playing "Piano 2" – written in the bass clef – is part of the autistic child's support network, the desired outcomes may be achieved more quickly than expected. Suzuki believed that in the realm of music education, children learn primarily by example. According to him, affection is the key teaching tool in all dimensions.

6. Conclusions

Based on the premise of the group piano methodology, which is grounded in collaboration, positive reinforcement, interaction, and the creation of a true support network that makes learning as engaging and humane as possible, we present this new proposal for the creation of playful pianos adapted to the needs of individuals with autism. These pianos, with notes associated with chromotherapy principles, are silent, respecting a key sensory consideration for those on the spectrum, and are inspired by silent pianos. Before we speak of inclusion and acceptance, we must understand that diversity is what makes life richer and more meaningful.

Contrary to today's world, traditional group piano methodology does not create a space for competition but rather fosters solidarity and empathy. We conclude this proposal – focused on embracing diverse individuals – by affirming that it is possible to create a more sensitive and cooperative learning environment if we truly understand that normal is to be different. And for others to thrive, we must first be well with ourselves so that, together, we may radiate beauty, love, and compassion into the world.

References

Alvin, J., & Warwick, A. (1991). *Musical therapy for the autistic child*. New York: Oxford University Press.

Araujo, M. M. de, & Alves, C. L. (2021). *Educação: Minorias, Práticas e Inclusão*. Ponta Grossa: Atena Editora.

Macedo, M. P. R. (2021). *O papel do afeto no desenvolvimento do autista*. Ponta Grossa: Atena Editora.

Neves, M., Parizzi, B., Freire, M., & Nunes, N. (2022). *Tocando do jeito delas: o piano como instrumento musicalizador de criancas com transtorno do espectro do autismo*. Belo Horizonte: Annals 8o Nas Nuvens... Congresso de Música.

Rissato, H. (2024, February 15). *Bilinguismo no autismo: conheça os benefícios em aprender uma língua no TEA*. Retrieved from www.genialcare.com.br

Tiburski, R. (2024, May 7). *Aprendizagem criativa*. Retrieved from www.diarioescolar.com.br

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

THE INCLUSIVE FRAMEWORK OF THE ABMOVE! PROJECT: ENHANCING MATHEMATICS LEARNING THROUGH ACTIVE BREAKS

Maria Moscato[1], Valeria Di Martino[1], Clarissa Sorrentino[2], Federica Raho[2], Rosa Bellacicco[3], & Francesca Capone[3]
[1]University of Palermo (Italy)
[2]University of Salento (Italy)
[3]University of Turin (Italy)

Abstract

Neuroscience and cognitive theories have shown the deep connection between mind, body, and interaction with the environment, forming the basis of the embodied cognition paradigm. This perspective, consistent with 20th-century philosophical and pedagogical traditions, emphasises the role of kinesthesia in cognitive development and learning. Recent studies highlight the effectiveness of active breaks - short periods of physical activity during lessons - particularly in mathematics education. Building on this foundation, the ABMOVE! project, within the framework of the Italian PRIN 2022 PNRR initiative the Italian PRIN 2022 PNRR Project *Inclusive Didactic for Enhancing Math Learning and Reducing Math Anxiety: Efficacy of Active Breaks in the Classroom* (Mission 4, Component 2). , promotes the integration of curriculum-based active breaks in primary school math teaching. The project follows an Educational Design Research approach and is grounded in the Universal Design for Learning approach, aiming to ensure inclusive, accessible, and participatory learning for all pupils. This paper presents the programme's inclusive structure and evaluates its outcomes through teacher feedback and data analysis. The results provide valuable insights into the efficacy of the inclusive strategies adopted, offering guidance for potential improvements and further refinement of inclusive approach in future teaching practices.

Keywords: *Active breaks, inclusive teaching, mathematics, primary school, universal design for learning.*

1. Theoretical framework: Active breaks as pedagogical tools for embodied learning

Contemporary education increasingly recognises the link between pupils' well-being and the integration of neuroscience and educational psychology findings on the connection between movement and cognition. The embodied cognition paradigm views the mind as rooted in sensorimotor interaction (Shapiro, 2019; Wilson & Golonka, 2013), aligning with 20th-century pedagogy that emphasises bodily experience as fundamental to learning (Dewey, 1938; Merleau-Ponty, 1945; Varela et al., 1991). Ceciliani (2018) emphasises how cognitive functions are profoundly integrated within the sensorimotor system and develop through concretely lived experiences, thereby overcoming the historical mind-body dichotomy. Within this theoretical framework, active breaks emerge as effective pedagogical tools for integrating bodily activation and learning (Masin, Coco, Russo, Dallolio & Ceciliani, 2023), counteracting sedentary behaviour and improving classroom climate (Monacis, Colella & Scarinci, 2020). Research classifies these breaks (Lander, Contardo Ayala, Mazzoli, Lai, Orr & Salmon, 2024), highlighting their impact on executive functions and emotional regulation (Bellacicco, Capone, Sorrentino & Di Martino, 2025), influenced by frequency and duration and their successful integration with curriculum and educator involvement (Vazou & Skrade, 2016). According to Watson, Timperio, Brown, Best and Hesketh (2017), classroom-based physical activity generally manifests in three distinct forms: *active breaks*, which are short physical activity bouts interrupting academic instruction; *curriculum-focused active breaks*, integrating curriculum content into these brief activity sessions; and *physically active lessons* integrating physical activity into non-physical education subjects, such as mathematics. Attention to the embodied approach is proving particularly promising from an inclusion perspective, suggesting that, despite the limited representation of pupils with Special Educational Needs in research, active breaks can promote behavioural regulation and enhance school inclusion (Piepmeier et al., 2015).

2. Embodied learning and UDL for inclusive mathematics

Mathematics education presents challenges for inclusive learning, especially for students with diverse needs (Healy & Ferreira dos Santos, 2014). Traditional approaches can increase cognitive fatigue and math anxiety, limiting engagement, with effects varying by teaching methodology (Ashcraft & Moore, 2009). Despite the link between physical activity and cognition, few interventions integrate movement into mathematics (Cecchini & Carriedo, 2020). Research lacks specifically designed active breaks for mathematical learning and inclusion (Bellacicco et al., 2025), particularly those addressing executive functioning and math anxiety. It is precisely within this context of promoting inclusive practices that value student variability that the Universal Design for Learning (UDL)[*] framework is situated (Meyer et al., 2014), serving as a methodological and pedagogical guide for the design of flexible and accessible learning pathways, based on the principles of engagement (offering diverse options for involvement, as each learner varies in how they can be inclined and motivated to learn); representation (offering varied options for the representation of content, as learners perceive information presented in different ways); and action & expression (offering multiple options for action and expression, as learners differ in how they can navigate a learning environment and express what they know). Designing active breaks according to UDL principles allows for the amplification of their inclusive and cognitive potential, for example through the bodily representation of concepts or by offering different modalities for demonstrating understanding via embodied activities, transforming movement not only into a tool for well-being but into a lever for constructing truly equitable, motivating and meaningful learning environments for all.

3. Research design

Leveraging these premises, the *ABMOVE! Inclusive Didactics for Enhancing Math Learning and Reducing Math Anxiety: Efficacy of Active Breaks in the Classroom* research aims to strengthen mathematics learning in primary school by integrating curriculum-based active breaks directly within the classroom setting. The intention is to foster a more dynamic, participatory, and inclusive educational experience, while simultaneously promoting the psychophysical well-being of all students. The project was established using a robust Educational Design Research (EDR) methodology (McKenney & Reeves, 2019), following cyclical frameworks that integrate analysis, design, development, and evaluation through iterative phases, involving sequential stages of investigation and conceptualisation. A crucial initial stage involved a systematic review of existing scientific literature on active breaks in relation to executive functions, mathematical learning, and mathematics anxiety (Bellacicco et al., 2025). Concurrently, a thorough analysis of the Italian school context was conducted to understand teachers' perceptions and attitudes regarding the challenges encountered in mathematics instruction, with a specific focus on mathematics anxiety. These two preliminary stages provided a solid empirical basis for the educational intervention structuring. The UDL framework served as a central guiding principle throughout the entire development process, ensuring the accessibility and participation of all students through the provision of multiple means for engagement, representation, and action/expression. The development of the ABMOVE! programme was significantly enriched by the active collaboration of various educational stakeholders, including teachers, school administrators, physical education specialists, and academic experts in the fields of inclusive education and mathematics education. The ABMOVE! programme aims to strengthen mathematics learning in primary school through the integration of curriculum-based active breaks directly within the classroom setting.

4. The ABMOVE! programme

The ABMOVE![†] intervention follows a systematically designed protocol involving three weekly active breaks, each lasting 10-15 minutes, integrated during mathematics lessons over a twelve-weeks period. ABMOVE! is structured logically and modularly, offering differentiated interventions for the first cycle (second and third grades) and the second cycle (fourth and fifth grades) of primary school, aligning with the thematic areas of the mathematics curriculum defined by the National Curriculum Guidelines

[*] https://udlguidelines.cast.org/static/udlg3-graphicorganizer-digital-numbers-a11y.pdf

[†] ABMOVE! is the acronym that defines the structured format of the individual active breaks designed within the project, providing teachers with all the necessary information for effective implementation. Each activity is organised into seven sections: *Activity* (detailed description of the task with clear instructions), *Be Ready* (preparation of the space and required materials), *Mathematics* (specific learning objectives and key mathematical terms), *On the Move* (motor actions to be performed), *Variations* (adaptations for different skill levels or contexts), *Extra* (suggestions for extensions or interdisciplinary connections), and *Inclusion* (!) (strategies to ensure accessibility and engagement for all students, in line with the principles of Universal Design for Learning).

(MIUR, 2012). Each active break follows a three-part structure: a) an initial phase (ABstart) with a brief, personalised musical cue (2 minutes) to signal the start of the activity and create a motivating atmosphere; b) a central phase (8-10 minutes) involving structured motor activities based on the curriculum's mathematical content, guided by the teacher with the aid of visual and technological tools, such as flashcards; and c) a concluding phase (ABstop) dedicated to mindfulness exercises (2 minutes) to encourage a return to calm and focus, fostering body awareness and emotional regulation. The proposed activities adopt a 'relational' approach to mathematics (Skemp, 1982) that prioritises the exploration of connections and creativity and are based on fundamental motor skills (walking, running, jumping, etc.) supported by scientific research (Barnett et al., 2016).

5. Teachers' perspectives on the program's effectiveness

The implementation phase of the ABMOVE! programme was carried out in 37 primary schools across three Italian regions: Piedmont, Apulia, and Sicily. A total of 139 primary teachers and 3,317 pupils took part in the initiative. Among them, 69 teachers were directly involved in the experimentation with active breaks.Within the methodological design of the ABMOVE! research, a central focus was the evaluation of the programme's effectiveness, aiming to analyse the extent to which the integration of curriculum-based active breaks produced tangible effects on the critical analysis of the voices and direct experiences of the participating teachers, who were recognised as key actors in the success and sustainability of the intervention. Data collection employed a mixed methods methodology with a comparative approach (Creswell and Creswell, 2017), integrating synchronous interaction along with a digital data collection tool. Specifically, monitoring meetings gathered data through open-ended questions, real-time polls (via Mentimeter), and discussions, aimed at exploring teachers' opinions regarding the educational impact of active breaks. The digital data collection tool, completed by individual teachers in the experimental classes after each active break, collected a total of 1149 responses and included open-ended questions and Likert scale questions, with scores ranging from 1 (not at all) to 5 (very much). Descriptive statistics for the scales were processed using SPSS Version 20.0 software. Qualitative data, obtained from open-ended responses and transcripts of the guided discussions, underwent analysis using an inductive approach based on Schreier' s (2012) qualitative content analysis model. The initial step involved identifying units of meaning, followed by coding responses using keywords or definitions to establish categories. Subsequently, the organised data was clustered to group similar elements and highlight key emerging themes. This clustering was achieved through the creation of a binary matrix, assigning each respondent the identified response mode, which enabled the calculation of response frequencies. For mere space considerations, the major results obtained will be presented below, along with a concise commentary.

Table 1. Descriptive Statistics.

Scale	Mean	Std. Deviation	Median	Min	Max
Effectiveness in reinforcing math learning	3.95	1.04	4	1	5
Motor effectiveness	3.99	1.01	4	1	5
Usefulness of technological support	3.49	1.21	4	1	5
Teacher satisfaction	3.96	1.08	4	1	5
Student satisfaction	4.34	0.96	5	1	5

Data presented in Table 1 indicates an overall positive evaluation of the ABMOVE! programme by teachers. The perceived effectiveness in terms of mathematics learning (M = 3.95) and motor activation (M = 3.99) was high, suggesting that the active breaks were considered beneficial for reinforcing subject content and integrating the physical-corporeal component. Teacher satisfaction (M = 3.96) was also notable, alongside student satisfaction (M = 4.34), which highlighted strong engagement. The perceived utility of technological supports (M = 3.49) displayed greater variability.

In reference to the qualitative findings (Table 2), the analysis of inclusive enrichments employed by teachers reveals a variety of approaches aimed at supporting the participation of all students. A notable proportion of teachers did not explicitly mention the use of specific inclusive enrichment strategies. However, among the most commonly employed adaptations are pair and/or group work to foster peer support. The adaptation of tasks through simplification and the use of adapted or manipulative materials represent another significant strategy. Personalised visual and technological support, alongside direct teacher intervention, underscores the attention given to individual needs. The adoption of compensatory tools and the provision of opportunities for student choice, although less frequent, indicate an openness towards the principles of Universal Design for Learning (UDL). Regarding the positive aspects of the ABMOVE! programme identified by teachers, the emotional-relational dimension emerges strongly. Student enthusiasm, engagement, and active participation are widely recognised as primary benefits.

The consolidation of learning and the promotion of socialisation and peer collaboration represent further significant advantages. The capacity of active breaks to foster relaxation and anxiety management, alongside improvements in attention and concentration, was also highlighted. Finally, the programme appears to have stimulated curiosity and interest in mathematics, as well as promoting reasoning and reflection. Concerning the negative aspects or challenges encountered, classroom management and maintaining order represent the most significant difficulties reported by teachers. A secondary concern involves a potential lack of focus on mathematical aspects during the activities. Issues related to classroom space, scheduling, and the specific structure of some activities were mentioned less frequently. It is noteworthy, however, that a considerable number of teachers reported no critical issues, suggesting a generally positive acceptance of the programme.

Table 2. Major Themes Emerged from the Qualitative Analysis.

Inclusive Enrichments Used		**Positive Aspects Identified**		**Negative Aspects Identified**	
Emerging Theme	**Occ.**	**Emerging Theme**	**Occ.**	**Emerging Theme**	**Occ.**
None	140	*Enthusiasm, engagement, and active participation of students*	374	*None*	130
Pair or group work to encourage peer support	52	*Consolidation of learning*	99	*Classroom management and maintaining order*	99
Simplification and use of adapted materials	19	*Socialization, collaboration, and peer support*	76	*Lack of interest in mathematical aspects*	61
Personalized visual and technological support	13	*Relaxation and anxiety management*	46	*Classroom space issues*	26
Teacher support	10	*Improvement in attention and concentration*	39	*Specific difficulties related to the structuring of the activity*	21
Compensatory tools	8	*Development of curiosity and interest in mathematics*	27	*Integrating break time with lesson and school schedule*	18
Modification of movements	8	*Promotion of reasoning and reflection*	18		
Possibility for students to choose	7	*Effectiveness of the activity in achieving learning objectives*	17		
		Development of specific skills in mathematics	15		
		Increase in motivation	13		
Tot.	**257**	**Tot.**	**724**	**Tot.**	**355**

6. Conclusions

The ABMOVE! project demonstrates the potential of integrating active breaks, designed within the Universal Design for Learning framework, to enhance mathematics learning in primary school settings. The findings highlight the positive perceptions of teachers regarding the programme's effectiveness in promoting both mathematical understanding and student engagement. By incorporating movement into the curriculum, ABMOVE! not only addresses the need for a more dynamic and inclusive learning environment but also contributes to the growing body of evidence supporting the link between physical activity and cognitive development. While acknowledging the challenges related to classroom management and the integration of active breaks, the study underscores the importance of providing teachers with structured support and resources to effectively implement such interventions. Ultimately, ABMOVE! offers valuable insights into creating equitable and engaging learning experiences that cater to the diverse needs of all students.

Acknowledgments

This research was funded by the PNRR 2022 project ABMOVE! Inclusive Didactics for Enhancing Math Learning and Reducing Math Anxiety: Efficacy of Active Breaks in the Classroom, supported by the European Union – Next Generation EU- Mission 4, Component 2 (CUP: F53D23010970001).

This work is the result of the combined contributions of the authors, each of whom is credited in detail for their respective parts: M. Moscato paragraph 5; V. Di Martino paragraph 3, C. Sorrentino paragraph 1; R. Bellacicco paragraph 2, F. Capone paragraph 4; F. Raho paragraph 6.

References

Ashcraft, J., & Moore, A. (2009). Mathematics anxiety and the affective drop in performance. *Journal of Psychoeducational Assessment*, *27*(3), 197-205. https://doi.org/10.1177/0734282908330580

Barnett, L. M., Lai, S. K., Veldman, S. L. C., Hardy, L. L., Cliff, D. P., Morgan, P. J., Zask, A., Lubans, D. R., Shultz, S. P., Ridgers, N. D., Rush, E., Brown, H. L., & Okely, A. D. (2016). Correlates of gross motor competence in children and adolescents: a systematic review and meta-analysis. *Sports Medicine*, *46*(11), 1663-1688. https://doi.org/10.1007/s40279-016-0495-z

Bellacicco, R., Capone, F., Sorrentino, F., & Di Martino, V. (2025). The Role of Active Breaks and Curriculum-Based Active Breaks in Enhancing Executive Functions and Math Performance, and in Reducing Math Anxiety in Primary School Children: A Systematic Review. *Education Sciences*, *15*(1), 47.

Cecchini, J. A., & Carriedo, A. (2020). Effects of an interdisciplinary approach integrating mathematics and physical education on mathematical learning and physical activity levels. *Journal of Teaching in Physical Education*, *39*(1), 121-125.

Ceciliani, A. (2018). Dall'Embodied Cognition all'Embodied Education nelle scienze dell'attività motoria e sportiva. *Journal of Phenomenology and Education Encyclopaideia*, *22*(51), 11-24.

Coco, D., Masini, A., Casolo, F., Dallolio, L., & Ceciliani, A. (2023). Active Breaks e DAD: nuove strategie per educare al benessere ed al movimento. *Q-TIMES WEBMAGAZINE*, *15*(2), 29-44.

Creswell, J. W., & Creswell, J. D. (2017). *Research design. Qualitative, quantitative, and mixed methods approaches* (5th ed.). Los Angeles: Sage. https://doi.org/10.1080/15424065.2022.2046231

Dewey, J. (1938). *Experience and Education*. Macmillan.

Healy, L., & Ferreira dos Santos, H. (2014). Changing perspectives on inclusive mathematics education: Relationships between research and teacher education. *Education as Change*, *18*(1), S121-S136.

IBM Corp. (2011). *IBM SPSS Statistics for Windows, Version 20.0*. New York: IBM Corp.

Lander, N. J., Contardo Ayala, A. M., Mazzoli, E., Lai, S. K., Orr, J., & Salmon, J. (2024). Beyond "brain breaks": A new model for integrating classroom-based active breaks. *Journal of Physical Education, Recreation & Dance*, *95*(4), 22-30. https://doi.org/10.1080/07303084.2024.2308253

Masini A., Coco D., Russo G., Dallolio L., & Ceciliani A. (2023). Active breaks in primary school: Teacher awareness. *Formazione & insegnamento*, *21*(1S), 107-113.

Masini, A., Marini, S., Gori, D., Leoni, E., Rochira, A., & Dallolio, L. (2020). Evaluation of school-based interventions of active breaks in primary schools: A systematic review and meta-analysis. *Journal of science and medicine in sport*, *23*(4), 377-384.

Mayer, A., Rose, D. H., & Gordon, D. (2014). *Universal Design for Learning: Theory and Practice*. Wakefield: CAST Professional [electronic version].

McKenney, S., & Reeves, T. (2018). *Conducting educational design research*. London: Routledge.

Merleau-Ponty, M. (1945). *Phénoménologie de la perception*. Paris: Gallimard.

MIUR. (2012). *Indicazioni nazionali per il curricolo della scuola dell'infanzia e del primo ciclo d'istruzione*. https://www.mim.gov.it/documents/20182/51310/DM+254_2012.pdf

Monacis, D., Colella, D., & Scarinci, A. (2020). Health education intervention in primary school: active breaks for the promotion of motor activity. *Form@re, 20*(1), 336-355. https://doi.org/10.13128/form-7404

Piepmeier, A. T., Shih, C. H., Whedon, M., Williams, L. M., Davis, M. E., Henning, D. A., et al. (2015). The effect of acute exercise on cognitive performance in children with and without ADHD. *Journal of Sport and Health Science*, *4*(1), 97-104. https://doi.org/10.1016/j.jshs.2014.11.004

Schreier, M. (2012). *Qualitative Content Analysis in Practice*. Sage. https://doi.org/10.4135/9781529682571

Shapiro, L. (2019). *Embodied cognition (New Problems of Philosophy)* (2nd ed.). New York: Routledge.

Varela, F. J., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience*. MIT Press.

Vazou S., & Skrade M. A. B. (2016). Intervention integrating physical activity with math: Math performance, perceived competence, and need satisfaction. *International Journal of Sport and Exercise Psychology*, *15*(5), 508-522.

Watson, A., Timperio, A., Brown, H., Bes, K., & Hesketh, K. D. (2017). Effect of classroom-based physical activity interventions on academic and physical activity outcomes: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act*, *14*, 114. https://doi.org/10.1186/s12966-017-0569-9

Wilson, A. D., & Golonka, S. (2013) Embodied cognition is not what you think it is. *Frontiers in Psychology*, *12*(4), 1-13.

THE INTERACTION BETWEEN SCHOOL SOCIAL WORKERS AND TEACHERS: THE DEVELOPMENT OF HUNGARIAN SCHOOL SOCIAL WORK IN A GLOBAL CONTEXT

Andrea Farmosi
Eszterházy Károly Catholic University, Educational Doctoral School (Hungary)

Abstract

In my presentation, I will explore the current state of school social work in Hungary, focusing on the interaction between social professionals and other actors within the public education system. Special attention will be given to the practical implementation of social work in schools, alongside the influence of professional and legal frameworks. From an international perspective, school social work has undergone significant transformations across Europe and globally in recent years. However, its development in Hungary has been notably slower, shaped by various historical and systemic factors. My presentation will address these challenges, sharing recent domestic experiences and highlighting practical dilemmas and useful insights. I will also examine the significant differences in how school social work is practiced internationally. While the original focus of the profession was on prevention, in Hungary, the emphasis has shifted toward direct assistance and intervention. I will analyze the reasons behind this divergence from global practices and classical social work methodologies, considering factors such as legislation, societal changes, and the structure of Hungary's social and educational systems. The emergence of school social work in Hungary has fostered a strong interaction with the teaching community, bringing to light systemic issues that warrant discussion. These issues extend beyond schools, indirectly impacting families and society as a whole. I will emphasize key ideas and developments that could shape the future of this emerging profession, for better or worse. Furthermore, I will highlight areas where meaningful progress has been achieved, particularly in child protection and prevention, through effective collaboration between social workers and educators. However, significant attitudinal changes are needed in both professions to ensure continued progress. My analysis is based on insights gathered from social workers and teachers in 75 Hungarian public education institutions, supplemented by a comparative examination of domestic and international regulations. This broader perspective aims to contribute to the ongoing development of school social work in Hungary and its alignment with international best practices.

Keywords: *School, social work, child care, competences, interactions.*

1. Introduction

School social work plays a vital role in supporting the holistic development of children in educational institutions. It aims to ensure children's successful academic progression, promote their physical and mental well-being, and maintain strong collaboration between social, educational, and health care sectors. In Hungary, this area of practice has undergone significant transformation over the past decades, with growing recognition of the importance of integrated, cross-sectoral support systems for children (Methodological Guide, 2022). This paper explores the evolution of school social work in Hungary in September 2018 as a new service within the family and child welfare centers. The data presented are primarily based on results achieved in the Northern Hungary region, specifically within the Eger District.

2. Functions and scope of school social work

A school social worker is a trained professional who provides direct support to children in schools and dormitories. Their core responsibilities include promoting students' social and emotional development, facilitating their integration into the educational environment, and preventing vulnerability or school dropout. These specialists help resolve conflicts involving students, parents, and teachers, and act as mediators between families and educational institutions (Máté, 2015).

The activity itself was incorporated through an amendment to Act XXXI of 1997 on the Protection of Children and Guardianship Administration (hereinafter referred to as the Child Protection Act, or CPA), which entered into force on September 1, 2018. The primary objective of this amendment was to ensure the presence of a social professional in every educational institution, who would be capable of coordinating the full range of services offered by the family and child welfare centers with the opportunities available within the institutions. It is important to highlight that these professionals are external to the educational institutions; that is, their employer is not the school's maintainer but the territorially competent family and child welfare center. Looking back on the history of the profession, various models have emerged, and experience has shown that it is most effective when the professional is not selected from within the institution itself, as this external status helps maintain genuine neutrality. In 2018 and 2019, the Educational Authority and the Department of Social and Child Welfare Services issued several documents that provided initial guidance for the introduction of school social work activities. In autumn 2022, a comprehensive methodological guide was published, offering a significantly more detailed and systematic framework. It defines the concept, objectives, and content of the activity, outlines work methods, specifies personal and material requirements, and identifies potential settings for the activities. Furthermore, it elaborates on the documentation requirements and process structures, providing practitioners with clear guidance for their daily work. The guide was developed by gathering and analyzing four years of practical experiences, aiming to deliver an even more detailed and practical manual for social workers. According to Section 40/A (2) ag) of the Child Protection Act, the provision of school social work is a core responsibility of the family and child welfare centers. It is classified as a specialized service aimed at promoting children's upbringing within their families and preventing endangerment. This service is mandatory for all educational institutions, which must ensure access for social worker professionals and cooperate with the respective family and child welfare centers to establish the necessary working conditions. This collaboration is formalized through a cooperation agreement that details the social worker's working hours, tasks, competencies, rights, and responsibilities, as well as the required physical and other conditions. Such an agreement is essential in practice because social workers must be predictably and consistently present in kindergartens, schools, and dormitories. Trust, reliability, and stability form the foundation of their work. For instance, if a social worker displays their office hours but is not available when a client seeks the service, the principle of reciprocity and reliability, central to the ethos of social work, is violated, and thus the service cannot operate as intended. Over time, this could have wider implications for the institution's environment: if the professional is perceived as accessible and trustworthy, they are likely to be sought out frequently; however, inconsistent availability could prevent the service from becoming firmly established (Methodological Guide, 2022).

Following the introduction of the service, a closer relationship gradually developed between social workers and their clients within the educational institutions. It is important to clarify who qualifies as a client in this context. Clients include not only the children and their parents or family members but also the teachers and other staff working in kindergartens, schools, and dormitories, including school health professionals, school security officers, and even administrative and maintenance personnel, as they all interact directly with the children and may thus become involved in the social worker's activities. Naturally, strict boundaries are maintained regarding the methods, forms of intervention, confidentiality, and data protection, depending on the specific client group being engaged (Methodological Guide, 2022). The key actors with whom school social workers may interact within educational institutions include:

- Children and pupils
- Parents
- Teachers
- Institution heads (principals)
- School healthcare professionals (school nurses, school doctors)
- School psychologists
- Special education teachers and developmental educators
- Child and youth protection officers
- School police officers / crime prevention advisors
- School security officers
- School secretaries, economic and technical staff

In summary, this is an intersectoral service designed to ensure that children in educational institutions receive support from a professional well-versed in the social and child protection systems.

To gain an understanding of the specific characteristics of the Eger region, it is important to note that Eger is a city with county rights, surrounded by 22 settlements at the district level. Altogether, there are 75 educational institutions (kindergartens, schools, dormitories) operating in the area. Nearly 17,000 children attend these institutions. Considering the legally prescribed standard of one social worker per 1,000 children, the Family and Child Welfare Center of Eger employs 17 school social workers in the district. On

average, each worker is responsible for 2 to 11 institutions, depending on the size of the institutions. Out of the 17 social workers, one also performs coordinator duties, which means they support and supervise the work of other social workers and are therefore responsible for only one institution themselves.

3. Historical development in Hungary

The development of school social work in Hungary has seen several phases. Since the 1990s, multiple experimental models emerged. One early attempt involved assigning teachers with additional child protection responsibilities, but this approach lacked the depth and expertise of professional social work. A more sustainable model was the internal school social worker system, adopted by alternative schools that served disadvantaged or underperforming students. In this setup, schools directly employed social workers, creating a functional alignment between school philosophy and social support. The most notable and lasting innovation, however, was the external school social work model, such as the Ferencváros Fehér Holló Child Welfare Service established in 1992. This approach positioned social workers as external coordinators linking schools, families, and support institutions, rather than replacing internal school staff. Their work emphasized partnership and communication across professional boundaries, reflecting the interdisciplinary nature of school social work (Máté, 2015).

4. Challenges in the educational landscape

Hungarian schools face mounting challenges due to broader social changes. Economic pressures, evolving family structures, and increased performance expectations have placed new burdens on both students and parents. As a result, children exhibit a growing range of behavioral, emotional, and developmental difficulties, while teachers, often overburdened and under-resourced, are left without the tools to manage these complex issues effectively. Schools are now expected to cultivate creativity, resilience, and social competencies alongside academic knowledge (N.Tóth, 2017). A multidisciplinary response—featuring teachers, psychologists, nurses, and social workers—is increasingly recognized as necessary for addressing students' complex needs (Nagy és Szabóné, 2018). School social workers bring a systems-oriented perspective, working not only with students but also with their families, teachers, and the broader community. They help navigate challenges such as bullying, absenteeism, mental health issues, and socio-economic barriers, contributing to a more inclusive and supportive school environment (Methodological Guide, 2022).

Unfortunately, in practice, several challenges arise. Educational institutions often lack the necessary infrastructure, and even with the best intentions, they are sometimes unable to offer a separate room for the social worker. In such cases, social workers are forced to find vacant classrooms, or at times must conduct their work in hallways, courtyards, or other shared spaces. Clearly, this makes it much harder to provide high-quality professional services, although it must not prevent service delivery. Social workers regularly report these problems to their supervisors, and it is hoped that over time, these experiences will contribute to improving working conditions and advancing the profession. In the Eger District, these infrastructural difficulties are most commonly encountered in the most popular and overcrowded institutions. These schools and dormitories often lack enough space even for their own educational activities, let alone providing an additional office for social work. Moreover, the higher the educational level they offer, the fewer class hours are available for activities linked to social work. There is still a lack of widespread recognition that strengthening children's social skills and supporting their emotional well-being can also positively influence academic performance. At present, based on our experience, the priority in schools remains focused on meeting curriculum and examination requirements rather than developing social competences.

5. Conclusion

School social work in Hungary is undergoing meaningful institutionalization, driven by the growing complexity of children's needs and the limitations of traditional educational responses. Integrating social work into schools offers a promising way forward, providing children with comprehensive support and enabling teachers to focus on education. By adopting a systemic, preventive, and collaborative approach, school social workers contribute to the resilience and well-being of students, families, and educational communities. As international models demonstrate, school social work can be a cornerstone of inclusive education—if provided with the recognition, resources, and flexibility required for success (N. Tóth, 2017).

It is not easy for social workers to integrate into the atmosphere of educational institutions, even though both fields work with children. Education and instruction, viewed purely from a pedagogical

perspective, belong to a well-structured, thematically organized system based on old methods, where teachers have clearly defined tasks. In contrast, social workers, when the service was first introduced, entered these institutions independently, tasked with establishing a mindset that was not only unfamiliar but sometimes seemed unacceptable or even incompatible with the existing practices. For example, when a student begins to behave differently at school or does not conform to the expected classroom behavior, a teacher typically responds using disciplinary methods that consider the interests of the whole class and school community. These measures might include punishments (e.g., written warnings, poor grades, summoning parents, notifying the principal) or actions that, rather than helping the student, may worsen the underlying problem. This can happen when a student is publicly reprimanded or the issue is made visible to the peer group. When a social worker addresses the same situation, they start from a different perspective, considering the student's mental and social needs, and approach the problem with greater sensitivity and empathy—something teachers, due to their professional focus and heavy workload, often cannot afford to prioritize. They must keep up with the curriculum and manage the needs of the entire class. Over the years, it has been challenging for social workers to introduce and promote an alternative approach and working method that provides space and opportunity for a different way of addressing students and their problems. The traditional focus in schools has remained centered around fulfilling academic requirements. It takes a long time to recognize that the well-being of children—and thereby the entire community—depends not on success in individual math or history lessons but rather on maintaining mental health. And to support that, professionals like social workers are essential in schools. There is no doubt that this service is greatly needed. It fills significant gaps in the education system, creating important connections between professional fields that were previously divided. It is crucial to provide specialized training for future social workers specifically for this field because it covers a large part of social work practice and is necessary and beneficial not only in the short term but also in the long run, for individuals, communities, and society as a whole.

References

Máté, Zs. (2015). Iskolai szociális munka. *Esély*, *4*, 77-95.

Ministry of the Interior, Deputy State Secretariat for Social Affairs, Slachta Margit National Institute for Social Policy. (2022). *Methodological guide for kindergarten and school social work activities*. Budapest: Ministry of the Interior, Deputy State Secretariat for Social Affairs.

Nagy, I., & Szabóné Szalay, Cs. (2018). Óvodai- és iskolai szociális segítő tevékenység a Család- és Gyermekjóléti Központnál. *Szociálpolitikai Szemle*, *26*(1), 55-72.

National Assembly of Hungary. (1997). *Act XXXI of 1997 on the protection of children and guardianship administration*. Budapest: National Assembly of Hungary.

N. Tóth, Á. (2017). *Régi-új kihívások a magyar oktatásban*. Eger: Líceum Kiadó.

TOWARDS GLOBAL INTERCULTURAL & INTERDISCIPLINARY PROJECT-BASED LEARNING: THE EVOLUTION OF THE GIPE EDUCATIONAL MODEL

Manfred Meyer
Department or Mechanical Engineering, Westfälische Hochschule, Bocholt (Germany)

Abstract

The evolution of the Global Intercultural Project Experience (GIPE) Educational Model exemplifies the dynamic transformation of higher education towards more globally integrated and interdisciplinary learning environments. Based on experiences from bilateral German-Namibian "International Software Engineering Project" courses in 2015 and 2018, we responded to the German Academic Exchange Service's (DAAD) "UAS.International" program call and expanded our educational reach through partnerships in Latin America and Southeast Asia under the GIPE framework from 2019 to 2023. Even amidst the global pandemic's travel restrictions, the program adapted by implementing fully online Collaborative Online International Learning (COIL) methods, maintaining the delivery of valuable student-led solutions to international clients. As the global situation improved, the return to in-person engagement at the 2022 Spring School in Germany and client visits enabled deeper intercultural collaboration and personal growth, fostering an enduring network within the "GIPE family." This progressive model evolved from software-focused projects to interdisciplinary challenges that involve diverse academic fields such as IT, Business, and Engineering. Notably, in 2023, the program's partnership with the United Nations Development Program (UNDP) Accelerator Labs demonstrated its evolution from engaging local clients to executing projects on a global scale, illustrating the capacity of higher education methodologies to adapt and thrive in an interconnected world. Aiming to make Intercultural Project-Based Learning an integral component of Higher Education, the model has further developed into the Global Sustainable Intercultural & Interdisciplinary Project Experience (GIPE++) framework. With additional funding from DAAD and Erasmus+ for the next three years, GIPE++ is poised to emphasize sustainability both in project focus on the United Nations' Sustainable Development Goals (UN-SDGs) and in perpetuating the approach itself, ensuring its enduring impact on global education.

Keywords: *Project-based learning, intercultural learning, interdisciplinary learning, collaborative online international learning, interdisciplinary students project.*

1. Background

The evolution of educational models has been shaped by the changing needs of society, technological advancements, and pedagogical research. Traditionally, education followed a teacher-centered model characterized by one-way knowledge transmission and rote learning (Freire, 1970). However, the shift towards constructivist theories in the late 20th century emphasized active learning, critical thinking, and student engagement (Piaget, 1954; Vygotsky, 1978). This change paved the way for learner-centered approaches that focus on personalized instruction and collaborative projects (Bransford, Brown, & Cocking, 2000). The integration of technology in the 21st century further transformed education, facilitating blended and online learning environments that offer greater flexibility and access (Graham, 2006). Educational models have then increasingly adopted competency-based frameworks that prioritize skill mastery over seat time, reflecting the demand for graduates who are prepared to navigate and contribute to a rapidly changing world (Sergis, Sampson, & Pelliccione, 2018). As pedagogical research continues to evolve, educational institutions are exploring interdisciplinary, experiential and project-based learning strategies to better equip students with the critical skills necessary for the 21st century. With economies and societies becoming more interconnected, the workforce also faces global challenges requiring not only technological proficiency but also critical thinking, adaptability, intercultural awareness and cross-cultural communication (Wilson, 2010).

2. Related work

Project-Based Learning (PBL) is effective in promoting hands-on learning through real-world challenges (Bender, 2012). This approach engages students in projects that mirror professional settings, fostering deeper understanding and practical application of knowledge (Bell, 2010), preparing them with critical thinking, problem-solving, and collaboration skills needed in the modern workplace (Krajcik & Shin, 2014). Moreover, addressing complex issues like climate change, public health, and technological innovation requires collaborative, cross-disciplinary solutions.

Intercultural and Interdisciplinary Project-Based Learning (IPBL) is essential for solving real-world problems by combining interdisciplinary approaches with intercultural settings to enhance understanding and communication among diverse cultural groups (Gregersen-Hermans, 2017; Warr & West, 2020). Hart (2019) explores how IPBL in intercultural groups enhances students' intercultural competence. It underscores the importance of reflective practice and structured interaction in developing the ability to navigate and appreciate cultural differences. The findings suggest that PBL environments, where students engage with real-world issues from multiple disciplinary perspectives, can significantly improve their intercultural skills alongside their academic learning. Oladiran, Uziak, Eisenberg, and Scheffer (2011) report on the Global Engineering Teams (GET) program that promotes project-oriented tasks in virtual student teams working in collaboration with industry partners. Students from different countries and disciplines collaborate on engineering design projects. It illustrates how technology can facilitate international collaboration among students, allowing them to apply their diverse knowledge and cultural perspectives to create innovative solutions.

Collaborative Online International Learning (COIL) is recognized as an innovative, cost-effective method that promotes intercultural learning through online faculty and student collaboration across countries (Rubin, 2017). Although online collaboration in student projects began in the 1990s, the focus on international and intercultural aspects has gained prominence only recently (Brereton, Gumbley & Lees, 1998; Appiah-Kubi & Annan, 2020).

Focusing on sustainability challenges, Sulkowski, Kowalczyk, Ahrendsen, Kowalski, and Majewski (2020) highlight a program where students from various disciplines and countries collaborate on projects aimed at promoting sustainable development. The initiative showcases how PBL with an intercultural and interdisciplinary focus can lead to innovative approaches to sustainability, encouraging students to think critically about environmental, economic, and social issues from a global perspective.

All related work underscores the effectiveness of interdisciplinary project-based learning in fostering not just academic growth, but also intercultural competence and collaborative skills (Brassler & Dettmers, 2017).

3. The GIPE (Global Intercultural Project Experience) Educational Model and its evolution

The evolution of the GIPE Educational Model took place over more than a decade now, from small bilateral software engineering projects towards a now well-established framework for global intercultural and interdisciplinary students' projects on sustainable development goals tackling real-world problems of real clients in the countries of our partner universities.

3.1. Intercultural collaboration on (distributed) software development projects

In 2014, we desiged a course "International Software Engineering Project" at our university and our partner university in Namibia getting students to apply theoretical knowledge to real-life software projects in international set-ups covering all phases from requirements collection to the final hand-over. In 2015 and 2018, two instances of this distributed software development approach were run including one-week visits to Namibia strengthening intercultural collaboration and awareness. While requirements gathering and project planning was partly done together on-site in Namibia ("Presence"), development was online and deployment was organized by the Namibian partner locally ("*Presence-Online-Local*").

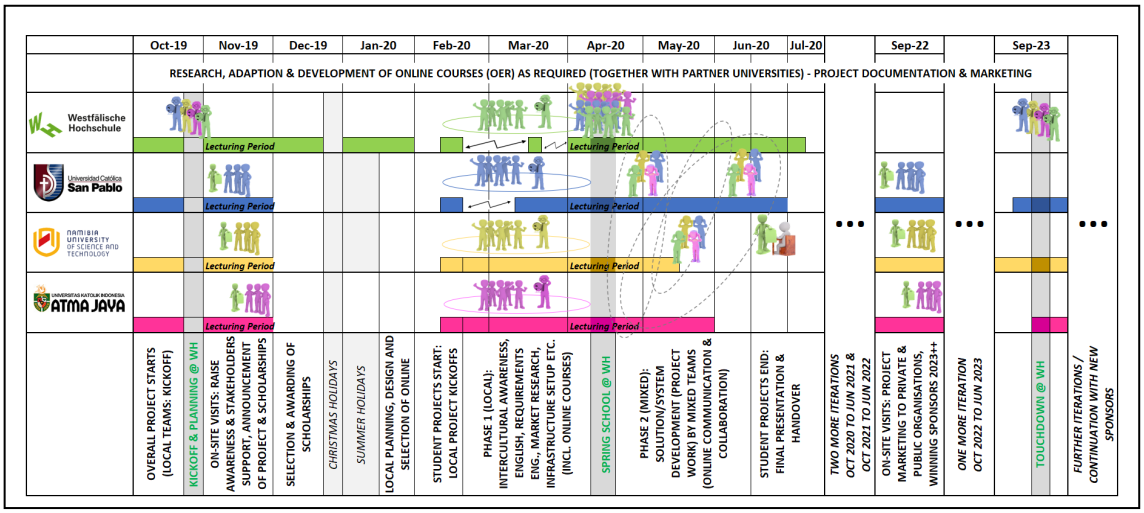
3.2. Towards a global intercultural project experience – Dawn of the GIPE framework

In 2019, we responded to an initiative by the German Academic Exchange Service (DAAD) aiming at strengthening internationalization efforts at German Universities of Applied Sciences and developed a framework that integrates IPBL and COIL, augmented by short-term physical mobility phases, to provide deeper intercultural exposure and facilitate effective online collaboration across continents and cultures. Over four years, from 2020 until 2023, we were able to offer selected students from participating institutions in Germany, Indonesia, Namibia and Peru the opportunity to gain a truly Global Intercultural Project Experience (GIPE) by working over one semester in a multicultural team on an international project for a real client (Meyer et. al., 2022a).

The annual student projects take place from February to June/July (subject to different academic calendars and lecturing periods) proceeded by client and project selection, evaluation of students' applications and awarding scholarships as well as requirements gathering and project planning together on-site ("*local*") with the selected client. The students' projects then run in four phases (see Figure 1):

1. Online collaboration preparation: A virtual global kick-off event brings all stakeholders together. Students then get prepared for the various project tasks through targeted trainings. Students join the project in intervals depending on the home universities lecturing schedules.
2. Two-week face-to-face phase (*"presence"*): All participating students and one representative lecturer from each university meet in Germany for team-building, intercultural exposure and mixed-team-setup ('Spring School').
3. Online collaboration: the students continue working on their project tasks in mixed teams using various web-based collaboration tools ("*online*"). They are instructed ('guided') by academic staff from all partner institutions and different disciplines, e.g. in the 2021 project, a business sub-project ("stream") was guided by a lecturer/researcher team from Peru and Indonesia while another stream focusing on the developing of an educational adventure game was guided by a German academic together with a colleague from Namibia.
4. One-week project-touchdown and hand-over: The German students travel to the client in Peru, Namibia or Indonesia (alternating) offering them a true international exposure too (*"presence"*).

Figure 1. The Masterplan for the GIPE Framework 2019-2023.



Due to travel restrictions during the Covid-19 pandemic, the 2020 students project was held almost entirely online ('pure COIL') except for early requirements gathering on-site while in 2021 at least the hand-over to the client in Indonesia could take place later the year and with only a few students travelling. The planned "*Local-Presence-Online-Presence"* model thus could only be held as "*Local-Online-Online-Online"* or "*Online-Online-Online-Presence"* respectively. Nevertheless, even almost without any meeting in person, both student projects were completed successfully and the results appreciated by the respective clients. However, in (Meyer et. al., 2022b) we explicitly discuss the importance of physical meetings during the two-week Spring School which is essential for our approach.

3.3. From software development to multi-disciplinary students' projects

While the first students' project within GIPE in 2020 focused on the development of a web-portal for a parastatal institution in Namibia, the focus of the 2021 project serving an eco-spirit center in Indonesia was already broadened allowing students from various disciplines to join and work on different tasks ranging from the development of a web-based booking system, a new business model, the implementation of a multi-layer educational computer game to the monitoring of sensor data through Internet-of-Things (IoT) technology. However, the various sub-projects ("streams") were run almost independently without much interaction or dependencies.

This changed slightly with the 2022 students' project serving a school in the outskirts of Arequipa (Peru) where all stream results got integrated under the roof of a newly developed website. Additionally, the dying out of the Covid-19 pandemic allowed for student mobilities in both directions leading to much deeper intercultural understanding and collaboration, fostering personal growth and establishing worldwide friendships within the "GIPE family". However, as the Spring School (to be more safe) had to be moved to June, this resulted in a "*Local-Online-Presence-Presence*" pattern with the handover visit of the German students to Peru following shortly after the "Spring School" in Germany.

3.4. Serving a globally distributed client – the UNDP students' project

When in 2023 we proudly served the United Nations Development Program (UNDP) Accelerator Labs in all our partner countries, the evolution of the GIPE Educational Model took the next step from a local to a globally distributed client. This allowed the local student teams to gather local requirements through on-site visits and meetings with client representatives in their respective countries – except for the German students who focused on global requirements during this first project phase. As the Spring School could also be held at the beginning of the joint lecturing period in April, this for the first time allowed for an early intercultural exposure and team-building, resulting in the implementation of the "*Local-Presence-Online-Presence*" pattern as originally planned for in the GIPE framework.

3.5. Focusing on Interdisciplinarity and Sustainability – from GIPE to GIPE++

Although the impact of the Covid-19 pandemic only allowed a proper implementation of the "*Local-Presence-Online-Presence*" pattern within the final project in 2023, observations and feedback from all project participants at the final GIPE conference ("GIPECon") in late 2023 confirmed that this approach led to the best results as regards intercultural awareness and collaboration. Moreover, although this combined approach comes with increased complexity as regards governance, project management and administrative support, it did not only have the intended impact on the participating students, but has also shown significant impact on both academic and administrative staff, their collaboration and personal growth as well as the participating HEIs as such (Meyer, 2024a).

Therefore, aiming at Intercultural Project-Based Learning becoming an integral part of Higher Education, we further developed GIPE into a more flexible Global Sustainable Intercultural & Interdisciplinary Project Experience (GIPE++) framework with funding now granted for three more years from DAAD and Erasmus+ which supports the next evolutionary step towards sustainability as regards both the projects' focus on UN-SDGs and also the GIPE/GIPE++ approach itself: All students' projects will explicitly address the UN-SDGs, e.g. the fight against the impact of climate change. Moreover, the students' projects now focus on true interdisciplinarity rather than offering mostly independent tasks for students from a variety of disciplines (multi-disciplinarity).

Therefore, in the current 2025 GIPE++ students' project serving a local community on a small island in the Jakarta Bay (Indonesia), in each stream students from various fields collaborate on tackling some client problem contributing to an overall solution to one major problem. In this case, students are conducting a baseline environmental study, analysing the current situation, e.g., as regards land erosion or beach pollution, its causes and possible remedies leading to a business model for sustainable tourism including social media and fundraising campaigns, a booking platform for local homestays as well as activities like mangrove planting, waste collection or creation of souvenirs, all integrated in one website.

The new GIPE++ framework thus fosters holistic and innovative approaches to problem-solving, encouraging students to think beyond the confines of their own disciplines. This cultivates critical soft skills such as teamwork, communication, and conflict resolution, as students learn to effectively work with others who have different expertise, perspectives or cultural background (Meyer, 2024b).

4. Conclusions

The GIPE++ concept of Interdisciplinary and Intercultural Project-Based Learning in the context of sustainable development goals has evolved over more than a decade from a small yet visionary course design in 2014 – and will further evolve. It offers numerous advantages in higher education, from enhancing student engagement to developing critical thinking, cultural awareness and collaboration, as well as real-world application skills. By fostering more active and student-centered learning, GIPE++ prepares students not only to succeed academically but also to excel in their future careers.

Acknowledgments

The GIPE and GIPE++ Projects were funded by the German Federal Ministry for Education and Research (BMBF) through the German Academic Exchange Service (DAAD) under grant no. 57510482 and 57755632, respectively.
The view on the GIPE Educational Model as a long-term evolutionary process was coined together with Heike Winschiers-Theophilus for a presentation at the GIPE Conference in 2023.

References

Appiah-Kubi, P. & Annan, E. (2020). A Review of a Collaborative Online International Learning. *International Journal of Engineering Pedagogy, 10*(1), 109-124

Bell, S. (2010). Project-Based Learning for the 21st Century: Skills for the Future. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 83*(2), 39-43.

Bender, W. N. (2012). *Project-Based Learning: Differentiating Instruction for the 21st Century*. Thousand Oaks, CA, USA: Corwin Press.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (2000). *How People Learn: Brain, Mind, Experience, and School*. Washington, DC: National Academy Press.

Brassler, M., & Dettmers, J. (2017). How to enhance interdisciplinary competence - interdisciplinary problem-based learning versus interdisciplinary project-based learning. *Interdisciplinary Journal of problem-based Learning, 11*(2).

Brereton, P., Gumbley, M., & Lees, S. (1998). Distributed Student Projects in Software Engineering. In *Conference on Software Engineering Education and Training* (pp. 4-22), IEEE Computer Society.

Freire, P. (1970). *Pedagogy of the Oppressed*. New York, NY: Herder and Herder.

Graham, C. R. (2006). Blended learning systems: Definition, current trends, and future directions. In C. J. Bonk & C. R. Graham (Eds.), *The Handbook of Blended Learning: Global Perspectives, Local Designs* (pp. 3-21). San Francisco, CA: Pfeiffer.

Gregersen-Hermans, J. (2017). Intercultural competence development in higher education. In *Intercultural competence in higher education* (pp. 67-82). Routledge.

Hart, J. (2019). Interdisciplinary project-based learning as a means of developing employability skills in undergraduate science degree programs. *Journal of Teaching and Learning for Graduate Employability, 10*(2), 50-66.

Krajcik, J. S., & Shin, N. (2014). Project-based learning. In R. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences.* Cambridge, UK: Cambridge University Press

Meyer, M. (2024a). Understanding the Impact of Intercultural Project-Based Learning on Students, Staff and Higher Education Institutions. In C. Mafalda Carmo (Ed.), *Education Applications & Developments, Vol. 2* (pp. 214-218). Lisbon, Portugal: inSciencePress.

Meyer, M. (2024b). Worth Every Penny: The Invaluable Returns of Investing in Intercultural and Interdisciplinary Project-Based Learning in Higher Education. In *Proceedings 17th International Conference of Education, Research and Innovation* (pp. 6723-6729), Seville, Spain: IATED.

Meyer, M., Gamundani, A., Becker, K., Malpartida, D., Nugroho, A., Ochoa-Luna, J., Stanley, C., & Winschiers-Theophilus, H. (2022a). Global Intercultural Project Experience (GIPE): A Distributed Interdisciplinary Project-Based Learning Framework. In C. Mafalda Carmo (Ed.), *Education Applications & Developments VII* (pp. 187-205). Lisbon, Portugal: inSciencePress.

Meyer, M., Becker, K., Gamundani, A., & Stanley, C. (2022b). A Global Intercultural Project Experience (GIPE): Reflections on Combining Online and On-site Project-Based Learning across four Continents. In K. Macari (Ed.), *Transformative Teaching*. *Focus on Pedagogy. AMPS Proceedings Series 31* (pp. 243-251). Architecture Media Politics Society (AMPS).

Oladiran, M. T., Uziak, J., Eisenberg, M., & Scheffer, C. (2011). Global engineering teams–a programme promoting teamwork in engineering design and manufacturing. *European Journal of Engineering Education, 36*(2), 173-186.

Rubin, J. (2017). Embedding collaborative online international learning (COIL) at higher education institutions. *Internationalisation of Higher Education, 2*, 27-44.

Piaget, J. (1954). *The Construction of Reality in the Child*. New York, NY: Basic Books.

Sergis, S., Sampson, D. G., & Pelliccione, L. (2018). Educational design and technology in competency-based learning environments In D. Sampson, R. Ifenthaler, J. M. Spector, & Kinshuk (Eds.), *Digital technologies: Sustainable innovations for improving teaching and learning* (pp. 3-24). Cham: Springer.

Sulkowski, A., Kowalczyk, W., Ahrendsen, B., Kowalski, R., & Majewski, E. (2020). Enhancing Sustainability Education Through Experiential Learning of Sustainability Reporting. *International Journal of Sustainability in Higher Education, 21*(6), 1233-1247.

Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press.

Warr, M., & West, R. E. (2020). Bridging academic disciplines with interdisciplinary project-based learning: Challenges and opportunities. *Interdisciplinary Journal of Problem-Based Learning, 14*(1).

Wilson, A. (2010). *Knowledge power: Interdisciplinary education for a complex world*. Routledge.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

EXAMINING THE ROLE OF LIFE SCIENCES SUBJECT ADVISORS IN COLLABORATIVE TEACHER PROFESSIONAL WORKSHOPS: A MULTIPLE CASE STUDY OF NORTHERN KWAZULU NATAL

Nomzamo Xaba
Department of Mathematics, Science, Technology and Engineering, University of Zululand (South Africa)

Abstract

Subject advisors play a critical role in strengthening teacher capacity and ensuring effective curriculum implementation, particularly in under-resourced contexts. Their responsibilities extend beyond administration to include pedagogical support, professional development, and sustained mentorship for in-service teachers. However, in many rural districts, subject advisors face numerous systemic constraints, including geographical isolation, resource limitations, and inadequate content knowledge, which hinder their ability to provide meaningful curriculum and instructional support. This qualitative study, situated within an interpretivism paradigm, explores how Life Sciences subject advisors perceive and enact their roles in a collaborative teacher professional development initiative between a local university and two districts in Northern KwaZulu-Natal. A multiple case study design was employed, and two subject advisors were selected using purposive and convenient sampling, as they held relevant advisory roles in Life Sciences education and had direct involvement in the professional development workshops. Data was collected through a close-ended questionnaire, semi structured interviews, field notes and researcher reflections. The roles encompass (i) logistical coordination, (ii) instructional support, and (iii) emotional encouragement. The findings suggest that subject advisors' roles in collaborative teacher professional development workshops are shaped by both structural conditions (e.g., district demands, workloads, time constraints) and personal professional commitment to supporting teacher learning. The key findings highlight that while logistical tasks such as arranging venues and sending circulars are essential for ensuring teacher participation, they are insufficient on their own to build sustained teacher capacity. The Findings reveal varying levels of engagement shaped by both systemic constraints such as workload and individual professional commitments. One advisor displayed a strong professional agency, frequently co-facilitating sessions and addressing teachers' practical needs, while the other primarily supported logistical arrangements due to competing departmental obligations. This study highlights the importance of clearly defining and supporting the professional roles of subject advisors in collaborative PD initiatives. It calls for ongoing partnerships between universities and education departments to ensure subject advisors are positioned not only as logistical coordinators but as active co-facilitators of sustainable teacher learning.

Keywords: *Community engagement, life sciences, subject advisors, teacher professional development and rural education.*

1. Introduction

Subject advisors play a central role in strengthening teacher capacity and improving instructional quality, particularly in under-resourced township and rural contexts across South Africa. Their responsibilities extend far beyond administrative functions to encompass curriculum mediation, pedagogical guidance, and sustained teacher mentorship (Sithole & Tachie, 2024; Sithole, 2020). In provinces such as KwaZulu-Natal, subject advisors have been shown to support teachers through a range of activities, including organising workshops, distributing teaching materials, and conducting school visits aimed at deepening curriculum understanding and improving classroom practices (Sithole, 2020; Shozi,2014). This support is especially critical in Life Sciences education, where rural schools face acute challenges, including a severe shortage of qualified teachers (Shozi, 2014; Tatane,2014). This shortage contributes to consistently poor Grade 12 learner performance and South Africa's low rankings in international science assessments (DBE, 2011; Howie, 1997). In such settings, subject advisors are expected to play a transformative role in enhancing teaching and learning outcomes. However, their effectiveness is often constrained by systemic issues such as limited access to resources, overwhelming workloads, and inadequate professional preparation for the complex demands of their roles (Sithole, 2020).

Sithole (2020) further indicates that the academic background and access to teaching aids significantly affect subject advisors' capacity to provide curriculum leadership and instructional support. In response to these challenges, the KwaZulu-Natal DBE, in collaboration with a local university, initiated a multi-disciplinary teacher professional development programme. Within the Life Sciences component of this initiative, university lecturers and subject advisors partnered to support teachers with content-rich methodologies and practical work strategies aimed at improving learner achievement. While the lecturers' responsibilities were clearly defined mainly focusing on the preparation of practical materials and content-based pedagogies, the specific role of the Life Sciences subject advisors in this collaborative arrangement remained vague. Preliminary observations suggest variation in their levels of involvement, which raises critical question "What is the perceived and enacted role of Life Sciences subject advisors in collaborative teacher professional development workshops?"

This paper addresses this key gap in literature by exploring how subject advisors perceive and enact their responsibilities within this partnership. The study contributes to a deeper understanding of how their involvement can be better defined, supported, and leveraged to enhance the impact of teacher professional development initiatives in rural contexts. By critically examining the intersection of subject advisory functions and university-led professional development, this study contributes to the discourse on sustainable teacher support frameworks in resource-constrained educational settings.

2. Literature review

This literature review focuses on two key areas: (i) the historical and policy foundations of subject advisory services, and (ii) the perceptions of subject advisors and their influence on curriculum implementation. These areas provide a contextual and theoretical basis for understanding the evolving roles of subject advisors within the context of teacher professional development.

2.1. Historical and policy perspectives on subject advisory services

The role of subject advisors has evolved significantly since the apartheid era in the South African context. In the former Transvaal Education Department (TED), formerly known as 'inspectors' had clearly defined roles and were actively involved in teacher monitoring, evaluation and promotion (TED, 1979). While this structure had its strengths in role clarity and teacher development, it also reflected a bureaucratic model deeply rooted in controlling teachers rather than capacitating and supporting them. By contrast, in the Department of Education and Training (DET), the advisory system was criticised for its inefficacy, lack of authority, and minimal engagement with teachers' real needs. Issues such as irregular visits, secrecy, and a compliance-driven appraisal system led to widespread mistrust between educators and subject advisors (ANC, 1994). However, towards the end of apartheid, attempts were made to re-define and re-imagine the role of subject advisors to focus on guidance and support rather than inspection and control (DET, 1993). As a result, emphasis was placed on teacher development, subject-expertise, curriculum support and innovation. Present policy frameworks such as the Integrated Strategic Planning Framework for Teacher Education and Development and Education of White Paper 6 now envision subject advisors as key agents in curriculum support, professional development, and stakeholder mediation (Jita & Mokhele, 2012; Bantwini, 2015). Nonetheless, the historical tension between supportive and supervisory roles continues to shape teacher perceptions and policy implementation in the present day. To overcome this legacy, it is essential to clearly define and communicate the supportive, developmental role of subject advisors in today's schooling system (Obi &Ticha, 2020).

2.2. Perceptions of subject advisors and their impact on curriculum implementation

The relationship between subject advisors and teachers plays a key role in the successful delivery of the curriculum. Teachers' perceptions of subject advisors often influence the uptake of their support. A study reported on (Sithole, 2020) suggests that while subject advisors provide guidance, many educators find themselves grappling with curriculum complexity, poor lesson planning skills, and lack of resources. These challenges necessitate a collaborative and sustained relationship between teachers and advisors (Obi & Ticha, 2020; Shozi, 2014). Research points (see: Sithole & Tachie, 2024; Shozi, 2014) out that the alignment between advisors and teachers determines the success of teaching and learning. Misalignment often leads to misunderstandings, resistance, and ineffective implementation. Thus, ongoing dialogue and trust-building between teachers and subject advisors are essential to support a shared understanding of curriculum expectations and practical delivery strategies (Obi & Ticha, 2020). Effective professional development requires meaningful collaboration between subject advisors and school-based leadership structures, such as departmental heads (Sithole & Tachie, 2024). Studies (e.g. Tatane,2014) have shown that while subject advisors are expected to provide continuous support, they often fail to meet the specific needs of teachers, especially in rural areas. Departmental heads report that the support received is generic and not sufficiently targeted to classroom realities (Sithole, 2020). Therefore, to enhance the quality of teaching and learning, collaboration between subject advisors, departmental heads, and other stakeholders

is critical, this the need for this study which begins to explore these collaborations and the roles played by each stakeholder and their impact.

3. Methodology

This qualitative study was framed within an interpretivist paradigm, which recognises that reality is constructed socially constructed and best understood through individual's subjective experiences (Creswell & Poth, 2018). Interpretivism was deemed suitable as it aligned with the choice of a qualitative multiple case study design used in this study. A multiple case study of two life science subject advisors from different districts enabled in-depth exploration of how they perceived and enacted their roles in a collaborative teacher PD workshop (Yin, 2018). The two Life Sciences subject advisors were purposively and conveniently sampled based on their official roles and active involvement in the PD workshops. The demographic information of the two participating subject advisors is presented in Table 1 below.

Table 1. Summary of the demographic information of the Life Sciences subject advisors.

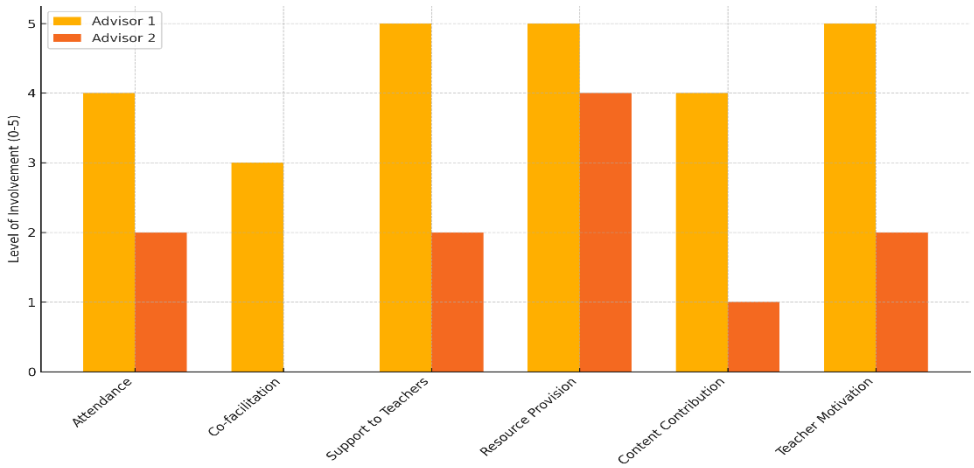
Attribute	**Subject Advisor 1**	**Subject Advisor 2**
Highest Qualification	Master's Degree	Pursuing PhD
Years of Experience	8 years	14 years
Number of Schools Overseen	45	50
District Performance	High-performing district	Lowest-performing district

A structured questionnaire was administered to the teachers at the end of the first year of the project. It consisted of six close-ended indicators which involved (i) Attendance (ii) Co-facilitation (iii) Support to Teachers (iv) Resource Provision (v) Content Contribution (vi)Teacher Motivation. All these indicators were informed by literature around the key roles of subject advisors. Each indicator was rated on a 0–5 scale (0 = Not Involved; 5 = Fully Involved). These scores were used to quantify and compare the level of involvement of each advisor. In addition, Semi-structured interviews were conducted with each advisor, lasting approximately one hour. The interviews focused on their perceptions, level of involvement, and challenges encountered in supporting teachers during the workshops. Supplementary data included observational field notes and researcher reflections, which helped contextualize the advisors' actions during workshops and their interactions with teachers and university facilitators. Thematic analysis (Braun & Clarke, 2006) was used to analyse interview data, while questionnaire results were presented using bar graphs to visually compare roles and levels of involvement. Ethical approval was granted by both the appropriate institutional ethical boards. All participants gave informed consent, and measures were taken to ensure their anonymity and confidentiality throughout the study.

4. Data analysis and findings

This section presents the findings emanating from the semi-interviews and questionnaires with two Life Sciences subject advisors who participated in a collaborative teacher PD project with a local university in Northern KwaZulu-Natal. The aim was to explore their perceptions of their roles and their levels of involvement in the project. Figure 1 below displays a comparative bar chart scoring each advisor's engagement across five categories: workshop attendance, co-facilitation, logistical support, teacher relationships, and content contribution on a 0–5 scale (where 0 = none; 5 = high involvement).

Figure 1. Comparison of subject advisors' levels of involvement in a collaborative workshop.



As shown above, **Subject Advisor 1** demonstrates high levels of engagement in most aspects of the teacher PD initiative. Subject advisor 1 attended most of the sessions (score of 4) and co-facilitated some of them (score of 3). His contributions were especially impactful in guiding teachers on the formulation of practical-based questions, addressing known teacher difficulties, and promoting scientific process skills. He also emphasised safety precautions and encouraged improvisation using available materials—practices aligned with curriculum standards for practical work in Life Sciences as revealed by his responses from the semi-structured interviews depicted on Table 2 below.

Table 2. Summary of subject advisor 1's perspectives regarding their roles in the teacher PD.

Themes	Advisor 1's responses during semi-structured interviews
Perceived Role	*"I see myself as both a mentor and a bridge between the university and our teachers."*
Teacher Support	*"I know these teachers. I know who needs help with planning, who struggles with assessments."*
Time Constraints	*"Sometimes I'm overwhelmed, but I try to be present. Even when I miss a day, I check in with the team."*
Content Contribution	*"After practicals, I remind them to frame questions—things like hypothesis, variables, safety, etc."*
Collaboration with Lecturers	*"I like that I'm learning too. The lecturers bring in fresh approaches, and I try to support that."*

From these findings, it is evident that subject advisor 1 went beyond logistical responsibilities by ensuring venues were properly equipped (e.g., projectors, sufficient furniture, and power access) and by regularly communicating with teachers via WhatsApp, where he shared materials, motivational messages, and reminders. These behaviors are reflected in his full scores for *Support to Teachers* (5), *Resource Provision* (5), *Teacher Motivation* (5), and a near-complete score for *Content Contribution* (4) as earlier depicted in Table 1 above.

In contrast, **subject advisor B** played a more limited role in the project. Although he also arranged venues and invited teachers (resulting in high attendance in his district of 50 schools), he seldom attended sessions and never co-facilitated. When he did attend, he often left before the end due to other work commitments. As such, his scores for Attendance (2), Co-facilitation (0), and Content Contribution (1) reflect a largely administrative engagement. The summary Table 3 below provides qualitative insights into his logistical support but also highlights a lack of active pedagogical involvement.

Table 3. Summary of subject advisor 2's perspectives regarding their roles in the teacher PD.

Themes	Advisor 2's responses during semi-structured interviews
Perceived Role	*"Mostly I'm handling logistics—venues, circulars. I haven't really had time to get involved in sessions."*
Teacher Support	*"They know I'm there if they need something, but I haven't had the chance to get into teaching aspects."*
Time Constraints	*"It's not that I don't want to attend—there's just too much on my plate at work."*
Content Contribution	*"I read the reports afterward, but I haven't co-facilitated any content myself."*
Collaboration with Lecturers	*"The lecturers are doing a great job. I just wish I had more time to be part of the actual sessions."*

In summary, the contrasting findings between the two advisors emphasise how meaningful engagement achieved through co-facilitation, tailored content input, and personal interaction with teachers can elevate the effectiveness of professional development activities.

4. Discussion of the findings, recommendations and conclusions

To answer the key guiding research question of "What is the perceived and enacted role of Life Sciences subject advisors in collaborative teacher professional development workshops?" The analysis indicates that the role of Life Sciences subject advisors in collaborative teacher PD workshops is multifaceted and varies. The roles encompass (i) logistical coordination, (ii) instructional support, and (iii) emotional encouragement. The findings suggest that subject advisors' roles in collaborative teacher PD workshops are shaped by both structural conditions (e.g., district demands, workloads, time constraints) and personal professional commitment to supporting teacher learning. The key findings highlight that while logistical tasks such as arranging venues and sending circulars are essential for ensuring teacher participation, they are insufficient on their own to build sustained teacher capacity. Subject advisor 1's more active role resulted in stronger connections with teachers and likely contributed to a deeper uptake of workshop content, particularly in improving practical work competencies. Thus, revealing that the impact

of PD workshops is significantly enhanced when subject advisors take on a more pedagogical and supportive role, working alongside university lecturers. Therefore, it is recommended that future projects clearly define and support the active instructional role of subject advisors, reduce conflicting responsibilities during PD sessions, and intentionally involve advisors in planning and facilitation. In under-resourced contexts especially, enabling subject advisors to engage more deeply can strengthen the relevance, uptake, and sustainability of teacher PD efforts. Thus, calling for targeted ongoing discussions between the university and the DBE to find better ways of integrating subject advisors as co-facilitators in teacher professional learning.

References

Bantwini, B. D. (2015). How teachers perceive the new curriculum reform: Lessons from a school district in the Eastern Cape Province, South Africa. *International Journal of Educational Development, 41*, 304-310.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). Thousand Oaks, CA: Sage Publications.

Department of Basic Education. (2011). *Report on the National Senior Certificate Examination: 2011*. Pretoria: Department of Basic Education.

Department of Education and Training (DET). (1993). *A New Direction: An Overview of Educational Reform in South Africa*. Pretoria: DET.

Howie, S. J. (1997). *Mathematics and science performance in the middle school years in South Africa: A summary report on the performance of the South African students in the Third International Mathematics and Science Study (TIMSS)*. Pretoria: Human Sciences Research Council.

Jita, L. C., & Mokhele, M. L. (2012). When teacher clusters work: Selected experiences of South African teachers with the cluster approach to professional development. *South African Journal of Education*, *32*(2), 190-203.

Obi, U. N., & Ticha, I. K. (2020). Involvement of teachers and subject advisers in the curriculum development process in South Africa: Evidence from the Fort Beaufort Education District in Eastern Cape. *Gender & Behaviour*, *18*(4), 16551-16566.

Shozi, A. B. (2014). *The role of subject advisors in supporting teaching and learning in selected schools of KwaZulu-Natal* (Unpublished Master's thesis, University of KwaZulu-Natal, Durban).

Sithole, S. (2020). An evaluation of the effectiveness of curriculum delivery support programmes rendered by subject advisors. *Journal of Contemporary Issues in Education, 15*(1), 56-72.

Sithole, S., & Tachie, S. A. (2024). Enhancing teacher development through subject advisor support in South African schools. *International Journal of Educational Sciences, 40*(2), 120-132.

Tatane, R. M. (2014). *An investigation of the role of subject advisors in improving the quality of education in South African schools* (Unpublished Master's dissertation, University of the Free State, Bloemfontein).

Transvaal Education Department (TED). (1979). *Annual report of the Inspectorate: Transvaal Education Department*. Pretoria: TED.

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Thousand Oaks, CA: Sage Publications.

THE IMPACT OF DISASTER ON EDUCATION: UNDERSTANDING LOSS AND PATHWAYS TO RECOVERY

Lee Ann Rawlins Williams
University of North Dakota (USA)
PhD, CRC, CFLE

Abstract

Disasters—both natural and human-made—disrupt educational systems in profound and enduring ways. Beyond the immediate damage to physical infrastructure, these events generate far-reaching psychological, social, and institutional challenges that hinder the continuity and quality of education. This paper examines the multifaceted impact of disasters on education, with a particular focus on the concept of loss extending beyond material resources to include emotional, developmental, and relational dimensions affecting both students and educators. The erosion of routine, stability, and educational access contributes to widening disparities in learning outcomes, especially among vulnerable populations. Central to post-disaster educational recovery is the recognition of loss as a critical element in building resilience. Acknowledging the trauma experienced by students, teachers, and communities enables more responsive and sustainable recovery strategies. This study explores key components of understanding the scope of loss, understanding the impact of educational disruption in the wake of global disaster and importance of a framework of preparedness and resilience in time of disaster or crisis. In addition, the paper highlights the significance of interventions and interdisciplinary collaboration in restoring educational stability. Drawing from a review of global literature and case studies in disaster-affected regions, it identifies effective models that integrate social-emotional learning, mental health resources, and multi-tiered systems of support (MTSS) focused on educators. These findings underscore the necessity of a proactive, scalable approach that prepare educators at all levels to navigate both immediate disruptions and long-term consequences of crisis.

Keywords: *Disaster recovery, educational resilience, loss and trauma, mental health in education, policy adaptation.*

---

1. Introduction

Disasters, both sudden and prolonged, have an undeniable impact on educational systems worldwide (UNDRR, 2022). From wildfires in California to earthquakes in Myanmar, heatwaves in Bangladesh, and floods in Sri Lanka, disasters continue to destabilize education systems across both high- and low-resource contexts. Education is often an overlooked casualty as its disruption affects not only infrastructure but also the emotional and professional well-being of those within it. This paper offers a comprehensive analysis of how such crises impact learning environments and makes a case for embedding disaster preparedness into national and global education strategies. Central to this approach is emerging work on educator mental health and self-care, including a Multi-Tiered System of Supports for Teachers (MTSS-T). Case studies such as the 2025 Los Angeles wildfires are used to highlight the layered dimensions of loss experienced by educators and students alike. These cases underscore the urgent need for educational systems worldwide to be both compassionate and resilient in the face of crisis. To guide these efforts, the paper outlines key components of a preparedness and resilience framework, including mental health support, trauma-informed pedagogy, adaptive policy design, and flexible learning infrastructure.

2. Methodology

This paper is based on a comprehensive review of the literature related to disaster impacts on education, teacher mental health, and global educational resilience. The review followed an integrative literature review methodology, enabling synthesis across empirical, theoretical, and policy-oriented sources. The databases searched included ERIC, PsycINFO, Scopus, JSTOR, and Google Scholar, and

search terms included combinations and variations of "disaster and education," "teacher mental health," "school recovery post-disaster," "trauma-informed pedagogy," "MTSS," and "global education resilience."

The inclusion criteria included: (a) peer-reviewed articles published from 2000 to 2024; (b) international reports and white papers from agencies such as UNESCO, UNICEF, WHO, and the World Bank; and (c) qualitative and quantitative studies involving teachers and schools impacted by disaster. Exclusion criteria eliminated studies not addressing K-12 or higher education contexts or those that lacked focus on educator perspectives.

Over 120 documents were initially reviewed, and a final sample of 62 sources were selected based on relevance and methodological rigor. Data were synthesized to identify recurring themes and recommendations, which were then organized around three key domains: (1) the psychological and institutional dimensions of loss; (2) effective recovery and preparedness strategies; and (3) the emerging need for tiered, educator-focused support systems like the MTSS model. This method enabled a broad yet critically informed understanding of the current challenges and opportunities for global disaster-responsive education, policy, and practice.

3. Discussion

The impact of disasters on education is multifaceted, with consequences that stretch far beyond damaged buildings and disrupted academic calendars (Hebebci, 2023). At the core lies a profound and often under-recognized experience of loss felt deeply by students, educators, and entire communities (Williams, 2025a). This discussion section explores key dimensions of that loss. It draws upon both local and global impact, to illustrate the layered and recurrent nature of disaster-related educational disruption. Finally, it considers what an effective response might entail, proposing a proactive, scalable framework grounded in mental health supports, trauma-informed practice, and policy flexibility. Together, these components frame an urgent call for education systems to prepare not only for recovery, but for sustained resilience in the face of future disaster and crisis.

3.1. Understanding the scope of loss

Loss in education during disasters goes beyond the physical destruction of school infrastructure (Patel, 2024). It encompasses emotional, cognitive, and social losses that affect both students and teachers. The absence of daily routines, the displacement of families, and the interruption of developmental milestones compound the trauma. Teachers experience a dual form of loss; (1.) the personal impact of the disaster itself, and (2.) the professional challenge of supporting students through their own grief and instability (Gunawardena et al., 2024). Despite their central role in school recovery, this layered experience of educator loss remains insufficiently acknowledged in both disaster policy and educational planning.

Educator well-being is increasingly recognized as a cornerstone of educational resilience in the face of disaster, crisis, or disruption (Jimenez, 2021). Without proper support, teachers are more likely to experience burnout, stress, and attrition that can destabilize classrooms and interrupt the recovery process. These trends have been documented across global contexts, with recent studies identifying consistent patterns of emotional strain and systemic breakdown following crises (Agyapong et al., 2023; Doan et al., 2024; Reinke et al., 2025). Additionally, Williams (2025b) developed the Multi-Tiered System of Supports for Teachers (MTSS-T), a framework designed to address the unique needs of educators during times of disruption. By focusing on educator resilience as a key component of recovery, teacher support is reframed as a structural necessity rather than an optional supplement. Ultimately, understanding and responding to the scope of loss (emotional, cognitive, and professional) is not just about helping individuals recover. It is about preserving the continuity, quality, and humanity of education in the wake of disaster.

3.2. Educational disruption in the wake of global disasters

The January 2025 wildfires in Los Angeles, California, USA offer a compelling and current case study. These fires led to the closure of at least 19 school districts, including the Los Angeles Unified School District (LAUSD), which suspended operations due to fire threats and the destruction of two elementary schools. The Palisades Fire destroyed nearly 2,000 structures, including Palisades Charter Elementary School, resulting in the relocation of students and staff. Meanwhile, the Las Virgenes Unified School District shut down multiple campuses in active evacuation zones, and UCLA shifted to online learning through mid-January. The Mountain Fire in Ventura County, which began in late 2024 and intensified in early 2025, added further strain by forcing school closures, mass evacuations, and additional loss of community infrastructure. These events exemplify the compounding impact natural disasters have on education: destruction of facilities, interrupted learning, disrupted routines, and heightened psychological distress among educators and students.

Similar patterns have emerged around the globe in recent years. In March 2025, a powerful 7.7-magnitude earthquake struck Myanmar, killing over 1,600 people and causing significant damage to schools, highlighting how both trauma and infrastructure loss disrupt learning continuity (Rathi, 2025). In April 2024, Bangladesh faced an extreme heatwave that led to the closure of schools nationwide, affecting approximately 33 million children and underscoring the impact of climate-related events on educational access (Sarkar, 2024). Likewise, in May and June 2024, monsoon flooding in Sri Lanka resulted in school closures and the displacement of thousands of students (Phys Org, 2024), while the March 2024 earthquake in Papua New Guinea forced 86 schools to suspend classes indefinitely due to damage and safety concerns (PNG Education News, 2024).

These global cases illustrate the urgency of addressing disaster preparedness in education (Fu & Zhang, 2024; Guo, et al., 2025; Harris, et al., 2024. In regions already burdened by economic hardship, disasters compound existing inequities and limit recovery. The psychological effects of educational disruption specifically in low-resource settings where access to mental health support and infrastructure repair is limited are profound (Badger, et al., 2024; Mazrekaj & DeWitte, 2023). These examples reinforce the critical need for internationally informed, cross-sector collaboration to build resilient education systems capable of both mitigating the impacts of future crises and supporting recovery in the wake of loss.

3.3. Toward a framework of preparedness and resilience

Given the increasing frequency, intensity, and complexity of disasters worldwide, it is no longer effective for educational systems to focus solely on post-crisis recovery. Instead, nations must consider proactive, education-centered disaster preparedness frameworks that embed resilience-building at every level of schooling. These frameworks should be guided by both global best practices and local contextual needs, integrating mental health, pedagogy, infrastructure, and policy into a cohesive and responsive system.

Key components of such a framework include:

- **Mental health support systems** that are embedded within school environments and accessible to both students and educators before, during, and after a crisis.
- **Integration of trauma-informed pedagogy** into teacher training and curriculum development to ensure educators are equipped to respond to the emotional and cognitive needs of learners affected by trauma.
- **Multi-tiered systems of support (MTSS)** for both students and educators, which offer differentiated interventions based on levels of need.
- **Flexible learning modalities**, including remote and hybrid options, extended lesson assignments, asynchronous instruction, and alternative assessment strategies, that enable educational continuity during periods of displacement, infrastructure loss, or prolonged disruption.
- **Sustained investment in crisis training and recovery planning** at the school and district levels, tailored to regional hazards and risks.

While many of these elements have been piloted or implemented for student populations, there remains a significant gap in targeted supports for educators themselves particularly in the aftermath of disaster. To address this need, the Multi-Tiered System of Supports for Teachers (MTSS-T), developed by Williams (2025b), provides a groundbreaking approach. This model extends the MTSS framework specifically to the educator workforce, offering tiered, responsive universal and individualized supports designed to enhance coping, reduce burnout, and increase workforce stability. MTSS-T includes universal strategies for promoting wellness, targeted supports for those showing early signs of stress, and intensive interventions for those with significant intervention needs.

By prioritizing the well-being of educators, MTSS-T recognizes teachers as frontline responders in educational recovery and agents of stability for entire school communities (Williams, 2024). Embedding this model within disaster preparedness frameworks supports recovery efforts as a holistic process including emotional and professional needs of the individuals who hold educational systems together.

Educational institutions, when equipped with the right tools and supports, are not merely sites of vulnerability, they are engines of resilience (Borazon & Chuang, 2023). With thoughtful investment and implementation, schools can become anchors of continuity, healing, and community cohesion in times of crisis. Incorporating these components into national and international education policy can help shift disaster response from reactive to anticipatory. Rather than viewing schools solely as sites of vulnerability, this framework positions them as strategic hubs for community stabilization and recovery. When supported by coordinated funding, training, and policy alignment, educational institutions can serve as pillars of resilience and spaces that foster connection, rebuild routine, and provide psychosocial scaffolding to entire communities.

Ultimately, acknowledging the layered dimensions of loss (emotional, institutional, and pedagogical) is essential to driving meaningful and lasting reform. By embedding preparedness and resilience into the core of educational systems, nations can safeguard the continuity of teaching and learning, not only during times of stability but also amid disruption and crisis.

4. Conclusion

As disasters increasingly challenge the stability of educational systems, resilience and preparedness must become guiding principles for the future of education. True recovery extends beyond rebuilding. It requires intentional investment in the people who sustain learning, especially educators. Their well-being is not secondary, but foundational. By adopting proactive models, education systems can continue to shift from reactive crisis management to sustained, responsive care. Embedding emotional recovery, professional support, and adaptive structures into educational planning ensures that learning can endure, and potentially lead, in the face of disruption. Resilience is not built after the storm, but begins with preparedness.

References

Agyapong, B., Brett-MacLean, P., Burback, L., Agyapong, V. I. O., & Wei, Y. (2023). Interventions to Reduce Stress and Burnout among Teachers: A Scoping Review. *International Journal of Environmental Research and Public Health*, *20*(9), 5625. https://doi.org/10.3390/ijerph20095625

Badger, J. R., Holst, C. G., Thompson, P., et al. (2024). Effects of educational disruption and changes in school context on children's mental health: Associations with school level disadvantage and individual bullying involvement. *British Educational Research Journal, 50*(5), 2300-2319. https://doi.org/10.1002/berj.4022

Borazon, E. Q. & Chuang, H.bH. (2023). Resilience in educational system: A systematic review and directions for future research. *International Journal of Educational Development, 99,* 102761. https://doi.org/10.1016/j.ijedudev.2023.102761

Doan, S., Steiner, E. D., & Pandey, R. (2024). Teacher well-being and intentions to leave in 2024: Findings from the 2024 State of the American Teacher survey. *RAND Corporation*. https://doi.org/10.7249/RRA1108-12

Fu, Q. & Zhang, X. (2024). Promoting community resilience through disaster education. *PLOS One*. https://doi.org/10.1371/journal.pone.0296393

Gunawardena, H., Leontini, R., Nair, S., et al. (2024) Teachers as first responders: classroom experiences and mental health training needs of Australian school teachers. *BMC Public Health, 24*, Article 268. https://doi.org/10.1186/s12889-023-17599-z

Guo, L., Fang, M., Liu, L., et al. (2025). The development of disaster preparedness education for public: a scoping review. *BMC Public Health, 25*, Article 645. https://doi.org/10.1186/s12889-025-21664-0

Harris, C., O'Neal, P., & Taylor, M. (2024). The Urgent Need for Disaster Education as a Core Competency in Accredited Schools and Colleges of Public Health by the Council on Education for Public Health. *Disaster Medicine and Public Health Preparedness*, *18*, e199. doi:10.1017/dmp.2024.274

Hebebci, M. T. (2023). The impact of natural disasters on education. In *Proceedings of the International Conference on Social Science Studies (IConSoS)*. Retrieved from https://www.researchgate.net/publication/375238926_The_Impact_of_Natural_Disasters_on_Education

Jimenez, E. C. (2021). Impact of mental health and stress level of teachers in learning resources development. *Shanlax International Journal of Education, 9*(2), 1-11. https://www.shanlaxjournals.in/journals/index.php/education/article/view/3702

Mazrekaj, D., & De Witte, K. (2023). The impact of school closures on learning and mental health of children: Lessons from the COVID-19 pandemic. *Perspectives on Psychological Science*, *19*(4), 686-693. https://doi.org/10.1177/17456916231181108

Patel, R. B. (2024). Impact of natural calamities on education. In *Proceedings of the International Conference on Disaster Resilience* (pp. 45-58). IIP Publishing.

Phys.org. (2024). *Sri Lanka monsoon floods kill 14, schools shut*. Retrieved from https://phys.org/news/2024-06-sri-lanka-monsoon-schools.html

PNG Education News. (2024). Schools suspend classes indefinitely in East Sepik. *PNG Facts*. https://edu.pngfacts.com/news/schools-suspend-classes-indefinitely-in-east-sepik

Rahaman Sarkar, A. (2024). Schools shut for 33 million children as intense heatwave sweeps Bangladesh. *The Independent*. https://www.independent.co.uk/asia/south-asia/bangladesh-heatwave-schools-shut-b2326789.html

Rathi, A. (2025). Deadly 7.7 Magnitude Earthquake Rocks Myanmar. *Foreign Policy*. https://foreignpolicy.com/article/deadly-earthquake-myanmar

Reinke, W. M., Herman, K. C., Stormont, M., & Ghasemi, F. (2025). Teacher stress, coping, burnout, and plans to leave the field: A post-pandemic survey. *School Mental Health*. https://doi.org/10.1007/s12310-024-09738-7

United Nations Office for Disaster Risk Reduction. (2022). *The invisible toll of disasters*. Retrieved from https://www.undrr.org/explainer/the-invisible-toll-of-disasters-2022

Williams, L. A. (2024). Students do better and schools are more stable when teachers get mental health support. *The Conversation*. Retrieved from https://theconversation.com/students-do-better-and-schools-are-more-stable-when-teachers-get-mental-health-support-219071

Williams, L. A. (2025a). What Los Angeles-area schools can learn from other districts devastated by natural disasters. *The Conversation*. Retrieved from https://theconversation.com/what-los-angeles-area-schools-can-learn-from-other-districts-devastated-by-natural-disasters-247777

Williams, L. A. (2025b). *Reimagining educator support: A framework for a multi-tiered system to promote teacher well-being and mental health*. Manuscript submitted for publication at the END 2025 Conference.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

AI IN ECONOMICS AND FINANCE EDUCATION: INNOVATIONS, CHALLENGES AND FUTURE DIRECTIONS

Luis Enrique García Pérez*
Universidad de las Américas Puebla (Mexico)

Abstract

The integration of Artificial Intelligence (AI) into economics and finance teaching represents a transformative shift in pedagogical strategies, offering opportunities to enhance learning outcomes and institutional efficiency. This study explores the applications of AI tools, such as generative models and big data analytics, and personalized learning. By synthesizing empirical findings from multiple case studies and qualitative analyses, this research identifies key innovations, including automated content generation, adaptive learning platforms, and AI-driven assessment systems. These tools enable educators to address diverse student needs, streamline repetitive tasks, and foster critical thinking through real-world scenario simulations. However, the adoption of AI also presents significant challenges, such as algorithmic biases, data privacy concerns, and the risk of overreliance on technology diminishing human interaction. The study highlights the necessity of continuous teacher training to effectively integrate AI into pedagogical practices while maintaining ethical standards. Furthermore, institutional support, through updated infrastructure, interdisciplinary collaboration, and policy frameworks, is critical to overcoming barriers like technological inequity and resistance to change. The research employs a mixed-methods approach, combining literature reviews, surveys of educators, and practical implementations of AI tools in classroom settings. Results indicate an increase in AI adoption among educators when supported by structured training programs, alongside improved student engagement in complex topics like financial modeling and economic policy analysis. Case studies from universities in Mexico illustrate how AI can democratize access to advanced resources while fostering global competencies in students. In conclusion, AI serves as a complementary force in education, enhancing, not replacing, the role of educators. Strategic implementation, grounded in ethical considerations and pedagogical goals, can bridge gaps in traditional teaching methods and prepare students for a digitized economy. This study advocates for balanced innovation, emphasizing collaborative efforts between academia, policymakers, and technology providers to create sustainable, inclusive educational ecosystems.

Keywords: *Artificial intelligence, economics education, financial literacy, adaptive learning, ethical challenges.*

1. Artificial Intelligence in teaching economics and finance

Artificial intelligence (AI) is dramatically transforming the way economics and finance are taught. Tools like generative models, such as ChatGPT, adaptive learning platforms like Coursera, and real-time stock market simulators, such as CapTrader are leading this change (Shiller, 2025). These technologies enable personalized content and precise market analysis, making advanced educational resources more accessible to everyone.

This study arises from the critical need to analyze this duality. On one hand, tools like ChatGPT and stock market simulators have shown to increase student engagement in complex topics such as financial model analysis and economic policies. On the other hand, highly volatile and stressful financial phenomena reveal the limits of automation in uncertain contexts, where human judgment remains indispensable (Kasneci *et al.*, 2023).

This tension between technical capabilities and human limitations extends to classrooms: while universities with advanced infrastructure implement interactive simulations, others lack even the connectivity to access updated financial data. The relevance of this research lies in the debate over case studies, showing how hybrid strategies that combine adaptive AI with specialized tutoring can be effective, while also identifying risks such as reduced interaction between teachers and students.

* ORCID: https://orcid.org/0000-0002-1836-9709 ; email: enrique.garcia@udlap.mx

Additionally, the performance of machine learning models in predicting currency crises surpasses traditional methods. Studies from Meese and Rogoff (1983) to Bluwstein *et al.* (2020) show that techniques like neural networks and ensemble combining (Sermpinis *et al.*, 2019) better capture volatility in emerging markets. However, challenges remain algorithms do not fully incorporate factors such as international capital flows (Rey, 2015) or global monetary policies (Miranda-Agrippino and Rey, 2020), and their effectiveness varies across market regimes.

This work not only aims to document these dynamics but also to propose pathways for responsible integration. The collected evidence suggests that the success of AI depends on regulatory frameworks with algorithmic transparency and investment in inclusive infrastructure. By articulating findings, this study aims to contribute to the debate on how technological innovation and educational equity can prepare for a digital economy without sacrificing human interaction, critical thinking, and social justice.

2. AI in teaching economics and finance: Asymmetries, ethical challenges and tensions

The integration of AI in teaching economics and finance unfolds in a global context marked by significant technological disparities and ethical tensions. In Mexico, this duality is evident: while institutions like Tecnológico de Monterrey invest over $2 million in specialized laboratories (Tec Review, 2023), 23% of rural areas lack internet access, and only 34% of their inhabitants have connectivity compared to 68% in urban areas (INEGI, 2023). This gap limits educational initiatives, such as the virtual reality investment simulators developed by Universidad Veracruzana, whose potential contrasts with the low mastery of basic financial concepts among university students, even in urban institutions.

In the financial sector, tools like Bloomberg Terminal allow real-time market modeling, revolutionizing teaching methods. However, their adoption coexists with structural barriers: platforms like Kueski exhibit algorithmic biases that discriminate against women in marginalized municipalities (CONEVAL, 2023). Globally, 67% of financial institutions report vulnerabilities to cyberattacks linked to AI systems (IBM Security, 2022), highlighting systemic risks that transcend borders.

Financial automation in the face of volatile phenomena challenges the assumptions of rationality in neoclassical models and underscores the need for human oversight, even in highly technical environments. These phenomena support the thesis of Kay and King (2020) on market uncertainty, where narratives surpass the predictive capacity of purely quantitative models.

Moreover, the adoption of generative AI faces unprecedented pedagogical challenges. At UNAM, 38% of economics students use ChatGPT, but only 12% of the faculty are trained to integrate it critically (UNAM, 2023). UNESCO establishes three pillars for the ethical development of AI in education: universal access, permanent human supervision, and continuous impact assessment (Vázquez, 2021).

Interventions in schools, combining adaptive AI with specialized tutoring, improve outcomes, demonstrating that technology acts as an amplifier rather than a substitute for educational processes (Lara *et al.*, 2024). However, risks such as a 67% reduction in interactions between teachers and students are identified (ANUIES, 2023). These findings emerge from a mixed-methods design that combines:

The equitable implementation of AI in economic and financial education requires balancing four key dimensions:

1. Inclusive Infrastructure: Projects should prioritize not only connectivity but also access to devices and teacher training, bridging gaps between elite institutions and marginalized communities.
2. Algorithmic Transparency: Develop regulatory frameworks to audit biases and enforce ethical standards in the use of sensitive data.
3. Hybrid Pedagogy: Combine AI tools with specialized tutoring.
4. Global Collaboration: Promote partnerships between academia, industry, and governments to harmonize policies that balance innovation and stability.

This framework not only validates the transformative potential of AI but also outlines critical pathways for its responsible adoption, where technology enhances rather than replaces human capabilities in training future economists and financiers.

3. Pedagogical, technological and ethical integration of AI in teaching

The implementation of AI in teaching economics and finance is based on three interdependent theoretical pillars that combine technological innovation, pedagogical principles, and ethical standards. These pillars address the challenges and opportunities, providing a conceptual framework to analyze its impact on higher education.

- **Pedagogical Dimension: Adaptive Learning**

The adaptive learning theory of Moloi and Marwala (2020) supports the design of platforms like CapTrader, which personalize content according to the individual progress of students. This approach aligns with constructivist principles, where tools like interactive simulations allow students to experiment with abstract economic concepts, such as modeling fiscal policies in Python. Platforms like iTalk2Learn integrate curriculum domain models and pedagogical strategies, achieving a 27% improvement in conceptual retention by applying the growth mindset theory of Dweck (2006).

- **Technological Dimension: Generative Models and Automation**

Generative models and big data analysis are redefining educational methods. Systems like FearNot! (Vannini *et al.*, 2011) use virtual agents to simulate complex social interactions, while neuroeducation (Howard-Jones, 2014) validates how gamification with uncertain rewards increases intrinsic motivation. However, these advances contrast with theoretical limitations in economics: while the neoclassical approach of Samuelson (1947) assumes rationality and efficient markets, behavioral economics by Hens and Riege (2016) shows that 95% of financial decisions are based on subjective perceptions. This theoretical conflict explains phenomena like the 2010 Flash Crash (Kay and King, 2020), where algorithms amplified stock market crashes, highlighting that AI cannot handle radical uncertainty without human intervention.

- **Ethical Dimension: Biases, Privacy, and Governance**

Ethics emerges as a critical axis. Studies like those by Hernández *et al.* (2023) reveal how algorithms on platforms replicate discriminatory biases, while financial institutions report cyberattacks. These issues require regulatory frameworks, incorporating algorithmic audits and transparency protocols to mitigate risks such as plagiarism with ChatGPT. Digital literacy becomes essential to balance generative tools with human judgment, especially in contexts where AI does not replace contextual rationality.

4. Practical applications in financial markets

Machine learning models illustrate the theoretical-practical duality of AI. Techniques such as Random Forest and Gradient Boosting (Bluwstein *et al.*, 2020) outperform traditional methods in predicting currency crises. However, their effectiveness varies according to market regimes and does not fully incorporate macroeconomic factors such as international capital flows (Rey, 2015) or global monetary policies (Miranda-Agrippino and Rey, 2020). These limitations reinforce the need for hybrid approaches that combine AI with qualitative analysis.

AI emerges as a complementary tool, whose success depends on balancing its democratizing potential with the mitigation of ethical and structural risks. This theoretical framework increased student participation, resistance to change in outdated institutions, and also outlines a critical path for responsible implementations:

- Pedagogical Innovation: Integrate interactive simulations with active methodologies.
- Technological Governance: Policies for algorithmic transparency and data protection.
- Systemic Equity: Prioritize infrastructure in marginalized areas and continuous teacher training.

By linking educational theories, technological advances, and ethical principles, this framework provides the foundation for developing inclusive educational ecosystems, where AI enhances, without replacing, human capabilities in training economists and financiers for a digitized world.

5. Evaluation of the impact of AI in teaching economics and finance

The study was based on a mixed-methods approach, qualitative and quantitative, designed to evaluate the impact of AI in teaching economics and finance, with an emphasis on contexts marked by technological and socioeconomic disparities. The design proposal allowed for the integration of empirical and theoretical perspectives, addressing three critical dimensions: pedagogical (effectiveness of tools like stock market simulators), technological (performance of predictive models like Random Forest and Gradient Boosting), and ethical (identification of algorithmic biases and cybersecurity risks). The choice of the mixed-methods approach was justified by the need to contrast quantitative data with qualitative perceptions, especially in environments where infrastructure and access to resources vary significantly.

Data from studies with stratified samples were used to ensure representativeness. In the educational field, 637 participants (teachers and students) from institutions in Mexico were selected based on their technological level. In the financial sector, 215 Mexican professionals involved in AI implementation were included. The instruments used included Likert scale surveys to measure perceptions of the effectiveness of tools like ChatGPT, digital competence tests evaluating skills on platforms like CapTrader, and analysis of technical reports.

In the quantitative component, robust regressions (Majjate *et al.*, 2024) were applied to quantify teacher adoption associated with AI training. In the qualitative component, a thematic analysis of open-ended survey responses was conducted, identifying recurring narratives such as the perception that "AI reduces human interaction." Additionally, case studies of hybrid projects in rural Mexican areas (Lara *et al.*, 2024) were reviewed, triangulating these findings with quantitative data to ensure consistency.

Ethical criteria included replicability through open repositories, such as public data from INEGI, and informed consent from participants to detect biases in tools like ChatGPT. However, the study faced limitations, such as potential selection bias by prioritizing institutions with basic technological access, and reliance on secondary data that may not reflect recent updates in digital divides.

6. Interpretation of findings

The results revealed a dual landscape. Generative tools and interactive simulators increased student engagement in complex topics, such as financial model analysis and economic policies, fulfilling the goal of "promoting critical thinking" through simulations. The learning and prediction capabilities of machine learning models support the idea of AI's potential to "prepare students for a digitized economy."

Structural and Ethical Challenges:

- Technological Gaps: Lack of internet access limits initiatives like the virtual reality simulators, reflecting "resistance to change in institutions with outdated infrastructure."
- Operational Risks: The constant risk of cyberattacks on financial and educational institutions that compromise user data.

7. Pedagogical tensions

- Excessive automation reduced teacher-student interactions by 67% (ANUIES, 2023).
- Only 12% of the economics faculty at UNAM are trained to critically integrate tools like generative models (UNAM, 2023), highlighting the need for "continuous teacher training."

Based on the findings, strategic implementation pathways are proposed:

1. Hybrid Pedagogy: Combine adaptive AI with human tutoring, replicating the approach of "personalized learning."
2. Ethical Governance: Develop regulatory frameworks with algorithmic transparency to mitigate biases and protect sensitive data.
3. Technological Inclusion: Prioritize projects that provide connectivity, access to devices, and teacher training, bridging gaps between institutions.
4. Global Collaboration: Promote partnerships between academia, industry, and governments, realizing multisectoral collaboration.

8. Conclusions

AI is established as a transformative tool in economic and financial education, demonstrating its ability to improve learning outcomes and institutional efficiency. The findings validate that tools like generative models and stock market simulators increase student engagement when accompanied by structured teacher training, fulfilling the goal of optimizing pedagogical processes through AI. However, risks are confirmed: excessive automation reduces human interactions, and technological gaps limit its democratic reach.

While AI democratizes advanced resources such as simulations with real data, financial platforms replicate biases, highlighting "ethical challenges." On the other hand, machine learning models improve financial predictions, though the need for supervision in the face of uncertainty is emphasized. Additionally, partnerships between universities and the private sector should translate into multidisciplinary audits and adaptive frameworks that prepare students for a digitized economy without sacrificing human interaction.

Longitudinal studies are required to evaluate medium-term impacts that measure not only statistical accuracy but also effects on critical thinking. This responds to the call for creating "sustainable and inclusive educational ecosystems," where AI enhances rather than replaces human capabilities.

The responsible implementation of AI in education is not merely a technical challenge but a social one. We emphasize that its success depends on prioritizing equity, ethics, and global collaboration, ensuring that technology serves as a bridge rather than a barrier to a more just and digitally competent society.

References

ANUIES. (2023). *Estado actual de las tecnologías 2023*. ANUIES. Retrieved from: https://publicaciones-tic.anuies.mx/descargas/2023/libros/Estado_Actual_Tecnolog ias_2023.pdf

Bluwstein, K., Buckmann, M., Joseph, A., Kang, M., Kapadia, S., & Simsek, Ö. (2020). Credit growth, the yield curve and financial crisis prediction: evidence from a machine learning approach. *Bank of England Staff Working Paper No. 848*. Retrieved from: https://www.bankofengland.co.uk/working-paper/2020/credit-growth-the-yield-curve-and-financial-crisis-prediction-evidence-from-a-machine-learning

CONEVAL. (2023). *Informe de Enfoque de Resultados 2023*. Retrieved from: https://www.coneval.org.mx/coordinacion/Documents/monitoreo/informes/Informe_EdR_2023.pdf

Dweck, C. S. (2006). *Mindset: The new psychology of success*. Random house.

Hens, T., & Riege, M. (2016). *Financial economics: A concise introduction to classical and behavioral finance*. Springer.

Hernández, R., Rentería, J., & Cervantes, G. (2023). La Educación Financiera de los Estudiantes Universitarios de Contaduría Pública: un Estudio de Caso. *Ciencia Latina Revista Científica Multidisciplinar, 7*(6), 1330-1343. https://doi.org/https://doi.org/10.37811/cl_rcm.v7i6.8769

Howard-Jones, P., Holmes, W., Demetriou, S., Jones, C., Tanimoto, E., Morgan, O., & Davies, N. (2014). Neuroeducational research in the design and use of a learning technology. *Learning, Media and Technology, 40*(2), 1-20.

IBM Security. (2022). *Reporte anual de amenazas cibernéticas en educación*. Retrieved from: https://latam.newsroom.ibm.com/2022-02-23-Reporte-IBM-ransomware-persistio-como-el-tipo-mas-comun-de-ataque-en-America-Latina-en-2021

INEGI. (2023). *Encuesta Nacional de Ingresos y Gastos de los Hogares 2020*. Retrieved from: https://www.inegi.org.mx/contenidos/productos/prod_serv/contenidos/espanol/bvinegi/productos/nueva_estruc/889463918189.pdf

Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., & Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences, 103*, 1-9.

Kay, J., & King, M. (2020). *Radical Uncertainty: Decision-Making Beyond the Numbers*. WW Norton.

Lara Serna, L., Sosa Morales, E., Lara Menéndez, A., & Hernández González, D. F. (2024). *Educación financiera en universidades mexicanas: Desafíos y oportunidades de mejora a través de la tecnología*. Universidad Veracruzana. https://doi.org/10.37811/cl_rcm.v8i3.12253

Majjate, H., Bellarhmouch, Y., Jeghal, A., Yahyaouy, A., Tairi, H., & Zidani, K.A. (2024). AI-Powered Academic Guidance and Counseling System Based on Student Profile and Interests. *Applied System Innovation, 7*(1), 6. https://doi.org/10.3390/asi7010006

Meese, R. A., & Rogoff, K. (1983). Empirical exchange rate models of the seventies: Do they fit out of sample? *Journal of International Economics, 14*(1-2), 3-24. https://doi.org/10.1016/0022-1996(83)90017-X

Miranda-Agrippino, S., & Rey, H. (2020). U.S. monetary policy and the global financial cycle. *The Review of Economic Studies, 87*(6), 2754-2776. https://doi.org/10.1093/restud/rdaa019

Moloi, T., & Marwala, T. (2020). *Artificial Intelligence in Economics and Finance Theories*. Springer Nature Switzerland AG. https://doi.org/10.1007/978-3-030-42962-1_1

OpenAI. (2023). *ChatGPT*. Retrieved from: https://openai.com/chatgpt/overview

Rey, H. (2015). Dilemma not trilemma: The global financial cycle and monetary policy independence. *NBER Working Paper No. 21162*. https://doi.org/10.3386/w21162

Samuelson, P. A. (1947). Some implications of "Linearity.". *The Review of Economic Studies*, *15*(2), 88-90.

Sermpinis, G., Stasinakis, C., Theofilatos, K., & Karathanasopoulos, A. (2019). Modeling, forecasting and trading the EUR exchange rates with hybrid rolling genetic algorithms. *European Journal of Operational Research, 247*(3), 831-846. https://doi.org/10.1016/j.ejor.2015.06.052

Shiller, R. (2025). Mercados financieros. *Coursera*. Retrieved from: https://www.coursera.org/learn/financial-markets-global-es

Tec Review. (2023). *Reporte anual de innovación tecnológica*. https://hdl.handle.net/11285/651699

UNAM. (2023). *Recomendaciones para el uso de Inteligencia Artificial Generativa en la docencia*. Retrieved from: https://cuaed.unam.mx/descargas/recomendaciones-uso-iagen-docencia-unam-2023.pdf

Vannini, N., Enz, S., Sapouna, M., Wolke, D., Watson, S., Woods, S., & Aylett, R. (2011). "FearNot!": A computer-based anti-bullying programme designed to foster peer intervention. *European Journal of Psychology of Education, 26*(1), 21-44.

Vázquez Pita, E. (2021). La UNESCO y la gobernanza de la inteligencia artificial en un mundo globalizado. Anuario de la Facultad de Derecho. *Universidad de Extremadura, 37*, 273-302. https://doi.org/10.17398/2695-7728.37.273

ARTIFICIAL INTELLIGENCE IN SPECIAL EDUCATION: PERSPECTIVES FROM SOUTH AFRICAN SPECIAL NEEDS EDUCATORS

Thabiso Nkohli, Paseka Patric Mollo, & Lukanda Kalobo
Central University of Technology, Free State (South Africa)

Abstract

Artificial intelligence (AI) has the potential to revolutionise the education of students with special needs, but its implementation in South African special schools remains largely unexplored. This study addresses this gap by investigating the perceptions of special-needs educators regarding AI and its potential impact on their teaching practices and student outcomes. This paper is situated in the Unified Theory of Acceptance and Use of Technology (UTAUT) framework. A qualitative research methodology, consisting of individual interviews, was employed to explore educators' perceptions of AI in relation to their teaching and learning in special education. A purposive sample of five educators from a special school in South Africa was used to collect data. This research suggests that educators acknowledge AI's potential to enhance customised learning, alleviate administrative responsibilities, and increase instructional clarity. Nevertheless, barriers such as accessibility issues, inadequate training, infrastructure limitations, and ethical concerns hinder its widespread adoption. Moreover, socio-economic disparities across South African special schools exacerbate the digital divide, influencing educators' readiness to use AI. This paper further emphasizes the need for professional development that integrates AI within the context of governmental support and regulation, ensuring the inclusive and ethical use of AI in special education for individuals with special needs. The article concludes with strategies for leveraging AI in special needs education in South Africa.

Keywords: *Artificial Intelligence, special education, special needs educators, assistive technology, South Africa.*

1. Introduction

Inclusive education aims to provide equitable learning opportunities for all students, including those with disabilities, within traditional educational environments. In South Africa, this initiative is governed by the policies outlined in White Paper 6 (2001). However, its implementation faces several challenges, including limited resources, inadequate teacher training, and insufficient infrastructure. The integration of Artificial Intelligence (AI) with Assistive Technology (AT) holds the potential to offer innovative solutions to these obstacles. AI can facilitate contextualized educational experiences, develop adaptive assessment tools, and deliver immediate feedback, all of which can significantly enhance teaching practices. Assistive technologies, including screen readers, speech-to-text systems, and Braille devices, improve accessibility for students with disabilities. AI can transform special needs education by providing customized learning experiences, reducing administrative burdens, and clarifying instructional content. Nevertheless, funding constraints and a lack of adequate training for educators continue to hinder widespread implementation. Despite these challenges, ongoing initiatives and advancements in technology present promising opportunities to cultivate a more inclusive educational environment in South Africa.

The perspectives of special needs educators in South Africa are critically significant due to their deep understanding of the unique challenges and opportunities present within the nation's special education landscape. Considering the resource constraints and diverse learning needs that characterize many South African schools, the insights provided by these educators are essential for informing the effective implementation of artificial intelligence (AI) to address specific educational challenges and to foster inclusive learning environments. Additionally, an examination of these educators' perspectives can reveal potential ethical considerations and cultural nuances that may influence the acceptance and integration of AI within the context of special education in South Africa. By grasping the lived experiences and professional insights of educators, policymakers, and technology developers, they can make informed decisions that resonate with the needs and values of the South African educational community.

This understanding will enable all stakeholders to recognise the possibilities inherent in AI-driven personalized learning within educational institutions.

The increasing significance of AI literacy in contemporary society further underscores the need for comprehensive research on its integration into educational frameworks, as AI becomes increasingly intertwined with various facets of daily life, from credit assessments to medical advice (Rizvi, Waite, & Sentence, 2023). Therefore, fostering AI literacy among students is imperative to ensure their success in an increasingly AI-dominated society (Park et al., 2023). This involves equipping students with the capacity to critically evaluate AI technologies, communicate effectively with AI systems, and utilize AI as a functional tool across diverse contexts (Lalor, Lorenzi, & Rami, 2015). Furthermore, empowering students with a robust understanding of AI enables them to confront ethical dilemmas, make informed choices regarding its applications, and actively participate in shaping its future trajectory.

AI literacy encompasses a foundational understanding of AI concepts and methodologies, enabling individuals to distinguish between technologies that utilise AI and those that do not (Otero et al., 2023). Additionally, it empowers individuals to critically assess the quality of data utilized in training AI systems and to evaluate the outcomes and recommendations produced by such systems. By fostering AI literacy, students gain the ability to comprehend the broader societal implications of AI technology while also addressing associated ethical and social challenges (Otero et al., 2023).

2. Theoretical framework: Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) is the foundational theoretical framework guiding this research. The UTAUT model offers a structured methodology for understanding how technology is adopted within educational settings, particularly in light of recent advancements (Venkatesh, 2022; Venkatesh et al., 2003). This framework highlights four essential constructs: performance expectancy, which relates to the perceived benefits of using technology; effort expectancy, indicating the ease of use; social influence, reflecting the impact of peers and the broader community on adoption decisions; and facilitating conditions, which encompass the necessary resources and support for effective implementation. Together, these factors are crucial in determining educators' willingness to incorporate artificial intelligence (AI) into their teaching practices (Venkatesh, 2022). This study aims specifically to explore both the practical and perceived barriers to the integration of AI within the realm of special needs education in South Africa.

3. Methodology

To investigate these issues, a qualitative research methodology was employed, with individual interviews serving as the primary data collection method. Educators from a special school in South Africa were selected as the subjects of this study, enabling a comprehensive examination of their unique experiences and perspectives. This qualitative approach enables a comprehensive understanding of educators' beliefs, attitudes, and concerns regarding the integration of AI in their classrooms. A purposive sampling technique was employed to select a group of five educators who possess rich insights relevant to the study's objectives.

During the data collection process, individual interviews were conducted with each participant, providing a platform for them to express their thoughts on how AI could influence their teaching practices and enhance learning outcomes for students with special needs. These interviews were meticulously recorded to ensure accurate representation of the educators' voices. The resulting data were systematically organized into a table format to aid in analysis, and thematic analysis was employed to identify common patterns and insights from the interviews. To uphold ethical standards and protect participant privacy, each educator was assigned a pseudonym, thereby ensuring their confidentiality throughout the research process.

4. Results

The educators responded to six key questions, addressing their experiences with special needs learners, the role of AI in education, its benefits, challenges, and the support needed from the education system. These responses were analysed using the UTAUT theoretical framework.

The responses from educators were analysed to evaluate the impact of Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), and Facilitating Conditions (FC) on their acceptance and utilisation of AI in assisting learners with special needs (Vantekash *et al.,* 2003).

Performance Expectancy (PE)

Educators recognise that AI can improve teaching efficiency by saving time and simplifying tasks. Multiple educators observed that AI tools facilitate the rapid generation of tasks and the organisation of content, thereby enhancing lesson planning and delivery. Educator 3 noted that AI enhances their class preparation and allows for the customisation of lessons to accommodate varying learning levels. Concerns were expressed about excessive dependence on AI, with Teacher 1 and Teacher 3 highlighting the importance of learners not relying solely on AI.

Effort Expectancy (EE)

Some educators perceive AI as beneficial, while others exhibit unfamiliarity with the technology, leading to resistance to its adoption. Educator 2 indicated that AI was not part of their formal training, necessitating adaptations. Educator 4 acknowledged a deficiency in knowledge regarding AI, citing generational differences as the reason. Several educators recognized the need for training to enhance their understanding and application of AI tools. Research indicates that AI can be advantageous when educators are provided with sufficient training on its effective utilisation.

Social Influence (SI)

Social pressure influences the adoption of AI, especially among learners. Educator 3 observed that learners currently possess access to AI, suggesting that educators must advance accordingly. Some educators view AI as a beneficial instructional tool, yet they express concerns about potential dependence and its impact on creativity. Educator 5 articulated concerns regarding the potential for AI to induce complacency among educators, thereby hindering their critical engagement in lesson planning. Educator 4 expressed scepticism, characterising AI as a concept introduced by younger generations.

Facilitating Conditions

Educators have identified a notable challenge: the limited resources available for implementing AI. Educators emphasised the importance of laptops, Wi-Fi connectivity, and training to facilitate the effective integration of AI in special needs education. Educators 1 and 2 emphasised that the lack of adequate infrastructure hinders the adoption of AI. Educator 5 proposed the formulation of guiding policies to govern AI utilisation and ensure alignment with educational goals. Furthermore, certain educators suggested the implementation of institutional support mechanisms, including frameworks that facilitate the use of AI by learners within a regulated setting.

5. Discussion

The results indicate that educators acknowledge AI's capacity to enhance special needs education by conserving time, automating administrative tasks, and facilitating lesson planning (Chen, Chen, & Lin, 2021). This study supports the literature reviewed, which indicates that there is a strong positive and effective PE and EE from educators across Africa, despite challenges surrounding financial constraints FC in most African countries (Bandoh, Akweittey, Lotey, Gordon, & Appiagyei, 2024). Several educators emphasised AI's capacity to facilitate personalised learning by adjusting to the unique learning levels of each learner. Nonetheless, a considerable challenge is the absence of familiarity and formal training, as senior educators convey unease stemming from their restricted exposure to technology. Concerns regarding excessive reliance on AI were widespread, with some educators apprehensive that an overdependence on AI-generated tasks might inhibit creativity in lesson planning. Bandoh *et al.* (2024) found that facilitating conditions are often a detriment to the integration of ICT in mathematics. Moreover, access to infrastructure poses a significant obstacle, as many schools lack sufficient computers, Wi-Fi, and adequate AI training programs to support educators effectively.

To enhance AI integration in special needs education, educators advocate for extensive training programs, revised policies, and equitable access to technological resources. Some advocate for the utilisation of AI as an assistive tool rather than a substitute for critical thinking, thereby ensuring that educators retain authority over their pedagogical methods (Chen *et al.,* 2021). Furthermore, protocols for the responsible utilisation of AI in educational institutions could mitigate misuse while enhancing its advantages. The results underscore the need for institutional support, encompassing investment in technology and the implementation of explicit policies to aid educators in transitioning to AI-driven teaching methodologies, thereby ensuring that learners with special needs receive high-quality, individualized education (Chen *et al.,* 2021).

6. Conclusion

In conclusion, the integration of AI in special needs education presents both advantages and challenges. To achieve effective implementation, it is crucial to prioritise educator training, technological accessibility, and appropriate deployment. While AI can enhance lesson planning, streamline processes, and facilitate personalised learning, it is essential to address concerns regarding over-reliance, a potential loss of creativity, and digital inequality. Future research should focus on examining the long-term impacts of AI on learning outcomes, exploring strategies to bridge generational and technological knowledge gaps among educators, and evaluating the effectiveness of AI-driven tools in differentiated instruction for students with special needs. Additionally, research on AI governance in education could help inform policy frameworks and establish ethical and practical guidelines for its implementation. By addressing these areas, AI has the potential to make a significant contribution to a more inclusive educational environment.

References

Bandoh, S. O., Akweittey, E., Lotey, E. K., Gordon, J. F., & Appiagyei, E. (2024). Using UTAUT model to assess the factors influencing the use of ICT in Ghanaian pre-tertiary mathematics education. *Journal of Digital Educational Technology, 4*(1), ep2407. https://doi.org/10.30935/jdet/14297

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *Ieee Access*, *8*, 75264-75278.

Lalor, J., Lorenzi, F., & Rami, J. (2015). Developing Professional Competence through Assessment: Constructivist and Reflective Practice in Teacher-Training. *Eurasian Journal of Educational Research, 15*(58). https://doi.org/10.14689/ejer.2015.58.6

Landsberg, E., Krüger, D., & Swart, E. (2019). *Addressing barriers to learning: A South African perspective*. Van Schaik.

Otero, L. C., Català, A., Fernández-Morante, C., Taboada, M., López, B. C., & Barro, S. (2023). AI literacy in K-12: a systematic literature review. *International Journal of STEM Education, 10*(1). https://doi.org/10.1186/s40594-023-00418-7

Park, J., Teo, T. W., Teo, A., Chang, J., Huang, J., & Koo, S. (2023). Integrating Artificial Intelligence into Science Lessons: Teachers' Experiences and Views. *International Journal of STEM Education, 10*(1). https://doi.org/10.1186/s40594-023-00454-3

Rizvi, S., Waite, J., & Sentance, S. (2023). Artificial Intelligence teaching and learning in K-12 from 2019 to 2022: A systematic literature review. *Computers and Education Artificial Intelligence, 4*, 100145. https://doi.org/10.1016/j.caeai.2023.100145

South African Department of Education. (2001). *White Paper 6: Special Needs Education – Building an Inclusive Education and Training System*.

Venkatesh, V. (2022). Adoption and Use of AI Tools: A Research Agenda Grounded in UTAUT. *Annals of operations research*, *308*(1), pp.641-652.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS quarterly*, 425-478.

Woolf, B. P. (2020). *AI in education: Promises and implications for teaching and learning*. Cambridge University Press.

LLM AGENTS: ADVANCING TRULY PERSONALIZED ONLINE EDUCATION

José Ochoa-Luna[1], Ricardo Lazo[1], & Manfred Meyer[2]
[1]*Department of Computer Science, Universidad Católica San Pablo, Arequipa (Peru)*
[2]*Department of Mechanical Engineering, Westfälische Hochschule, Bocholt (Germany)*

Abstract

Since the advent of ChatGPT, the development and release of Large Language Models (LLMs) have accelerated at an unprecedented pace. The most advanced LLMs, such as Deepseek R1 and ChatGPT-4o, exhibit sophisticated reasoning capabilities with significant potential for transforming education. These models can enable personalized learning by dynamically adapting to individual preferences and needs. However, despite their growing adoption, the real-world impact of LLMs in education remains limited, with few implementations demonstrating measurable effectiveness. In this paper, we investigate the potential of LLMs to transform education and propose a framework centered on LLM agents in online learning environments. First, we advocate for a new generation of online learning platforms where LLM agents are not merely add-ons but integral components, shifting from traditional Learning Management Systems (LMS) that function as static content repositories to dynamic, interactive ecosystems. In these environments, agents actively "intervene" to support and guide learners. Second, we emphasize the development of multi-agent systems that facilitate content delivery, foster interaction, promote critical thinking, enhance engagement, and provide personalized feedback. Finally, we highlight the necessity of rigorous evaluation methods to assess the actual impact of these technologies on learning outcomes. This paper presents the initial findings of our approach, which focuses on automating content generation in online learning environments while addressing predominant learning styles: Visual, Auditory, Read/Write, and Kinaesthetic. We aim to convert traditional text-based content into multimodal formats tailored to diverse learning preferences. While this transformation presents significant challenges, it is greatly facilitated by LLM agents leveraging advanced generative AI capabilities, including text-to-text, text-to-image, text-to-audio, and text-to-video generation.

Keywords: *Personalized education, LLM agents, generative AI, learning styles, online learning.*

1. Introduction

Personalized education has long represented a central aspiration within the Artificial Intelligence (AI) research community. Despite the proliferation of theoretical frameworks over the past several decades, their practical implementation has remained largely constrained, only becoming more feasible with recent technological advancements (Gao et al., 2024). This paper explores how the integration of intelligent agent architectures with Large Language Models (LLMs) presents transformative potential for the realization of viable personalized education systems. Intelligent agents, introduced in the 1990s as promising frameworks for managing complex tasks, contributed significantly to theoretical developments in areas such as agent planning and communication protocols. However, their practical deployment was hindered by a fundamental limitation: insufficient reasoning capabilities (Chu et al., 2025). Early reasoning mechanisms were largely rule-based and computationally intensive, rendering them unsuitable for dynamic, real-world educational environments. The emergence of advanced LLMs has revitalized interest in agent-based approaches by effectively addressing these reasoning limitations. These models offer robust simulations of cognitive processes, enabling intelligent agents to function with a level of flexibility and responsiveness previously unattainable. Furthermore, the ReAct paradigm enables LLMs to simultaneously "think" and "act" via external tools, facilitating agent applications across multiple domains. The robust natural language understanding capabilities inherent in LLMs, combined with the task automation functionalities of LLM-powered agents, render them particularly suitable for addressing persistent challenges in educational contexts (Wang et al., 2025).

The evolution of online education necessitates a critical examination of how recent technological advancements can be optimally integrated into pedagogical frameworks. While the global pandemic precipitated widespread adoption of virtual learning environments, significant deficiencies persist in current implementations. Specifically, contemporary online educational platforms demonstrate inadequate mechanisms for instructors to comprehensively assess collective student engagement and comprehension in real-time (Xu et al., 2024). This paper proposes a novel framework for online education in which the instructor maintains a central but augmented role through the strategic deployment of LLM agents. The underlying principle asserts that technological integration should enhance, rather than supplant, human creativity and pedagogical oversight. We argue that the integration of advanced technologies, particularly LLM-based agent systems, holds substantial potential to enhance the personalization of education and, in turn, produce measurable improvements in learning outcomes. Realizing this potential necessitates a fundamental re-evaluation of current content delivery paradigms employed by mainstream Learning Management Systems (LMS) such as Moodle and Canvas. Specifically, we advocate for a shift from static, content-centric repositories to dynamic, agent-mediated learning environments characterized by high levels of collaboration, interoperability, and adaptability. Our research focuses on the design and deployment of multi-agent systems composed of proactive computational entities capable of identifying knowledge gaps, optimizing instructional content delivery, facilitating meaningful learner interactions, promoting critical thinking, increasing student engagement, and delivering personalized assessment feedback.

The actualization of this advanced learning platform requires a sequenced implementation approach. Our initial research phase concentrates on automating content generation processes within online learning environments while accommodating the four predominant learning modalities: Visual, Auditory, Read/Write, and Kinaesthetic (Gao et al., 2024). This phase aims to transform conventional text-based instructional materials into multimodal formats optimized for diverse learning preferences: i) Visual modality: Implementation of conceptual maps, statistical visualizations, diagrammatic representations, and abbreviated video content ii) Auditory modality: interactive activities involving speech and listening. iii) Read/Write modality: Creation of textual assessment instruments, including examinations, assigned tasks, structured worksheets, and analytical compositions. iv) Kinaesthetic modality: Design of experiential learning activities including scenario-based role simulations, practical exercises, and immersive simulations. While this comprehensive modality transformation presents considerable technical challenges, the process is substantially facilitated through LLM agent architectures that leverage contemporary generative artificial intelligence capabilities, including sophisticated text-to-text, text-to-image, text-to-audio, and text-to-video conversion technologies. Preliminary experimental findings are presented in subsequent sections.

2. Related work

The application of artificial intelligence within educational frameworks has demonstrated significant expansion during recent decades. Kamalov et al. (2023) categorize these implementations into four principal domains: (1) Personalized Learning Systems, (2) Intelligent Tutoring Systems, (3) Assessment Automation Mechanisms, and (4) Teacher–Student Collaborative Interfaces. Within the scope of the current investigation, personalized learning approaches and intelligent tutoring systems demonstrate particular relevance. Personalized learning methodologies enable individualized educational progression, allowing students to advance according to their specific cognitive capabilities and temporal requirements. Luan & Tsai (2021) documented enhanced engagement parameters and improved learning outcomes associated with these approaches. Intelligent Tutoring Systems (ITS) provide immediate formative assessment, respond to learner inquiries, and facilitate comprehension of complex conceptual structures. Mousavinasab et al. (2021) observed that customization of instructional components according to individual student characteristics facilitates the development of engaging educational environments that enhance motivational factors and promote active learning behaviors. Our proposed framework incorporates elements of both personalized learning and intelligent tutoring systems, specifically implemented through LLM agents that leverage advanced reasoning capabilities and tool integration to deliver highly individualized educational experiences.

Despite their relatively recent emergence, LLM agents have demonstrated considerable potential for educational applications. A comprehensive taxonomic examination of LLM agents in educational settings by Chu et al. (2025) delineates two principal categories: (1) Pedagogical Agents and (2) Domain-Specific Educational Agents. Within this classification framework, our proposal is situated within the pedagogical agents category, which encompasses technologies designed to automate complex instructional functions, including classroom simulation and learning resource recommendation. Significant developments in this domain include EduAgent (Xu et al., 2024), which introduces a structured profiling methodology comprising distinct cognitive patterns to facilitate adaptive learning processes. Wang et al.

(2025) further advanced this field by providing mechanisms for personalized content delivery. Our proposal diverges from previous LLM agent approaches by specifically targeting online learning environments through the development of a novel platform architecture. The fundamental infrastructure of this platform consists of a multi-agent system that deploys specialized LLM agents to create highly personalized learning experiences.

3. LLM Agents

Computational agents are defined as autonomous software entities that execute planning and action sequences based on underlying reasoning architectures. LLMs demonstrate significant efficacy when implemented as agent systems capable of coordinating sequential actions to achieve predetermined objectives. These LLM-based agent architectures maintain essential functional components, including model input/output interfaces, processing chains, and memory structures, while integrating two critical additional elements (Alammar & Grootendorst, 2024): 1) External tools that transcend inherent model limitations. 2) Strategic planning systems that coordinate tool selection and execution processes.

Contemporary high-performance agent systems predominantly operate through the Reasoning and Acting (ReAct) framework as their foundational architecture (Yao et al., 2023). This framework establishes systematic integration between complementary cognitive and execution processes. To facilitate action capabilities, LLMs receive structured information regarding available tool sets and specific textual command protocols that activate these external functional modules. In contrast to isolated LLM agent implementations that function independently, LLM-based multi-agent systems deploy multiple coordinated LLM agents with differentiated functional profiles to collaboratively address complex task requirements (Guo et al., 2024).

4. A new generation of online learning platforms based on LLM agents

Conventional LMSs have predominantly functioned as static repositories for educational content, despite offering supplementary features such as asynchronous discussion forums, interactive exercises, and collaborative functionalities. These systems exhibit inherent limitations regarding adaptability and personalization. We propose a paradigm shift toward next-generation online learning platforms characterized by deep integration of multi-agent systems, leveraging LLMs as their cognitive architecture. Within this dynamic learning environment, computational agents proactively intervene to provide individualized support and guidance to learners. The proposed platform architecture comprises three principal components:

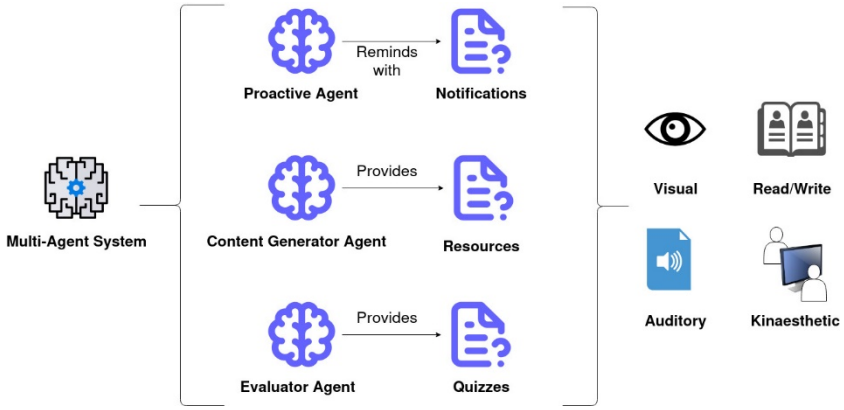
Content Repository and Delivery System: The platform maintains instructional materials in various modalities, including presentation slides, portable document format (PDF) files, video-based instructional content, interactive assessment instruments, and evaluation mechanisms. While traditional hierarchical navigation through instructor-designed content sections remains available, we have prioritized the implementation of a conversational interface (chat) to facilitate human-system interaction, thereby enabling learners to access the multifunctional capabilities provided by the LLM-based agent system.

Enhanced Information Retrieval Mechanism: The platform implements semantic search functionality based on vector embeddings and keywords, augmented through Retrieval-Augmented Generation (RAG) methodologies.

Multi-Agent System Architecture: This component constitutes the central architectural element of the proposed platform. We have designed and implemented multiple specialized LLM agents that perform complementary educational functions, including content delivery, interaction facilitation, critical thinking development, engagement enhancement, and personalized assessment feedback provision. Figure 1 illustrates the multi-agent system architecture comprising three primary LLM agents: content generation agents, proactive learning guidance agents, and learning process feedback agents, each fulfilling specific pedagogical functions within the integrated learning environment.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

Figure 1. A new generation of online learning platforms based on LLM agents.



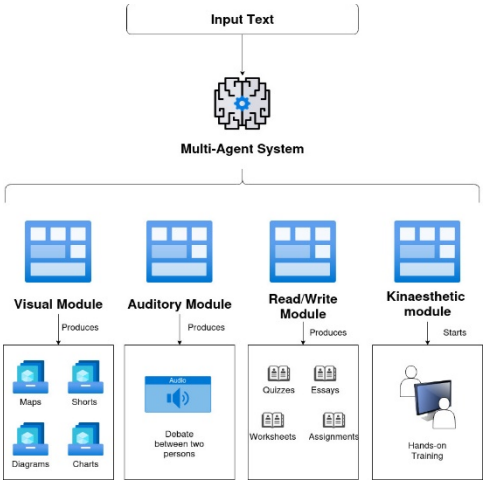
5. Preliminary results

The principal architectural component of this next-generation online learning platform is the multi-agent system. Despite inherent implementation complexities, the development of LLM agents is facilitated through established frameworks including Langchain, LlamaIndex, and Agent Development Kit (ADK). Our implementation utilizes LlamaIndex (accessible via https://docs.llamaindex.ai/en/stable/) as the primary development framework for LLM agent architecture. Additionally, we have employed Gemini 1.5 (accessible via https://gemini.google.com/) as the underlying LLM. It is worth noting that the architectural principles presented herein demonstrate framework-agnostic applicability and can be implemented across diverse agent frameworks and language models with tool execution or code execution capabilities.

To maximize student engagement parameters, we have developed mechanisms for dynamic, multimodal, and pedagogically valuable content generation. This functionality is implemented through LLM agents integrated within the online platform architecture described in the preceding sections. Acknowledging established learning modality preferences (Visual, Auditory, Read/Write, and Kinaesthetic), we have designed adaptive LLM agents capable of identifying and accommodating individual learning style preferences through iterative interaction analysis. Consequently, these agents demonstrate the capacity to transform conventional text-based instructional materials into multimodal formats optimized for diverse learning preferences: 1)Visual content generation: LLM agents equipped with visual generation tools process textual materials uploaded to the platform to create visual representations, including conceptual maps, statistical visualizations, diagrammatic illustrations, and abbreviated video content. 2)Auditory content synthesis: Utilizing text-to-speech conversion technologies, LLM agents can transform textual content into simulated dialectical exchanges between multiple speakers to facilitate comprehension of specific subject matter through auditory processing channels. 3) Read/Write content development: Through text-to-text transformation mechanisms, LLM agents generate assessment instruments, including examinations, assigned tasks, structured worksheets, and analytical compositions according to predetermined pedagogical criteria. 4) Kinaesthetic learning facilitation: LLM agents demonstrate behavioral adaptability based on learning outcome metrics and can simulate role-based scenarios through integrated visual, auditory, and textual modalities to provide experiential learning opportunities. This multimodal content generation architecture is illustrated in Figure 2.

To assess the viability of the proposed platform, we plan to conduct A/B testing within the online course offerings of the Department of Computer Science at UCSP. These courses currently utilize Moodle to provide access to learning materials and exercises, supplemented by real-time online instruction. Our evaluation will compare the learning outcomes of students using the traditional Moodle-based system with those engaging with the new platform, under equivalent instructional conditions and over the same period.

Figure 2. Content generation based on learning styles.



6. Conclusions

Most current LMSs function primarily as data repositories, which is useful for organizing content but limited in supporting active learning due to their static nature. To address this, we propose a new generation of online learning platforms centered around a multi-agent system powered by large language models (LLMs). These LLM agents deliver an engaging and highly personalized learning experience by answering specific questions, guiding learners through individualized learning paths, mediating discussions, and collaboratively supporting the achievement of targeted learning outcomes. While our findings are still preliminary, we plan to assess the impact of this approach through A/B testing.

References

Alammar, J., & Grootendorst, M. (2024). *Hands-on large language models: Language understanding and generation*. O'Reilly.

Chu, Z., Wang, S., Xie, J., Zhu, T., Yan, Y., Ye, J., Zhong, A., Hu, X., Liang, J., Yu, P. S., & Wen, Q. (2025). LLM agents for education: Advances and applications. *arXiv preprint arXiv:2503.11733*.

Gao, C., Lan, X., Li, N., Zhang, L., Zhang, Y., Zhou, H., & Zhou, Y. (2024). Large language models empowered agent-based modeling and simulation: A survey and perspectives. *Humanities and Social Sciences Communications, 11*, 1259. https://doi.org/10.1057/s41599-024-03611-3

Guo, T., Chen, X., Wang, Y., Chang, R., Pei, S., Chawla, N. V., Wiest, O., & Zhang, X. (2024). Large language model-based multiagents: A survey of progress and challenges. *Proceedings of the 33rd International Joint Conference on Artificial Intelligence (IJCAI 2024)*.

Kamalov, F., Santandreu-Calonge, D., & Gurrib, I. (2023). New era of artificial intelligence in education: Towards a sustainable multifaceted revolution. *Sustainability, 15*(16), 12451.

Luan, H., & Tsai, C. (2021). A review of using machine learning approaches for precision education. *Educational Technology, 24*, 250-266.

Modran, H. A., Bogdan, I. C., Ursuțiu, D., Samoilă, C., & Modran, P. L. (2025). LLM intelligent agent tutoring in higher education courses using a RAG approach. In M. E. Auer & T. Rüütmann (Eds.), *Futureproofing engineering education for global responsibility (ICL 2024),* 1281. Cham: Springer.

Mousavinasab, E., Zarifsanaiey, N., Niakan, R., Kalhori, S., Rakhshan, M., Keikha, L., & Ghazi, S. (2021). Intelligent tutoring systems: A systematic review of characteristics, applications, and evaluation methods. *Interactive Learning Environments, 29*, 142-163.

Wang, T., Zhan, Y., Lian, J., Hu, Z., Yuan, N. J., Zhang, Q., Xie, X., & Xiong, H. (2025). LLM-powered multi-agent framework for goal-oriented learning in intelligent tutoring system. *arXiv preprint arXiv:2501.15749*.

Xu, S., Zhang, X., & Qin, L. (2024). EduAgent: Generative student agents in learning. *arXiv preprint arXiv:2404.07963*.

Yao, S., Zhao, J., Yu, D., Du, N., Shafran, I., Narasimhan, K., & Cao, Y. (2023). ReAct: Synergizing reasoning and acting in language models. *Proceedings of the International Conference on Learning Representations (ICLR 2023)*.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

HACKING THE HACKATHON: A TOOL FIT FOR MANAGEMENT EDUCATION IN THE ERA OF GRAND CHALLENGES?

Sandrine Stervinou[1], Jennifer Goodman[2], Laurent Noël[2], Aline Polipowski[3], & Jean-Marc Charlot[4]
[1]Entrepreneurship, Stratégy and Innovation, Audencia (France)
[2]Organisation Studies and Ethics, Audencia (France)
[3]Pedagogical Engineer, Audencia (France)
[4]Information Systems and Supply Chain Management, Audencia (France)

Abstract

Originally conceived a decade ago to stimulate prototyping in the technology sector, hackathons have proliferated in management education. While bringing a practical tool into the classroom would seem to respond to calls for closer links between education and practice, we explore whether the hackathon is fit for purpose in management education and for addressing grand challenges. We define grand challenges as large-scale, complex problems such as climate change, poverty, inequality and environmental sustainability. This exploratory study focuses on hackathons on sustainable development that have taken place in a business school since 2016. We adopt a multi-stakeholder approach to analyse one of these hackathons, collecting data through questionnaires and interviews to explore the perspectives of the different stakeholders involved: students, professors, programme management and external stakeholders. Our empirical study identifies different types of value attributed to the hackathon by the participating stakeholders. We identify several tensions that lead us to caution the adoption of hackathons as a teaching tool for grand challenges and make recommendations for adapting the hackathon in context to ensure its pedagogical integrity. Hackathons do not seem to satisfy all stakeholders at the same time and for the same thing. These findings are particularly relevant given the current push for multi-stakeholder approaches to teaching sustainable development and the increasing popularity of hackathons in higher education.

Keywords: *Hackathons, grand challenges, practice-based tools, management education.*

1. Introduction

The ongoing debates in management and higher education literature focus on the nature, purpose, and future of business schools, particularly questioning the practical relevance of management education (Thomas & Ambrosini, 2021). This discussion is intensified by the urgent need to address grand challenges in management and sustainability (Ferlie et al, 2010; Schoemaker, 2008), prompting calls for new teaching methods (Montiel et al., 2020a). One such method is the hackathon, which has gained popularity in management education. Hackathons involve diverse groups working intensively over a short period to develop innovative solutions (Briscoe and Mulligan 2014; Komssi et al. 2015). Originating in the IT sector, hackathons have been adapted by various industries and are now used in management education to teach innovation, entrepreneurship, and sustainability through "green hackathons" (Zapico et al., 2013).

Despite their popularity, hackathons face criticism in both industry and higher education settings (Fabbri et al 2018; Endrissat 2019). This paper explores the suitability of hackathons in management education, particularly in addressing grand challenges, and examines whose purposes they serve. The study draws on data from six hackathons organized by a French business school since 2016, focusing on sustainable development. It includes surveys from 260 students and interviews with nine stakeholders, including program managers, external stakeholders, and teaching teams.

The findings reveal tensions between stakeholder expectations and the perceived value of hackathons. The study concludes that without adapting hackathons to academic purposes, they are unlikely to meet diverse stakeholder expectations. The paper offers recommendations to repurpose hackathons as educational tools that can create value for all stakeholders and contribute to developing sustainability competencies. The article is structured to discuss the current context of management education, the hackathon phenomenon, the study's methodology, findings, and practical implications.

2. Literature background

The debate surrounding management education has increasingly focused on its disconnection from the practical realities of management practice. Scholars argue that business schools emphasize academic rigor at the expense of real-world applicability, limiting students' preparedness for the workplace (Ferlie et al., 2010; Schoemaker, 2008). This issue is exacerbated by employers' growing reluctance to offer on-the-job training (Puri, 2018), prompting calls for experiential and professionally co-designed curricula (Bruno et al., 2021; Dean et al., 2020).

Parallel discussions concern responsible management education, prompted by corporate scandals such as Enron, which raised concerns about business schools' role in fostering ethical leadership (Beggs & Dean, 2007; Hibbert & Cunliffe, 2015). The UN's Principles of Responsible Management Education (PRME) and sustainability-focused pedagogical frameworks have since proliferated (Starik et al., 2010). However, evidence of their impact on practice remains inconclusive (Montiel et al., 2020b).

More recently, the concept of "grand challenges"—global, complex issues such as climate change and inequality—has gained prominence in management literature (Ferraro et al., 2015; Eisenhardt et al., 2016). These challenges demand interdisciplinary, collaborative solutions that span ethical, economic, and ecological domains (George et al., 2016; Martí, 2018). The European Commission's GreenComp framework reflects this need, promoting sustainability competencies through active, experiential learning (Bianchi et al., 2022). Scholars have similarly advocated for pedagogical models that integrate academic and managerial knowledge (Laasch, 2018; Armstrong & Fukami, 2009), though empirical applications remain limited (Montiel et al., 2020a).

Hackathons have emerged as a potential tool to bridge these gaps. Originally grassroots tech events (Briscoe & Mulligan, 2014), hackathons are now used in corporate and educational settings as intense, collaborative innovation platforms (Raatikainen et al., 2013; Lifshitz-Assaf et al., 2021). In higher education, hackathons promote active learning, team-based problem-solving, and student engagement with real-world challenges (Canopé, 2017; Suominen et al., 2018). Their adaptability was particularly valuable during the COVID-19 shift to remote learning (Braune et al., 2021).

However, critiques remain. Hackathons can be exclusionary, yield superficial results, and risk commodifying unpaid labor (Endrissat, 2019; Komssi et al., 2015). Their fast-paced structure may undermine critical reflection, limiting their suitability for addressing grand challenges (Ferraro et al., 2015). Despite these tensions, sustainability-themed educational hackathons are gaining traction, offering experiential opportunities to build competencies essential for addressing complex societal problems (Zapico et al., 2013; Saukkonen et al., 2020).

3. Method

In order to understand the effectiveness and purpose of educational hackathons in management education, particularly in the context of sustainable development, a study has been conducted in two steps:

1. Initial insights: The researchers gathered preliminary information from six different hackathons they have organised at a French business school since 2016. These hackathons focused on sustainability themes and involved a variety of stakeholders, including educators, students, programme managers and external partners. Common reflections have indicated dissatisfaction with the achievement of educational goals, mainly due to institutional constraints and misaligned stakeholder expectations.

2. In-depth Study: The researchers conducted a detailed study of one hackathon, the Critical Marketing Hackathon, which is part of a Marketing Major at the Master's level. This hackathon aimed to develop innovative marketing proposals addressing environmental and social issues. Data was collected from 260 student surveys and 13 semi-structured interviews with teachers, educators, program directors, and external stakeholders such as referent of companies 'partners.

4. Results

Experts found the hackathon relevant, allowing them to engage with new perspectives and understand the younger generation's view of CSR. Teachers appreciated its potential to foster interdisciplinary collaboration and critical thinking, although it could go even further. Lack of criticism is one of the sources of disappointment for organisers.

However, several frustrations and limitations were identified. Students found the format intense and often too short or, paradoxically, too long. Many of them would have liked the opportunity to develop their ideas further after the event and interact more with real stakeholders. Teachers and organisers pointed to the cumbersome organisation and logistical constraints. Participating organisations felt that the highly

structured format limited creativity and real-world applicability. The lack of diversity in the students' backgrounds and the lack of time to obtain expert feedback (referents from the participating organisations) were also seen as drawbacks.

Ultimately, while the hackathon did raise awareness of sustainability and encourage new teaching methods, the rigid structure, logistical constraints and mismatch between students' technical knowledge of the subject limited its full potential.

5. Discussion and conclusion

In this paper we discuss the role and considerations of hackathons as an educational tool within business schools, particularly in the context of addressing grand challenges. Hackathons are noted for their potential to create value for various stakeholders, making them a viable component of a forward-looking business school strategy that emphasizes co-creation with stakeholders (Cavallone et al., 2021; Thomas & Ambrosini, 2021). However, to effectively utilize hackathons as an educational tool, several critical points must be considered.

The empirical results suggest that the different types of value generated by hackathons need to be carefully balanced, as they may differ significantly from traditional teaching methods. The visibility and added value of a hackathon's event status for program managers, students, and external experts must be balanced with maintaining pedagogical integrity. The significant time and effort involved in organizing and facilitating a hackathon should be valued, considering the extended benefits such as interdisciplinarity, learning among educators, and building relations with external experts. Hackathons should not be viewed primarily as tools for cost reduction or efficiency enhancement.

A key aspect of using hackathons as a pedagogical tool is to carefully consider their objectives and required outputs. Hackathons, as practice-based tools, often focus on providing "answers" (Zapico et al., 2013), "innovative quick fixes" (Komssi et al., 2015; Macedo Guimarães et al., 2021; Page et al., 2016), or "fast-paced innovative solutions" (Komssi et al., 2015; Macedo Guimarães et al., 2021; Page et al., 2016). However, the findings indicate that green hackathons are more successful at creating awareness of complex issues and bringing together differing perspectives than at finding innovative solutions. To achieve this aim, it is crucial to consider how the hackathon's output will be evaluated. A focus on solutions in a short timeframe can reduce complexity and undermine educational objectives. The empirical data suggests that evaluations like final pitches or posters may encourage students to simplify their responses, focusing more on incremental changes and consensus rather than radical change and contestation, thus minimizing the potential for positive social and environmental impact and systems change. This aligns somewhat with previous claims that forced collaboration in pre-created teams annihilates differences of opinions (Endrissat, 2019).

Further consideration of how hackathons are embedded in the educational program is essential, both logistically and pedagogically. Connecting hackathons to pre- and post-event courses can enhance their value, helping to move from problem awareness to action and future scenarios. This linkage can also help resolve tensions between the interests of external experts in company-specific projects and the educators' desire for wider applicability. The positioning of a hackathon in a program is relevant not only for knowledge acquisition but also for skills development. Hackathons offer opportunities for self-directed learning, but this requires students to have some independent learning skills and educators to be knowledgeable about relevant pedagogies such as heutagogy (Blaschke, 2012; Kenyon & Hase, 2010).

In conclusion, the findings imply the need for caution when using hackathons, the need for a roadmap with clear objectives, and further work on adapting this tool to ensure its pedagogic integrity while maintaining its popular appeal. These insights are particularly relevant given the current push for multi-stakeholder approaches to teaching sustainability and developing "green" competences in future managers and leaders.

References

Armstrong, S. J., & Fukami, C. V. (2009). Past, present and future perspectives of management learning, education and development. In S. J. Armstrong, & C. V. Fukami (Eds.), *The SAGE handbook of management learning, education and development* (pp. 1-22). Sage.

Beggs, J. M., & Dean, K. L. (2007). Legislated ethics or ethics education?: Faculty views in the post-Enron era. *Journal of Business Ethics, 71*, 15-37.

Bianchi, G., Pisiotis, U., & Cabrera Giraldez, M. (2022). GreenComp: The European sustainability competence framework. In Y. Punie, & M. Bacigalupo (Eds.), *GreenComp.* Luxembourg: Publications Office of the European Union. doi:10.2760/13286

Blaschke, L. M. (2012). Heutagogy and lifelong learning: A review of heutagogical practice and self-determined learning. *The International Review of Research in Open and Distributed Learning, 13*(1), 56-71.

Braune, K., Rojas, P. D., Hofferbert, J., Valera Sosa, A., Lebedev, A., Balzer, F., ... & Poncette, A. S. (2021). Interdisciplinary online hackathons as an approach to combat the COVID-19 pandemic: case study. *Journal of medical Internet research, 23*(2), e25283.

Briscoe, G., & Mulligan, C. 2014. Digital Innovation: The Hackathon Phenomenon, *Creativeworks London Working Paper, 6*, 1-13.

Bruno, G., Diglio, A., Kalinowski, T. B., Piccolo, C., & Rippa, P. (2021). University-Business Cooperation to design a transnational curriculum for energy efficiency operations. *Studies in Higher Education, 46*(4), 763-781.

Canopé. (2017). *Hackathons – organiser des défis pédagogiques*. Editions Canopé.

Cavallone, M., Ciasullo, M. V., Douglas, J., & Palumbo, R. (2021). Framing higher education quality from a business perspective: setting the conditions for value co-creation. *Studies in Higher Education, 46*(6), 1099-1111.

Dean, K. L., Wright, S., & Forray, J. M. (2020). Experiential learning and the moral duty of business schools. *Academy of Management Learning & Education, 19*(4), 569-583.

Endrissat, N. 2019. Hackathons: A field of dreams for 'collaborative innovation'?: A review of recent studies. *Entreprendre & Innover, 38*(3), 69-75.

Fabbri, J., Toutain O., & Glaser A. (2019), "Hackathons & Co: entre fascination et rejet". *Entreprendre & Innover, 38*(3), 5-8

Ferlie, E., McGivern, G., & De Moraes, A. (2010). Developing a public interest school of management. *British Journal of Management, 21*, s60-s70.

Ferraro, F., Etzion, D., & Gehman, J. (2015). Tackling Grand Challenges Pragmatically: Robust Action Revisited. *Organization Studies, 36*, 363-390.

George, G., Howard-Grenville, J., Joshi, A., & Tihanyi, L. (2016). Understanding and Tackling Societal Grand Challenges through Management Research. *Academy of Management Journal, 59*, 1880-1895.

Hibbert, P., & Cunliffe, A. (2015). Responsible management: Engaging moral reflexive practice through threshold concepts. *Journal of Business Ethics, 127*, 177-188.

Kenyon, C., & Hase, S. (2010). Andragogy and heutagogy in postgraduate work. In T. Kerry (Ed.), *Meeting the challenges of change in postgraduate education*. London: Continuum Press.

Komssi M., Pichlis D., Raatikainen M., Kindstrom K., & Jarvinen J. (2015). "What are Hackathons for?", *IEEE software, 32*(5), 60-67.

Laasch, O., & Gherardi, S. (2018). Delineating and reconnecting responsible management, learning, and education (RMLE): Towards a social practices perspective on the field. *CRME Working Papers, 4*(5), 1-28.

Lifshitz-Assaf, H., Lebovitz, S., & Zalmanson, L. (2021). Minimal and adaptive coordination: How hackathons' projects accelerate innovation without killing it. *Academy of Management Journal, 64*(3), 684-715.

Macedo Guimarães, L. B. D., Bitencourt, R. S., Chrusciak, C. B., Derenevich, M. G., Poncini, C. R., Okumura, M. L. M., & Junior, O. C. (2021). Sustainability Hackathon: Integrating Academia and Companies for Finding Solutions for Socio-environmental Problems. In W. Leal Filho, U. Tortato, & F. Frankenberger (Eds.), *Integrating Social Responsibility and Sustainable Development* (pp. 591-607). Springer, Cham.

Martí, I. (2018). Transformational Business Models, Grand Challenges, and Social Impact. *Journal of Business Ethics, 152*, 965-976.

Montiel, I., Delgado-Ceballos, J., Ortiz-de-Mandojana, N., & Antolin-Lopez, R. (2020a). New ways of teaching: using technology and mobile apps to educate on societal grand challenges. *Journal of Business Ethics, 161*, 243-251.

Montiel, I., Gallo, P. J., & Antolin-Lopez, R. (2020b). What on Earth should managers learn about corporate sustainability? A threshold concept approach. *Journal of Business Ethics, 162*, 857-880.

Page, F., Sweeney, S., Bruce, F., & Baxter, S. (2016). The Use of the "Hackathon" In Design Education: An Opportunistic Exploration. In *DS 83: Proceedings of the 18th International Conference on Engineering and Product Design Education (E&PDE16), Design Education: Collaboration and Cross-Disciplinarity* (pp. 246-251). Aalborg, Denmark.

Puri, I. K. (2018). Is the Future of Education Learning by Doing? *World Economic Forum* https://www.weforum.org/agenda/2018/02/why-learning-from-experience-is-the-educational-wave-of-the-future/

Raatikainen M., Komssi M., dal Bianco V., & Kindstom, K. (2013), Industrial Experiences of Organizing a Hackathon to Assess a Device-centric Cloud Ecosystem. *2013 IEEE 37th Annual Computer Software and Applications Conference (COMPSAC)* (Vol. 1, pp. 790-799). Kyoto, Japan.

Saukkonen, J., Tarasanski, P., & Hämäläinen, T. (2020). Impacting Mindset and Innovation on Sustainability via Global Thematic Hackathon. *Proceedings of the European Conference on Innovation & Entrepreneurship* (pp. 595-603).

Schoemaker, P. J. (2008). The future challenges of business: Rethinking management education. *California Management Review, 50*(3), 119-139.

Szymanska, I., Sesti, T., Motley, H., & Puia, G. (2020). The Effects of Hackathons on the Entrepreneurial Skillset and Perceived Self-Efficacy as Factors Shaping Entrepreneurial Intentions. *Administrative Sciences, 10*(3), 73. https://doi.org/10.3390/admsci10030073

Starik, M., Rands, G., Marcus, A. A., & Clark, T. S. (2010). From the guest editors: In search of sustainability in management education. *Academy of Management Learning & Education, 9*(3), 377-383.

Suominen, A. H., Jussila, J., Lundell, T., Mikkola, M., & Aramo-Immonen, H. (2018). Educational hackathon: innovation contest for innovation pedagogy. *LUT Scientific and Expertise Publications, Reports (No. 78)*. Lappeenranta University of Technology; ISPIM.

Thomas, L., & Ambrosini, V. (2021). The future role of the business school: A value cocreation perspective. *Academy of Management Learning & Education, 20*(2), 249-269.

Zapico, J. L., Pargman, D., Ebner, H., & Eriksson, E. (2013). Hacking sustainability: Broadening participation through green Hackathons. *Fourth International Symposium on End-User Development*. June 10-13, 2013, IT University of Copenhagen, Denmark.

MATHEMATICAL ANXIETY MITIGATION THROUGH THE DEVELOPMENT OF SELF-REGULATED LEARNING SKILLS

Amal Sharif-Rasslan[1], & Amtiaz Fattum[2]
[1]Department of Mathematics, The Academic Arab College of Education (Israel)
[2]Department of Computer Science, The Academic Arab College of Education (Israel)

Abstract

Self- Regulated Learning (SRL) refers to how people manage their personal learning processes, specifically how to monitor, regulate, and evaluate their learning and plan learning actions and behavioral processes that increase the likelihood of goal achievement (Zimmerman, 2008). Mathematics Anxiety (MA) refers to the experience of fear and nervousness when participating in mathematical tasks. MA is a barrier to mathematical learning and is considered to hinder student engagement and the effectiveness of their metacognitive processes. Some scholars claimed that very few comprehensive studies link MA and metacognition or SRL in the secondary school context (Efklides, 2011; Morsanyi et al., 2019). Parveen and others (Parveen et al., 2023) suggested future research to explore the relationship between motivation, MA, mathematical learning, and mathematics perseverance. The aim of this study is to explore the impact of adopting an intervention program of the SRL skills on mathematical anxiety among high secondary school students. Sixty-eight 12^{th} graders who learned mathematics at low learning level, aged (M=17.34, SD=0.43), and studied according to an intervention program that was developed for the purpose of this study and based on practicing SRL skills while solving mathematical problems crossing the SRL stages following (Zimmerman, 2008), the learner: a) makes plans before starting to learn; b) monitors and regulates his cognition, motivation and behavior during the learning process; c) reflects on his learning process afterwards. Two (pre and post) mathematical achievement questionnaires (Matriculation exams preparation), Hopko (2003) MA questionnaire (was distributed pre and post intervention), and a questionnaire that examines the relationship between SRL and mathematical achievement was distributed post intervention. The findings indicated that the average of the students' achievements before the intervention program (M=50.16, SD=24.25), is significantly lower than the average of their achievements after the intervention (M=65.47, SD=20.41), t=-9.047, $p<0.01$. In addition, it was found that the students' MA before intervention (M=29.87, SD=9.44) was significantly higher than students' MA after the intervention (M=18.22, SD=6.13), t=23.75, $p<0.01$. Moreover, there is a significant weak positive correlation between SRL and mathematics achievements, $r_p=0.309$, $p<0.05$. This study offers both theoretical and practical contributions. Theoretically, the findings elucidate the role of SRL in mathematical cognition and performance. Practically, the study informs pedagogical strategies by underscoring the importance of fostering SRL in mathematics education and to reduce the level of MA and to increase their academic achievements.

Keywords: *Self-regulated learning, mathematics achievements, mathematical anxiety.*

1. Introduction

The constructivist learning theory is grounded in the active interaction between individuals and their environment, where knowledge is actively constructed by the learner. This process results in a personalized understanding of the world. Several learning models have emerged from this foundational idea, one of which is the Self-Regulated Learning (SRL) approach. In SRL, the student assumes responsibility for regulating and directing their own learning process. SRL is conceptualized as an active, cyclical process of self-management, encompassing key components such as planning, goal setting, self-monitoring, and reflection. These processes are informed both by the learner's intrinsic factors (e.g., cognition, motivation, emotion) and by the external learning environment, which includes physical and social contexts (Pintrich, 2000). For optimal development of learning and daily functioning, students must engage in their self-regulation skills. A lack of self-regulation in cognitive, emotional, and behavioral domains can hinder a student's ability to successfully complete academic tasks (Florez, 2011). There is

substantial empirical evidence supporting the idea that metacognitive skills are essential for effective and efficient learning, serving as a critical foundation for academic success (Schraw et al., 2006; Zimmerman, 2000).

Anxiety is a psychological symptom that can manifest in any individual. This phenomenon is observed in some students within the school environment, where anxiety is frequently associated with academic difficulties. Mathematics is a subject that many students find particularly challenging. For some, it is perceived as one of the most difficult disciplines, leading them to actively avoid it. As a result, students often experience heightened anxiety when faced with mathematical tasks (Anindyarini & Supahar, 2019).

Studies have highlighted the effectiveness of metacognitive training programs, which concentrate on problem-solving approaches in mathematics, in reducing anxiety among secondary school students (Veenman et al., 2000). Many studies suggest that MA may be driven by teaching methods that prioritize rote memorization of foundational skills, rather than those that emphasize problem-solving, understanding, and reasoning. However, there has been limited investigation into the relationship between anxiety and cognitive processes within the context of mathematics education (Kramarski et al., 2010).

2. Objectives

The purpose of this study is to examine the relationship between SRL and MA, as well as the effect of implementing an SRL teaching intervention program on MA among 12th-grade students.

Research Questions

1. Is there a difference in students' mathematical achievement before and after adopting the SRL teaching approach?
2. Is there a difference in the level of mathematics anxiety before and after the adoption of the SRL teaching approach?
3. Is there a relationship between the SRL teaching approach and MA? How is this relationship manifested?

3. Methodology

This study was designed quantitatively. The participants' academic achievements and MA levels were compared to pre and post intervention programs.

3.1. Participants

Sixty-eight 12th graders (41.2% males and 58.8% females) participated in this study. Those participants were chosen randomly out of 182 twelfth graders who learned mathematics at a low learning level according to the mathematics curriculum. The participants aged (M=17.34, SD=0.43), and studied according to an intervention program that was developed for the purpose of this study and based on practicing self-regulated learning skills while solving mathematical problems crossing the SRL stages following (Zimmerman, 2008), the learner: a) makes plans before starting to learn; b) monitors and regulates his cognition, motivation and behavior during the learning process; c) reflects on his learning process afterwards.

3.2. Instruments

In this study, the following instruments were used:

a. Two (pre, and post) mathematical academic achievement questionnaires (Matriculation exams preparation). The researchers developed both tests in alignment with the mathematics curriculum and previous matriculation exams. Content validity for both exams was established through expert review by the school's mathematics coordinator and an academic specializing in mathematics education
b. Hopko (2003) MA questionnaire (was distributed pre and post intervention program). Both questionnaires included 12 items. Students were asked to respond to the various items using a Likert-type scale consisting of five levels (0=not at all stressed; 1=a little stressed; 2=stressed; 3=a lot stressed; 4=very much stressed). The degree of anxiety was calculated by summing up the points of all the items. The higher the sum, the higher the level of anxiety (it is worth noting that the highest sum is 48). The degrees of anxiety were determined as follows: 0 Low degree: 1-12, Moderate degree: 13-24, Moderate degree: 25-36, High degree: 37-48. The reliability of the questionnaire according to Cronbach's alpha, was: α=0.847 before the intervention, and α=0.759 after the intervention.

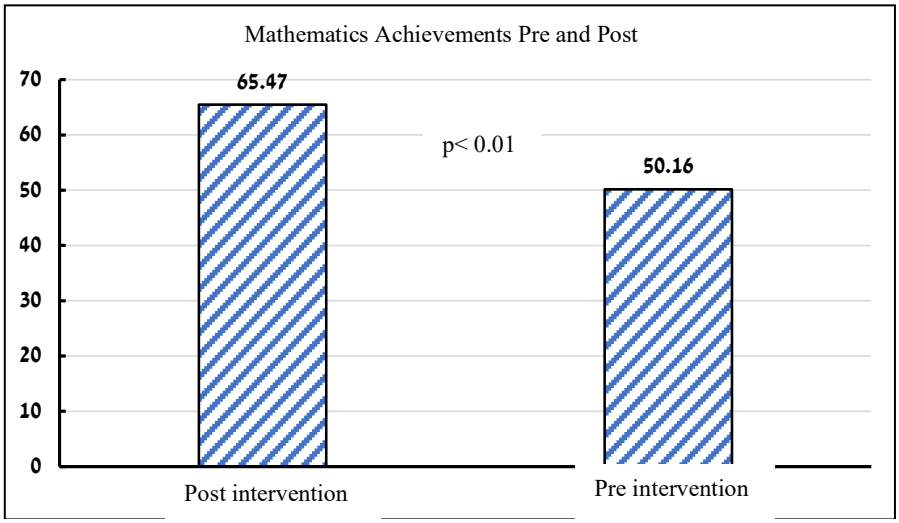
c. A questionnaire that examined the relationship between SRL and mathematical achievement was distributed post intervention. This questionnaire included 28 items relating to SRL and academic achievement. Students were asked to respond to the various items using a Likert-type scale consisting of five levels: (1=never; 2=rarely; 3=very often; 4=often; 5=always). The SRL level was determined by calculating the average of the participant's responses to all items. The reliability of the questionnaire α=0.743, was determined using Cronbach's alpha.

4. Results

4.1. Mathematics academic achievements

There was a significant difference with a large effect size between the students' achievement average before the intervention program (M=50.16, SD=24.25) and their average after the intervention program (M=65.47, SD=20.41), (t=-9.047, p<0.01, Cohen's d= 0.683), Figure 1.

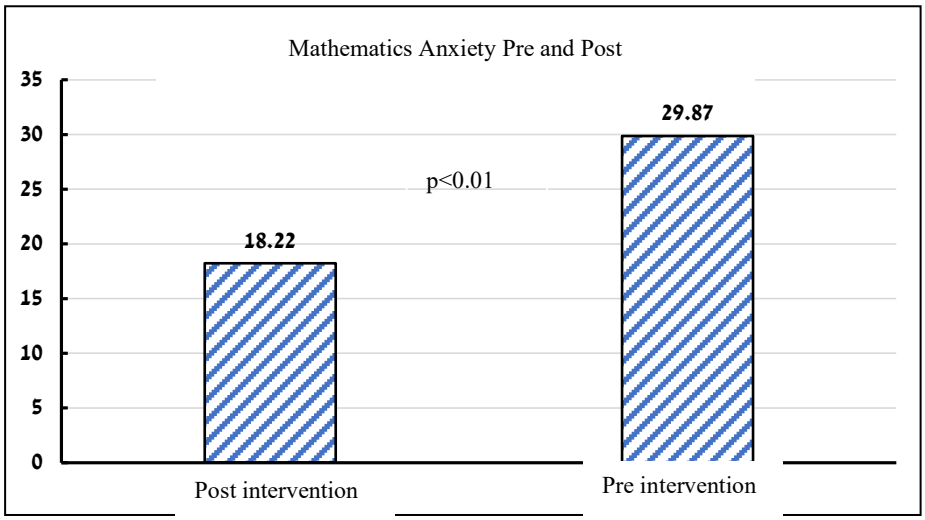
Figure 1. Mathematics Achievements Pre and Post.



4.2. Mathematics anxiety

There was a significant difference with a very large effect size between the students' MA level before the intervention (M=29.87, SD=9.44) and their MA level after the intervention (M=18.22, SD=6.13), (t=-23.75, p<0.01, Cohen's d=1.46), Figure 2.

Figure 2. Mathematics Anxiety Pre and Post.



4.3. SRL and Mathematics achievements

There is a significant weak positive correlation between SRL and mathematics academic achievements, r_p=0.309, $p<0.05$.

5. Discussion

The research literature consistently indicates that students' attitudes toward mathematics are significantly influenced by their school learning environment, which in turn shapes their mathematical understanding and application in both academic and real-world contexts. A pivotal principle in contemporary education is fostering SRL, wherein students take initiative in their learning processes, engage in inquiry, regulate their cognitive strategies, and develop metacognitive awareness (Pokhrel & Sharma, 2024). This framework provides a theoretical rationale for the observed improvement in student achievement following the implementation of an intervention program. The program equipped students with both cognitive and metacognitive skills, which functioned as tools for comprehending and solving mathematical problems effectively, thereby contributing to enhanced academic performance.

Our findings indicated that there was a significant difference with a very large effect size between the students' MA level before and after the intervention program. In other words, MA was reduced as a result of the SRL approach. This finding is supported by previous studies that claimed that implementing SRL approaches in mathematics education can effectively reduce MA by fostering self-efficacy, enhancing metacognitive awareness, and promoting emotional regulation. Educators are encouraged to integrate SRL techniques into their teaching practices to support students in overcoming math anxiety and achieving better mathematical outcomes (Kramarski et al., 2010, Hendral & Hidayati, 2023).

Moreover, our findings indicated that there was a significant weak positive correlation between SRL and mathematics achievements. This finding is supported by research literature, which indicates that SRL fosters mathematical thinking strategies that allow students to arrive at correct solutions independently and efficiently, which increases his/her academic mathematics achievement, and that high levels of SRL are associated with reduced MA, while lower levels are linked to increased MA. These findings highlight the importance of integrating SRL into mathematics education to reduce MA and enhance academic performance (Harahap et al., 2025). Furthermore, SRL supports the development of metacognitive abilities such as planning, monitoring, and evaluating problem-solving processes. These skills help reduce MA by increasing students' sense of control and self-confidence (Turgut & Bakır, 2024).

6. Conclusions

This study offers both theoretical and practical contributions. Theoretically, the findings elucidate the role of SRL in mathematical cognition and performance. Practically, the study informs pedagogical strategies by underscoring the importance of fostering SRL in mathematics education and reducing the level of MA and increasing their academic achievements.

References

Anindyarini, R., & Supahar (2019). A mathematical anxiety scale instrument for junior high school students. *Journal of Education and Learning (EduLearn), 13*(4), 447-456.

Efklides, A. (2011). Interactions of metacognition with motivation and affect in self-regulated learning: The MASRL model. *Educational Psychologist, 46*(1), 6-25.

Florez, I. R. (2011). Developing young children's self-regulation through everyday experiences. *Young Children, 66*(4), 46-51.

Harahap, L. E. S., Andayani, S., & Ekwan, D. (2025). How does self-regulated learning affect students' mathematics anxiety? *Pedagogical Research, 10*(1), em0230. https://doi.org/10.29333/pr/15648

Hendral, H. N., & Hidayati, K. (2023). The relationship between students' self-efficacy and mathematics anxiety: Meta-analysis investigation. *AIP Conf. Proc., 2540*(1), 070008. https://doi.org/10.1063/5.0105860

Hopko, D. R. (2003). Confirmatory factor analysis of the math anxiety rating scale–revised. *Educational and psychological measurement, 63*(2), 336-351.

Kramarski, B., Weisse, I., & Kololshi-Minsker, I. (2010). How can self-regulated learning support the problem solving of third-grade students with mathematics anxiety? *ZDM - International Journal on Mathematics Education*, *42*(2), 179-193. https://doi.org/10.1007/s11858-009-0202-8

Morsanyi, K., Cheallaigh, N. N., & Ackerman, R. (2019). Mathematics anxiety and metacognitive processes: Proposal for a new line of inquiry. *Psihologijske Teme, 28*(1), 147-169.

Parveen, A., Jan, S., Rasool, R., & Bhot, R. (2023). *Self-Regulated Learning*. Ch. 20. DOI: 10.4018/978-1-6684-8292-6.ch020

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 451-502). Academic Press.

Pokhrel, M., & Sharma, L. (2024). Investigating students' perceptions of self-directed learning in mathematics at the basic school level. *Journal of Mathematics and Science Teacher, 4*(3), em066. https://doi.org/10.29333/mathsciteacher/14616

Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in science education, 36*(1-2), 111-139.

Turgut, İ. G., & Bakır, N. Ş. (2024). The mediating role of mathematics anxiety in the relationship between high school students' metacognitive awareness and mathematical resilience. *HAYEF: Journal of Education*, *21*(2), 183-191. https://doi.org/10.5152/hayef.2024.23064

Veenman, M. V. J., Kerseboom, L., & Imthorn, C. (2000). Test anxiety and metacognitive skillfulness: Availability versus production deficiencies. *Anxiety Stress and Coping, 13*(4), 391-41.

Zimmerman, B. (2008). Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. *American Educational Research Journal, 45*(1), 166-183. https://doi.org/10.3102/0002831207312909

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of Self-Regulation* (pp. 13-39). Academic Press.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

MERGING PHYSICS AND ANATOMY: INNOVATIONS IN TEACHING HUMAN BODY MECHANICS

Hashini Mohottala, Agnieszka Machowski, Muhammed Umair, & Joseph Lothamer
Department of Physics, University of Hartford, CT (USA)

Abstract

This study delves into a novel approach that combines animation with a 3D-printed leg prototype, serving as an innovative tool for teaching mechanics in a multidisciplinary course, *Mechanics and the Human Body. This course is created to serve students* from physical therapy, exercise science, occupational therapy, and pre-medicine students. While biomechanics textbooks offer theoretical problems, they lack interactive animations. Moreover, physics educators frequently face a deficiency of demonstrations directly related to the human body. Our approach fills these gaps by integrating a physical prototype and dynamic animation to vividly illustrate core concepts such as torque, rotational motion, and static equilibrium, focusing on examining tendon force as a function of external force. The methodology involved 3D-printing a leg prototype and applying external forces to the ankle to simulate leg extension exercises. A string representing the tendon was attached to the leg and routed over the "kneecap" to a fixed Newton meter. This setup allowed for precise measurements of tendon force as external forces varied. The data collected provided students hands-on experience analyzing mechanical forces, further reinforced through an interactive Python animation. The animation allowed the manipulation of variables and visualization of outcomes real-time. Although the prototype restricted the length of the leg and its weight, through the animation, students were encouraged to change those key factors and check how the force on the tendon changes as a function of an external force. To evaluate the benefits of this teaching method, we compared student understanding and engagement with and without the use of the prototype and animation. Assessment results show significant improvement in the student's understanding of mechanical concepts and ability to apply them to human body mechanics. Feedback from students further emphasized the importance of the hands-on approach in making theoretical concepts more relatable to their major. In conclusion, we report our new approach to teaching the Mechanics and Human Body Course. The combined use of animation and 3D-prototype enhanced the learning experience of our students by providing a practical, multidisciplinary perspective on mechanics. The combo deepened the understanding and fostered a greater appreciation for the connection between mechanics and the human body. It holds promise for improving physics and health sciences education, benefiting many students, and reassuring educators of its practicality and effectiveness.

Keywords: *Tendon force, mechanics and human body, physics pedagogy, physics and leg extension*.

1. Introduction

Visual learning has consistently enhanced student understanding in STEM education, with research highlighting the benefits of animations, demonstrations, videos, and simulations across disciplines (Mayer, 2009). However, while some fields have ample visual learning aids, others suffer from inadequate resources. We have recognized one such area as studying Mechanics in the Human Body, where straightforward yet practical demonstrations can bridge the gap between physics and anatomy. The course focuses more on Newtonian mechanics and its applications, concentrating on the various movements in the Human Body. We have already initiated the development of life-sized physical prototypes accompanied by simulations for the Mechanics and the Human Body courses taught at our institution (Mohottala et al. 2024). This study focuses on a recent model we designed to examine the force exerted on the patellar tendon during leg extension exercises. Our objective is to create an educational tool that can enhance students understanding in complex physics concepts by linking them to familiar anatomical structures.

2. Background and motivation

Students enrolled in courses that combine human anatomy and mechanics often have a strong background in human physiology but limited exposure to physics and algebra. As a result, abstract physical concepts—such as torque, force distribution, and moments—can be challenging for them to grasp. Studies have shown that using physical models improves comprehension in biomechanics education by allowing students to interact with representations of forces and motion (Hall et al., 2021). By designing a physical prototype that mirrors the anatomy of the lower leg, we aim to create an intuitive learning experience where students can directly visualize and interact with the forces at play. This approach allows them to apply their anatomical knowledge in a way that makes physics concepts more accessible and meaningful.

2.1. Challenges in modeling the lower leg

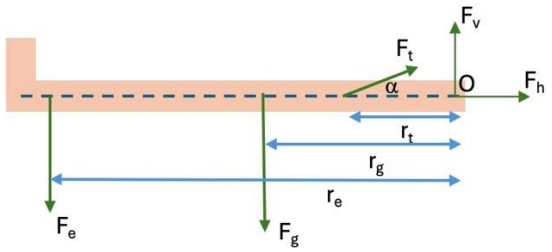
Developing an accurate prototype of the lower leg for modeling motion presented several challenges. One significant complexity arose in replicating the movement of the patella (kneecap). Unlike simple hinge joints, the patella does not follow a straightforward linear or rotational path; its motion is dictated by intricate interactions with surrounding tendons and muscles (Van Eijden et al., 1986). Misrepresenting this motion in a prototype could lead to an inaccurate understanding of force distribution during leg extensions. To address this, we 3D printed the lower leg using thermoplastic polyurethane (TPU) for flexibility, allowing for realistic articulation. To obtain a reasonable weight for the leg, we filled the leg with silicone. Additionally, we created multiple variations of the patella using polylactic acid (PLA) to explore different constraints and movement patterns. By iterating through these designs, we worked to refine a model that accurately represents how forces are transferred through the tibia during exercise.

The below discussion includes prototype design and 3D printing, the choice of printing material to mimic the natural elasticity of tendons and ligaments (Bertsch et al., 2022) and using PLA for the patella to evaluate its impact on the patellar tendon force distribution. Tendon force measurements during leg extension exercises and comparing force data with theoretical physics models are made at the end of the manuscript.

2.2. Physics behind

The main objective of this research, as stated in the introduction, is to help students grasp the fundamental physics involved in the motion of the human body. Specifically, this study focuses on the static equilibrium of forces in the lower leg around the kneecap. To achieve that, we began examining the forces acting on the leg. Figure 1 illustrates all the forces at work on the lower leg when it is subjected to an external pulling force at the ankle. Since we are considering static equilibrium, the distances from the pivot point are also indicated.

Figure 1. The force diagram of the leg where F_t, F_g and F_e are the force on patellar tendon, weight of the leg, and external force respectively and r_t, r_g and r_e are the corresponding distances from the kneecap to each force. The force acting on the patella is given in its vertical and horizontal components as F_v and F_h respectively.



Static equilibrium gives, that the net torque (τ) around point *"O"* equals to zero, leading to the below equation.

$$\Sigma\,\tau = 0$$

$$F_t r_t sin\alpha = F_g r_g + F_e r_e$$

$$F_t = \frac{F_g r_g + F_e r_e}{r_t sin\alpha}$$

$$F_t = \frac{r_e}{r_t sin\alpha} F_e + \frac{r_g F_g}{r_t sin\alpha}$$

y = mx + C type

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

The graph of F_t vs. F_e shows a linear relationship, y = mx + C type. Since we are dealing with the human body, there are limitations that applies on the upper limit of the external force (F_e). Within the boundaries, we applied forces on the ankle and recorded the F_t values and the complete discussions are given below.

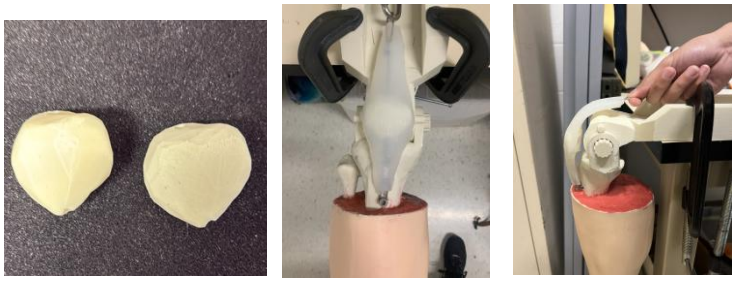
3. Methodology

Precise measurements are essential to create a realistic and anatomically accurate 3D-printed leg model. This model measures the forces exerted on the patellar tendon when external forces are applied to the ankle during full leg extension. Initially, a life-size skeleton was used to determine accurate dimensions of the bones and identify key anatomical components such as the femoral head, condyles, tibial plateau, and malleoli. As shown in Figure 2 a volunteer from the group performed a leg flexion exercise to assess the patellar angles at various flexion positions. During full leg extension, it was recorded that the patellar angle is at 19.9^o to the horizontal.

Figure 2. Leg flexion was done to assess the patellar angles at various flexion positions.

Following this, Fusion 360 was utilized to design the model based on the collected data. The components—including the Newton meter holder, femur holder, shin and foot skin shells, and the patella—were printed using the 3D Bambu Lab X1 printer. Since we needed solid parts for the Newton meter holder, femur holder, and patella, they were constructed from PLA synthetic filament as shown in Figure 3. However, the skin shells for the shin and foot were made from TPU synthetic filament leaving some room to stretch.

Figure 3. (a) shows two different size patellae printed using PLA. (b) shows the patella encapsulated in a silicon patella tendon and (c), the side view of the knee joint.



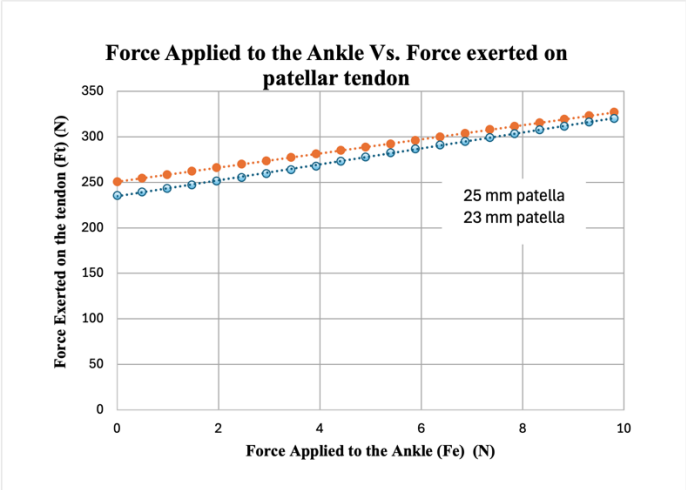
After all parts were printed, the model was assembled, and the skin shell was filled with silicone, resulting in a total mass of 3.86 kg. The completed model was securely fastened to the lab bench. The patella was encased in a silicone mold to simulate the patellar tendon. One end of the patellar tendon was connected to a pin located in the tibial tuberosity (the tendon attachment site), while the other end was secured to the Newton meter in the holder (Newton meter was used to read the tendon force), which was firmly attached to the bench with clamps.

Figure 4. (Left)The prototype of the completed leg attached to the clamp top view. (Right) The side view of the leg, the weight is hung at the ankle. Within the circled area, the orange meter is the Newton meter that we used to record the F_t data.

4. Discussion

Various masses, ranging from 50 grams to 1 kilogram, were hung around the ankle, and the resulting forces exerted on the tendon were recorded as a function of the forces applied at the ankle. Figure 5 shows the graph of tendon force (Ft) versus the externally applied force Fe. In this experiment we used two patellae that was 23 mm and 25 mm thick. The graph clearly shows the linear behaviors as predicted by the theory in equation (1). Also, the size differences make subtle changes in the actual F_t values as it slightly changes the length of the lever arm ($r_t \sin \alpha$).

Figure 5. The graph of applied force (F_e) versus the measured patellar tendon force (F_t).



Initially, this setup was used as an in-class demonstration to spark curiosity and introduce the concept. Students were then grouped and tasked with collecting data using different masses. They recorded their findings and compared them with theoretical predictions. In most cases, their experimental results matched the theoretical values within a 5% margin of error.

This hands-on experience boosted students' confidence, particularly among those who typically struggled with problem-solving. Encouraged by their progress, many students repeated the experiment—refining their measurements and comparing them with calculated values. This iterative process not only deepened understanding but also significantly improved engagement and retention in the class.

4.1. Conclusion and future directions

This study represents a step toward integrating physical prototypes and simulations into Human Body and Mechanics education. By providing students with tangible, interactive models, we enhance their ability to grasp fundamental physics concepts within an anatomical framework. Research indicates that hands-on engagement with physical models improves conceptual understanding and retention in STEM fields (Freeman et al., 2014). Future work will involve refining the model further, incorporating additional biomechanical factors such as muscle tension and external resistance, and expanding the use of simulations for in-depth analysis.

By continuing to develop these educational tools, we aim to foster a more comprehensive and engaging learning experience for students navigating the intersection of physics and human anatomy.

Acknowledgement

Part of this work was supported by the Dorothy Goodwin Scholarship at the University of Hartford.

References

Bertsch, A., Michel, T., Régnier, C., & André, J. C. (2022). Flexible micro-stereolithography: A new technology for 3D structures with rubber-like properties. *Advanced Materials*, *34*(12), 2201397.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, *111*(23), 8410-8415.

Hall, M. C., Riley, P. O., & Kerrigan, D. C. (2021). The role of physical models in teaching biomechanics: A systematic review. *Journal of Biomechanics Education*, *8*(1), 22-35.

Mayer, R. E. (2009). *Multimedia Learning* (2nd ed.). Cambridge University Press.

Mohottala, H., & Lothamer, J., (2025). Newton's laws and static equilibrium: measuring deltoid force in an arm lifting a load while wearing a heavy suit. *Physics Education*, *60*(2), 025002.

Van Eijden, T. M. G. J., Kouwenhoven, E., Verburg, J., & Weijs, W. A. (1986). A mathematical model of the patellofemoral joint. *Journal of Biomechanics*, *19*(3), 219-229.

Zajac, F. E. (1989). Muscle and tendon properties models: Their use in understanding human movement. *Exercise and Sport Sciences Reviews*, *17*, 79-137.

HEALTH PROMOTION THROUGH FACILITATING MASTERY, PARTICIPATION AND MOTIVATION IN SECONDARY SCHOOL

May Olaug Horverak[1], Gerd Martina Langeland[2], Emre Sari[1], & Tommy Haugen[3]
[1]Department of health and social sciences NORCE – Norwegian Research Centre (Norway)
[2]Department 2, Lillesand Upper Secondary School (Norway)
[3]Faculty of Health and Sports Sciences, University of Agder (Norway)

Abstract

Mental health issues have been on the increase for years in Norway, and after the pandemic, school absence has also increased. To meet these challenges, several national initiatives have been launched. New curricula emphasizing life mastery and public health have been implemented. In addition, various health promotion projects have been developed and executed in schools as part of a national public health program. The current study will present experiences from a project called SAMM – A systematic approach to mastery, participation, and motivation, where a five-step method has been applied, and relate this to a recently developed framework for health promotion in school. The five-step method for mastery, participation, and motivation applied included the following questions: 1) What is important in your life, and what goals do you have? 2) What about yourself and your life is good? Can you use this to achieve your goals? 3) Is there something in yourself or in general that stops you from reaching your goals? 4) What do you choose to work with the next month to achieve your goals? and 5) What will you do to carry this out? A quasi-experimental study with test and control groups was carried out, including an intervention of four sessions spread over about a month. In the first session, the teacher led a class discussion concerning how the students felt they mastered school and life in general, what was easy, and what was difficult; then, the students wrote anonymous answers to the three first questions, which the teacher collected. In the second session, the teacher summed up the answers from the students, and the final two questions were discussed before they wrote individual, anonymous answers. In the final two sessions, the students evaluated their own plans and efforts and adjusted for the next period. Seven upper secondary school classes were included as test groups, resulting in 132 student participants. Five control groups were included, resulting in 132 control students. Finding an appropriate scale to measure the effects of the intervention proved challenging. The General self-efficacy scale was used despite a rather limited focus. An ANOVA analysis was carried out, and no significant difference was observed between the test and control groups over time. However, the approach in the intervention relates to several aspects of health promotion, and a more extensive scale covering more of these aspects would perhaps have been more adequate to measure possible effects.

Keywords: *Health promotion, mastery, participation, motivation, secondary school.*

1. Introduction

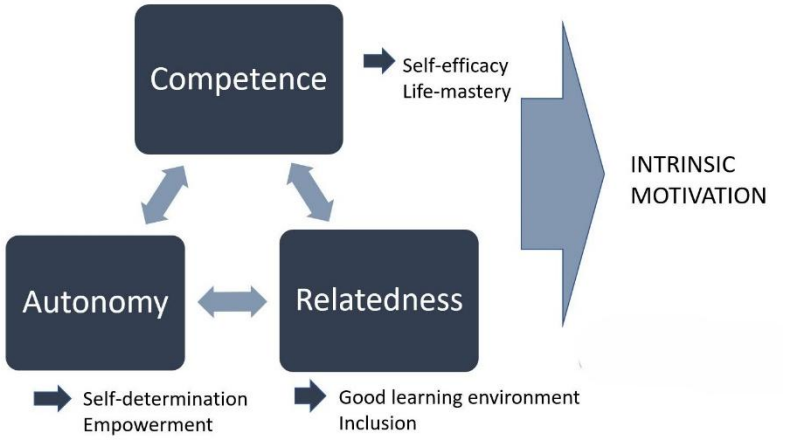
Mental health issues have been on the increase for years in Norway (Reneflot, 2018), and school absence has also been an increasing problem (Alver, 2020). Some of the problems students report, concern lack of motivation, pressure, varying degrees of anxiety, high drop-out, loneliness, and increased degree of bullying (Bakken, 2024; Enstad & Bakken, 2022, Parlikar et al., 2023). To meet these challenges, several national initiatives have been launched. The Norwegian schools renewed curricula emphasizing life mastery and public health have been implemented (The Norwegian Directorate of Education, 2017). In addition, various health promotion projects have been developed and executed in schools as part of a national public health program (Helmersen & Stiberg-Jamt, 2019). The current study presents one of these health promoting initiatives - a project called *SAMM – A Systematic Approach to Mastery, Participation and Motivation*, and investigates the potential of a five-step approach developed in this project. The five-step approach in SAMM builds on a combination of self-determination theory (Ryan & Deci, 2017) and health promotion theory (Antonovsky, 2012), which will be elaborated on below. The following research questions will be discussed: How can secondary school students be supported in experiencing mastery, participation, and motivation? How can this be measured? To answer these questions, a

quasi-experiment has been carried out, and the results will be discussed in relation to self-reported evaluations from students, as well as a framework for health promotion.

2. Self-determination and health promotion

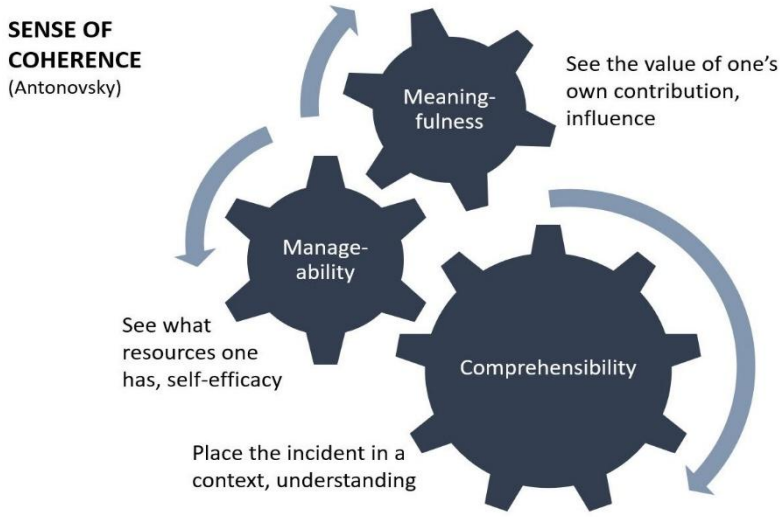
According to Ryan and Deci's (2017) self-determination theory, intrinsic motivation is achieved when the basic needs of competence, autonomy, and relatedness are met (see figure 1). Competence concerns mastering tasks in everyday life, and this could be related to Bandura's '(1997) theory on self-efficacy – if a person masters something, the expectation to master again, or the self-efficacy, is strengthened. Autonomy concerns participating in making decisions and having agency, setting one's own goals, and working towards these. Relatedness concerns having relations with others, which, for example, may be achieved by feeling included in a learning environment.

Figure 1. Self-determination theory and intrinsic motivation.



The theory on intrinsic motivation has some parallels to health promotion theory, or more specifically, Antonovsky's (2012) salutogenic theory. Antonovsky (2012) was concerned about identifying what made people experience good health rather than focusing on symptoms causing health problems. He identified three factors that made people resilient and robust enough to handle stress in everyday life through having a strong sense of coherence: comprehensibility, manageability, and meaningfulness (figure 2). Comprehensibility concerns understanding a situation and one's own role in that situation, manageability is about identifying one's own resources and resources in one's surroundings, and meaningfulness includes seeing the value of one's own contribution and feeling a possibility to influence a situation.

Figure 2. Health promotion theory and sense of coherence.



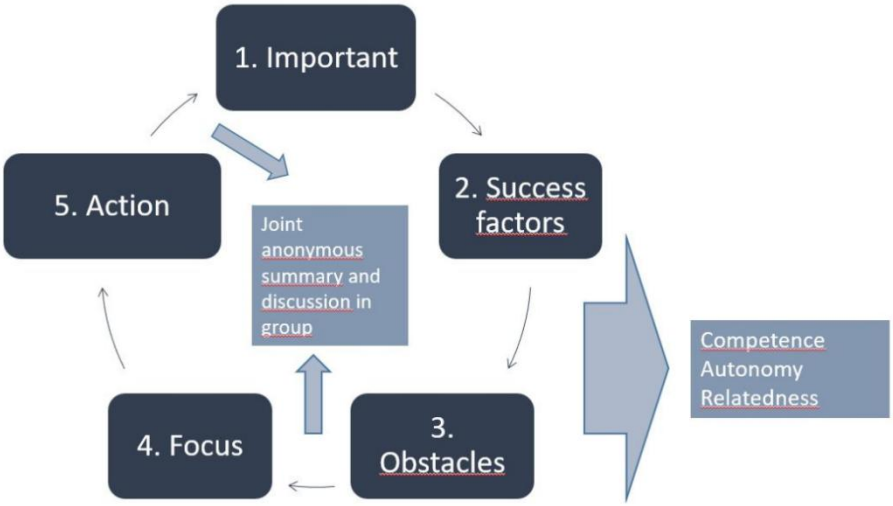
3. Research methodology

This study includes a quasi-experiment (Shadish et al., 2002) with test and control groups but without randomization. Convenience sampling was applied, due to limited possiblities to randomize within the context of the study. An intervention with the five-step approach, described below, was implemented in sessions every two to four weeks throughout the school year. The General Self-Efficacy scale (Schwartzer & Jerusalem, 1995) was used to measure at the beginning and the end of the school year, as pre-and post-tests. All data was collected anonymously and on paper, and students were informed that it was voluntary to participate in the research. As there was no way to identify the respondents, the project was not reported to the Norwegian data protection services for research. A two-way repeated measures ANOVA was used to analyze possible significant differences between test and control groups.

3.1. Intervention

The five steps include the following questions the students were to discuss and answer: 1) What is important in your life, and what goals do you have? 2) What about yourself and your life is good? Can you use this to achieve your goals? 3) Is there something in yourself or in general that stops you from reaching your goals? 4) What do you choose to work with the next month to achieve your goals? and 5) What will you do to carry this out?

Figure 3. The five-step approach in SAMM.



The first question, what is important in life, invites students to think about what they really want in life. It is important to reflect on this because often other persons tell them what to do and what matters – learning grammar, achieving higher grades in mathematics, etcetera. In addition, youths are affected by friends and social media on how to act, look or think. When they reflect on what is important to them, they typically list friends, family, education, good grades, a good job, and sports. To the second question, about what is good about themselves and their lives, they highlight personal qualities such as kindness, honesty, caring, and practical skills. To question three, many students list grades, tests, pressure, stress, lack of sleep, levels of anxiety, sadness, mental issues, and lack of motivation as obstacles. Dyslexia and disruptions from social media are also mentioned. Questions four and five are about choosing focus areas and making plans, and the students say that they want to focus on their concentration, grades, rest, homework, and on being social. Their action plans concern increasing their focus and efforts on schoolwork, as well as exercising and getting more sleep by going to bed earlier.

3.2. Sample

The sample included seven test groups and five control groups from the same upper secondary school, in the southern region of Norway, in total 132 student participants in each group. The school where the study took place is a combined upper secondary school with both general study students and vocational students, as well as students taking a third extra year to build on vocational studies to achieve competence to be admitted to universities.

Table 1. Participants.

Test or control group	Year in uss. (and age)	Type of group	Number of students
Test group 1	1 (15-16 y.)	General studies class with media specialization	22
Test group 2	1 (15-16 y.)	Vocational class – sales and transport	14
Test group 3	2 (16-17 y.)	Vocational class – sales and transport	4
Test group 4	2 (16-17 y.)	Vocational class – child and youth worker	12
Test group 5	3 (17-18 y.)	Extra year vocational class to achieve study comp.	25
Test group 6	1 (15-16 y.)	General studies class	30
Test group 7	2 (15-16 y.)	General studies class	25
Control group 1	1 (15-16 y.)	General studies class	25
Control group 2	3 (17-18 y.)	Extra year vocational class to achieve study comp.	26
Control group 3	1 (15-16 y.)	General studies class	29
Control group 4	2 (16-17 y.)	General studies class	24
Control group 5	2 (16.17 y.)	General studies class	28

Note. uss. = upper secondary school

4. Findings and discussion

This study aimed to investigate the potential of a five-step approach to support mastery and motivation for upper secondary school students. The results of the ANOVA analysis showed no significant difference between the groups. Although the statistical analysis did not show significant effects, it is important to consider that the self-efficacy scale may not fully capture the broader impacts of the intervention. Despite this, the observed trend in mean self-efficacy improvement favored the intervention group. This finding suggests a potential for further exploration in future studies that employ larger sample sizes. In line with this, the students' feedback on using the method, in general, has been positive: they report that they like it, and many students report becoming more motivated and better at planning and following up on their plans (Horverak et al., 2020, Horverak, 2020). Another study where the method was applied in a second language learning setting showed the potential of the method to help students choose strategies for language learning and to reduce foreign language anxiety (Horverak et al., 2022). The five-step approach is dynamic and is adjusted to the students' needs, whether it concerns life skills or challenges in a subject. The dynamic nature of the five-step approach makes it difficult to carry out an effect study, covering all aspects that may have been influenced by the approach.

One of the benefits of applying the five-step approach is that it gives students acknowledgment and respect by giving them an opportunity to focus on their qualities and success factors (Langeland & Horverak, 2021). Reflecting on personal qualities is extra important for young people because they are easily influenced and concerned with what others think, which can cause them to overlook or underestimate what is positive about themselves (Langeland & Horverak, 2021). Applying the five-step approach may help students balance their focus on the positive aspects of their situation and possible challenges and find solutions through discussions in the class. An essential goal of using this method, is that the students develop robustness and ability to deal with challenges (Langeland & Horverak, 2021). Identifying resources and solutions together with others may support students to experience intrinsic motivation through autonomy, competence, and relatedness (Ryan & Deci, 2017), as well as a strong sense of coherence through comprehensibility, manageability, and meaningfulness (Antonovsky, 2012).

Finding an appropriate scale to measure the effects of the intervention proved challenging, as the purpose of using the method includes a multitude of different aspects related to the students' general well-being. The chosen measuring instrument was limited to measuring self-efficacy (Schwartzer & Jerusalem, 1995). The method's main purpose is to contribute to the students' experience of intrinsic motivation, mastering, and participation (Langeland & Horverak, 2021; Ryan & Deci, 2017), and to achieve this, there is a need for experiencing trust, autonomy, competence, relatedness, safe surroundings, recognition and respect, aspects incorporated in a newly developed framework for health promotion (Horverak et al., 2024a; 2024b). A scale covering more aspects would be more adequate to measure possible effects.

5. Conclusion

To conclude, the results of this study show that applying the approach described above had no effect on students' self-efficacy, although there was a positive trend in the results in favor of the intervention group. However, the five-step method for working with mastery, participation, and motivation relates to several aspects of self-determination and health promotion. A more extensive scale is needed to investigate possible effects, covering more aspects of universal health promoting initiatives aimed at supporting students experiencing mastery and motivation.

Acknowledgments

The study reported is related to projects supported by RRF Agder and Agder County.

References

Alver, V. (2020). *Lærerrommet: frafall i videregående, hva skal vi gjøre?* Utdanningsforbundet. https://www.utdanningsforbundet.no/larerhverdagen/podkasten-larerrommet/larerrommet-frafall-i-videregaende-hva-skal-vi-gjore/

Antonovsky, A. (2012). *Helsens mysterium: Den salutogene modellen*. Gyldendal.

Bakken, A. (2024). Ungdata 2024. Nasjonale resultater. *NOVA Rapport 6/24*. Oslo: NOVA, OsloMet. https://oda.oslomet.no/oda-xmlui/bitstream/handle/11250/3145138/Ungdata2024_NasjonaleResultater_UU.pdf?sequence=1&isAllowed=y

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Freeman.

Enstad, F., & Bakken, A. (2022). Ungdata junior 2022. Nasjonale resultater. *NOVA Rapport 6/22*. Oslo: NOVA, OsloMet. https://oda.oslomet.no/oda-xmlui/bitstream/handle/11250/3011552/NOVA-rapport-6-2022.pdf?sequence=5&isAllowed=y

Helmersen, M., & Stiberg-Jamt, R. (2019). *HBS Agder: Førevaluering av tiltak for helsefremmende barnehager og skoler*. NORCE Samfunnsforskning og Oxford Research. https://norceresearch.brage.unit.no/norceresearch-xmlui/handle/11250/2621192

Horverak, M. O., Langeland, G. M., & Aanensen, M. (2020). Systematic work with motivation and life mastery skills in upper secondary school: An action research study from a Norwegian context. *The 8th European Conference on Education – London 2020 Official conference proceedings* (pp. 65-76). https://doi.org/10.22492/issn.2188-1162.2020.7 https://papers.iafor.org/submission57545/

Horverak, M. O. (2020). Developing resilience and life mastery skills in the classroom – a multiple case study comparing a Norwegian and Peruvian context, ISSN: 2189-1036. *The 5th IAFOR International Conference on Education – Hawaii2020 Official conference proceedings* (pp. 31-44). https://doi.org/10.22492/issn.2189-1036.2020.3 https://papers.iafor.org/submission53632/

Horverak, M. O., & Aanensen, M. (2019). Decreased motivation and increased mental illness among young people – a need for teaching life mastery skills in school. *The 7th European Conference on Education, Independence & Interdependence, official conference proceedings* (pp. 239-251). https://papers.iafor.org/submission52464/

Horverak, M. O., Langeland, G. M., Aanensen, M., Hellang, Ø., Eide, S. E., Haugen, T. & Helmersen, M. (2024). Et helsefremmende skolemiljø for økt skolenærvær. *Forebygging.no*. https://doi.org/10.21340/m9pw-ct37

Horverak, M. O., Langeland, G. M. Kühn, N. S., Hellang, Ø., & Helmersen, M. (2024). Health promotion principles and practices in school. *International Journal of e-Healthcare Information Systems, 10*(1). 10.20533/ijehis.2046.3332.2024.0036

Horverak, M. O., Langeland, G. M., Løvik, A., Askland, S., Scheffler, P. & Wach, A. (2022). Systematic work with speaking skills and motivation in second language classes. *IAFOR Journal of Education, 10*(1), 33-52. https://doi.org/10.22492/ije.10.1.02

Langeland, G. M. & Horverak, M. O. (2021). *Hvordan legge til rette for mestring, medvirkning og motivasjon: I ungdomsskole og videregående skole.* Cappelen Damm Akademisk.

Parlikar, N., Kvaløy, K., Strand, L. B., Espnes, G. A., & Moksnes, U. K. (2023). Loneliness in the Norwegian adolescent population: prevalence trends and relations to mental and self-rated health. *BMC psychiatry, 23*(1), https://doi.org/10.1186/s12888-023-05404-5

Reneflot, A., Aarø, L. E., Aase, H., Reichborn-Kjennerud, T., Tambs, K., & Øverland, S. (2018). *Psykisk helse i Norge*. Folkehelseinstituttet. https://www.fhi.no/globalassets/dokumenterfiler/rapporter/2018/psykisk_helse_i_nor ge2018.pdf

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. The Guilford Press.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference.* Houghton, Mifflin and Company.

Schwarzer, R., & Jerusalem, M. (1995). *General Self-Efficacy Scale (GSE)* [Database record]. APA PsycTests. https://doi.org/10.1037/t00393-000

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

VIRTUAL LABORATORIES AS A WAY TO ENHANCE STUDENTS LEARNING IN BIOSCIENCES

Angel Herráez
Biochemistry and Molecular Biology Unit, Department of Systems Biology, University of Alcalá (Spain)

Abstract

The rapid development of experimental techniques in biosciences makes it hard for institutions to include practical training for students in those fields. Difficulty often comes from lack of instrumentation in the teaching laboratories, limited economical resources, high student numbers, as well as safety concerns about handling some biological samples. Simulations and virtual laboratories offer a chance to supplement the on-site wet laboratory practicals as well as to offer students some experience with those experiments that are not feasible in the physical setting. It is hence significant for instructors to know about existing resources and to redesign their teaching plans to include virtual laboratories in the education process, in order to enhance students' learning and have them understand modern techniques even if they are not accessible in the physical facilities of the institution. A collection of free resources will be showcased, which means instructors anywhere in the world can access this approach. They are all used inside a web browser, without any requirements for other software, offered under a Creative Commons license. Topics include: chromatography (column chromatography of proteins, thin-layer chromatography for separating amino acids, lipids or pigments); electrophoretic analysis (proteins on cellulose acetate, SDS-polyacrylamide gel electrophoresis of proteins, DNA on agarose gels); UV-VIS spectrophotometric assays; a full-featured molecular biology virtual laboratory (enzyme restriction, polymerase chain reaction and electrophoretic analysis, applied to genetic polymorphisms, forensic analyses, paternity test, foodstuff adulteration, viral infection by SARS-CoV2 or Influenza). These resources are being used over the last decade by numerous instructors with their students, both at high school, professional training and university courses. Groups of students going through the experience of the molecular biology lab range from 6 individuals to 300. Some of the instructors have repeatedly used it for 8 years. Reports from the instructors inform of high satisfaction, particularly in lower-income countries where the teaching institutions have very limited economic resources and cannot have access to advanced techniques and related instrumentation. The presentation is addressed mainly to instructors in science subjects, particularly biological and molecular sciences, at high school or university level, as well as postgraduates with a perspective to become instructors.

Keywords: *Virtual laboratories, simulations, biomolecular sciences, experimental techniques.*

1. Introduction

Teaching laboratory techniques in molecular and biological sciences poses a number of challenges depending on the facilities available at the institution. One limitation may be the number of students that can be attended in a laboratory in the available space and time. Another is the requirement for instrumentation that is often expensive, particularly for state-of-the-art technologies. Not negligible is also the possibility to acquire biological samples and the precautions and safety hazards involved in their manipulation. Finally, there is usually little chance in a physical setup ("wet lab") for students to repeat experiments or to explore diverse experimental conditions, due to both space, time and economical constraints. All these difficulties are substantial in lower level educational institutions and in many countries where resources are scarce. However, in all settings it is expected that a graduate will be familiar with modern technology dealing with chemical and biological materials, and be well trained for a world that demands up-to-date professionals.

The continuous progress and affordability of the informatics and communication technologies has increasingly made possible to contemplate that computer simulations may provide a supplement or even an alternative to the real or physical laboratory for the training in experimental techniques in the biomolecular laboratory. Development of such tools may hence be useful to ameliorate the limitations described above.

We could summarize that the "virtual lab" may come handy to be combined with the "wet lab" to provide a more thorough training of the students while mitigating the limitations.

2. Objectives

The purpose of this communication is double. On the one hand, to present and share the material we have developed in the form of computer simulations and virtual laboratories, which may be used by both instructors and students to assist in the training process. Those resources are offered for on-line use, with no economical cost, with an open license, from any country, in both English and Spanish versions. Secondly, to put forward some reflections about the most profitable way these tools may be integrated into the teaching and learning process.

3. Design and contents

The collection of resources presented here is hosted in one of the university web servers (Herráez, n.d.) and is under continued development. It is hence available for users at any location, provided they have internet access. Most of the time materials, once they have been accessed, run locally in the memory of the user's device (i.e. not in the web server); therefore, there is no need for a strong connection. The Creative Commons license means that, if needed due to difficulty with network, the resources could be duplicated and used in local equipment without internet connection.

All modules are written in HTML, with heavy use of JavaScript and CSS to achieve the simulation effects and respond to the interaction by the user. Therefore, there is no need to install any software other than a standard, modern web browser. Some modules may be used in mobile devices, but due to limitations in screen size and in precision of tactile interaction, it is recommended to use a computer for a better experience.

The site is organized in sections focused on different techniques, namely electrophoresis, chromatography, spectrophotometry, and a molecular biology laboratory for DNA that includes restriction enzyme digestion, PCR, DNA sequencing and electrophoretic analysis.

In all modules, interactivity is a key feature. The user will have to make decisions, choose samples and conditions, prepare mixtures, and act on the elements displayed on the screen in order to perform the experiment. Results obtained will depend on which actions were taken, hence they are not always the same and even failures may be observed, at least in the most elaborate modules.

3.1. Electrophoresis

This section includes a simulation of the result of separating serum proteins on cellulose acetate strips, as well as another for lactate dehydrogenase isoenzymes (according to their charge, or their isoelectric point). Both include a choice of samples, like normal and pathological serum, and homogenates from several tissues. For the isoenzymes, there is also a module where the user must gather and apply samples onto the strip, then the separation is simulated and results collected. Another module represents separation of a protein mixture by SDS-PAGE, i.e. in a polyacrylamide gel containing sodium dodecyl sulfate, according to their molecular mass.

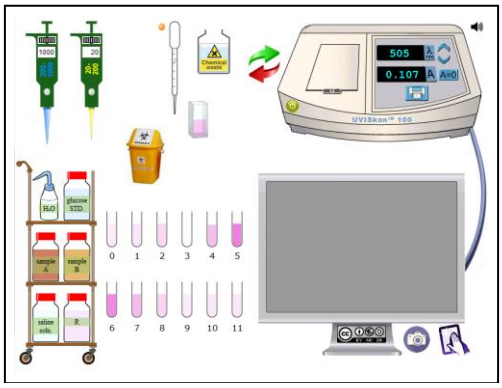
3.2. Chromatography

A column is simulated, with a choice of several resins and packings, for animating the separation of diverse protein mixtures. The resulting chromatogram is also displayed in real time. A separate module is used to analyze the content of glycated hemoglobin (HbA1c) in a blood sample, which is relevant for diagnosis of diabetes. Finally, thin-layer chromatography may be applied to mixtures of either amino acids, lipids or plant pigments; here the user will manipulate capillaries to apply samples and then run steps for the separation and reveal the result.

3.3. Spectrophotometry

A fully-fledged UV-VIS spectrophotometer is depicted, in a simulated laboratory complete with reagents, test tubes, cuvettes and micropipettes. User controls wavelength, introduces and extracts cuvettes with sample, records absorbance values or a spectrum. An assortment of virtual experiments may be run covering several assays: spectra, quantitation against a calibration curve, kinetic determination of enzyme activity, and effect of pH and temperature on the activity of an enzyme.

Figure 1. The spectrophotometry laboratory.

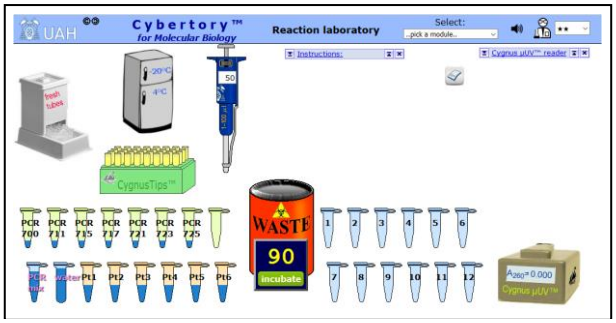


3.4. Cybertory: A molecular biology laboratory for genetic analysis

This is an elaborate module, maybe the most similar to real laboratory experiments for its flexibility. It simulates the selection of samples and reagents from a catalog, their acquisition (with order and invoice) and then the work in several modules. The application includes molecular diagnostics with RFLP or PCR of genetic polymorphisms, forensic analysis of DNA, a paternity test using multiplex PCR of polymorphic STR genetic markers, molecular analysis of foodstuff adulteration and mapping of DNA with restriction enzymes.

In the reaction laboratory, users may prepare in test tubes any mixture of the previously acquired samples and reagents, and accordingly run either digestion of DNA with restriction enzymes or PCR amplification with the chosen primers. Then, moving to the electrophoresis laboratory, DNA fragments will separate by size and the resulting pattern revealed and interpreted. There is also a sequencing laboratory where the classical Sanger method is applied, using dideoxynucleotides labeled with 4 fluorochromes.

Figure 2. The reaction laboratory within Cybertory.



Sample protocols are provided so that any user can perform a successful experiment on their own. Apart from that, it is expected that instructors will customize the procedure according to the context and abilities of their student groups.

4. Assessment on the use of a virtual laboratory

As already mentioned, the virtual laboratories are openly available in the web for anyone to use. We do not have a reliable estimate about their use, other than ranking in web searches and visit counters in a few sections. Only the Cybertory has access restricted by username and password, meant precisely to gain some knowledge about its use. Interested persons, either instructors or individual students, may get access just by email request, and this access must be renewed when a new year arrives. Some instructors have repeatedly used the resource with their groups of students over several years since 2017.

A survey was designed to assess how the Cybertory virtual laboratory has been used and how the experience has been. It was distributed by email to ca. 600 instructors worldwide (totaling 45 countries) that had requested access to the resource and used it with their students at some moments along the period 2017 to 2024. The online questionnaire, anonymous, with 11 items (table 1), received 170 responses from 21 countries.

Table 1. Questionnaire distributed as a survey of instructors' experience and assessment.

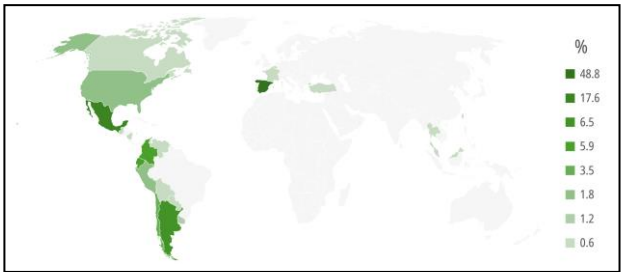
Q1	Which country are you in?
Q2	Educational level of your students. (If you use it in several, please fill a survey for each)
Q3	Number of students in each group using the Cybertory. (You can check more than one)
Q4	Total number of students using the Cybertory in an academic year. (You can check more than one)
Q5	Which experiments in Cybertory do your students work on? (You can check more than one)
Q6	In which stage do you use the Cybertory, within your teaching strategy? (You can check more than one)
Q7	Motivation for using the virtual laboratory.
Q8	Your perception of how much your students value these aspects: (1= little or no value; 3= neutral; 5= much valued)
Q9	Your own evaluation, as instructor, of these aspects: (1= little or no value; 3= neutral; 5= much valued)
Q10	Please value your overall satisfaction with the tool, as an instructor.
Q11	Please value how you perceive your students' overall satisfaction with the tool.

The extension of this short article does not allow for a detailed report of this survey, which will be provided in the oral presentation at the congress. As a brief summary, see table 2.

Table 2. Summary of results of the survey.

Q1	**21** countries (see fig. 3)
Q2	**18%** Secondary education / High school; **25%** Professional training degree / Technical degree; **52%** University (college, BSc); **4%** Master / Posgraduate degree
Q3	**13%** up to 10; **68%** 11 to 30; **18%** 31 to 50; **3%** 51-100; **4%** over 100 students per group
Q4	**7%** up to 10; **37%** 11 to 30; **25%** 31 to 50; **21%** 51 to 100; **10%** over 100 students per year
Q5	**58%** Forensic analysis PCR. **51%** Paternity test PCR. **46%** Forensic analysis RFLP. **36%** DNA sequencing. **32%** Beta-S globin (sickle cell anemia). **29%** Viral infection (COVID). **21%** Dairy products adulteration. **15%** Celiac disease. **10%** Cytochrome P450 polymorphism. **9%** Vegetable oil adulteration. **7%** Resistance in plants. **2%** RET protooncogene (MEN2A neoplasia)
Q6	**79%** Instead of the real laboratory, which is not feasible. **20%** After the real laboratory, as reinforcement, review or to expand the experiments. **39%** Previous to the real laboratory (wet lab), as preparation or training.
Q7	**28%** Don't have the equipment and techniques available in real laboratory. **20%** Have the equipment but economically not affordable. **52%** As a complement to the real laboratory.
Q8	(Mean | Median, max. 5 points) **4.6 | 5** Accessibility. **4.4 | 5** Ease of use. **4.6 | 5** Contribution to understanding of techniques and to learning. **4.3 | 4** Degree of realism (not just visual, but functional) compared to a real experiment. **4.6 | 5** Attractive character of the theme of the experiment.
Q9	(Mean | Median, max. 5 points) **4.8 | 5** Accessibility. **4.6 | 5** Ease of use. **4.8 | 5** Contribution to understanding of techniques and to learning. **4.5 | 5** Degree of realism (not just visual, but functional) as compared to a real experiment. **4.9 | 5** Economical considerations (against similar commercial products more sophisticated)
Q10	(Mean | Median, max. 10 points) **9.4 | 10**
Q11	(Mean | Median, max. 10 points) **8.6 | 9**

Figure 3. Location of users that responded to the survey.



5. Discussion

As we have presented in the introduction, computer simulations may provide alternatives to overcome limitations that affect teaching laboratories. Even where the real experience is available, there is

still benefit in using virtual laboratories so that students come more prepared to the physical setup, that they can review their work, repeat, try different conditions, explore both the techniques and the outcome of results from experiments that allow variations. This may bring a training more similar to real life research, using the scientific method, exploring freely, practicing interpretation of results, both predicted and unexpected. It is most important that the simulations and virtual laboratories have not a closed design with respect to both the options and the results, but are open to changing parameters and provide results strictly according to what was done. For example, although samples must be programmed in the software, it is preferable that they can be assigned randomly, in a way that the output will be different for each student at each attempt. In this way, the experience is richer than what may be provided by, for instance, slide shows and videos, which necessarily follow one single path and bring always the same result.

Several high-quality products are in the market, undoubtedly excellent solutions to complement students' training, but the cost makes them not a choice for many educational institutions. Open access and cost-free resources are a strong value for what we are presenting here, together with the possibility of dynamically expanding the virtual experiments available, through collaboration with interested instructors and scientists, as it has indeed happened in our case. Apart from this, we believe that the flexibility that some of our modules offer in terms of experimental design by the student, with coherent, variable, positive or negative results, is not present in many products and means a remarkable advantage for a solid training of our students, moreover when provided free to be used from any location in the world.

The survey conducted among instructors that use Cybertory reports use from secondary up to tertiary education, with stronger involvement in university and technical degrees. Most popular topics were genetic identity tests (forensic and paternity). A majority of users (79% in Q6) resorted to it as a replacement for some experiments they could not run physically; however, this does not mean they had no facilities at all, since the most frequent response (52%) on Q7 was that virtual complemented the real laboratory. Since we could not poll the students, we rely on what their instructors perceived about their interests and experiences. The score in all aspects was very high, averages above 4.4 over 5. In turn, instructors' appreciation was slightly higher and the economical issue was particularly valued (this question was not addressed to the students). The overall satisfaction with the Cybertory was valued 8.6 by students and 9.4 by instructors, with median values of 9 and 10 respectively.

To finish, here is a quote from the feedback received recently from a professor in a technological institute, who has been a user along the last five years:

> *I take this opportunity to express my gratitude for allowing us access to this powerful teaching-learning tool. Without a doubt, since I began using it in my classes, my students have lost their fear of not being able to understand and have become much more adventurous in trying it in real life. In the lab I lead, I don't have the tools to run all the analyses that I can perform thanks to the Cybertory. My students are surprised to see that in real-life situations, the same results are obtained, and I am delighted that each one can experience the importance of being thorough in the development of their experiments. Obtaining different results is fantastic because it motivates them to continue until they obtain their own results and compare them with their classmates. Without a doubt, the Cybertory has helped many young people at my institution change their perspective on the difficulty of performing this type of testing and has redirected the paths of several of them, inspiring vocations toward the field of molecular biology and its applications. I hope you allow us to continue using this tool, which has become indispensable for me and my students.*

Acknowledgments

The initial idea and part of the inner coding that runs the simulations in Cybertory are due to Robert M. Horton, Ph.D. (Horton & Tait, 1999), who offered it for the Netscape browser; in 2006 he released the code under GNU GPL license, which allowed us to convert to modern browsers syntax and to expand it for PCR assays and many new types of experiment.
The SDS-PAGE simulation adapted an original design by David Mix and Dr. Paul Craig (Rochester Institute of Technology), with valuable help from Prof. Robert M. Hanson (St. Olaf College).
Much code has been developed thanks to advice and examples openly shared in the web.

References

Herráez, A. (n.d.). *Biomodel Virtual Laboratories*. Retrieved March 14, 2025, from https://biomodel.uah.es/en/lab/

Horton, R., & Tait, R. (1999). A virtual molecular biology teaching laboratory. *BioTechniques, 27*, 298-300. doi:10.2144/99272ir01

ADOLESCENTS' EMOTIONAL RESPONSES TO A SUICIDE ATTEMPT SHARED ON SOCIAL MEDIA: INSIGHTS FROM COLLECTIVE INTELLIGENCE

Raquel Lozano, Sonia Valero, & Montserrat Aiger
Department of psychology and sociology, Faculty of Education, University of Zaragoza (Spain)

Abstract

Adolescents' use of social media has created spaces for identity expression and social interaction, but it has also highlighted challenges related to mental health and emotional well-being. This study examines how adolescents emotionally respond to a suicide attempt shared on social media, considering the impact of individual and group phases of response. The objective was to explore the polarity, subjectivity, and emotional concordance within these responses, emphasizing potential risk factors and support dynamics. Using text analysis tools such as Voyant Tools and Meaning Cloud, the study analyzed responses from adolescents to identify key emotional patterns. Voyant Tools enabled a word correlation analysis, while Meaning Cloud assessed sentiment metrics, including polarity (positive or negative), subjectivity, and emotional agreement. Data were analyzed across seven phases to observe emotional evolution and variability. The results revealed that the majority of responses displayed positive polarity, characterized by empathy and calls for professional help. Strong correlations emerged between terms related to support, such as "help" and "psychologist" (0.99, $p<.001$). However, a subset of responses contained negative polarity, including ridiculing the victim or reinforcing suicidal behavior. Correlations highlighted the diminished perceived role of parental figures, with "parents" negatively associated with terms like "support" and "divorce" (-0.25, $p<.01$). Additionally, references to bullying and self-objectification were frequent, reflecting adolescents' awareness of the social pressures linked to mental health struggles. The findings underscore the dual role of social media in providing both support and risk. While many adolescents demonstrated an understanding of the situation and offered constructive advice, others reflected a lack of empathy or even harmful behavior. The study also highlights the role of community dynamics, where individuals acted as either supporters ("lifeguards") or instigators ("trolls"), influencing outcomes in the online space. This research highlights the need for educational interventions that enhance digital literacy and emotional resilience among adolescents. Training programs should aim to foster empathetic online interactions while equipping young users with tools to identify and mitigate harmful behaviors. Platforms should also incorporate mechanisms to promote positive engagement and provide immediate access to support resources.

Keywords: *Emotional response, adolescent mental health, social media behavior, suicide prevention.*

1. Introduction

The contemporary adolescent experience is deeply intertwined with social media, serving as a key space for identity construction, emotional expression, and peer interaction. This summary synthesizes findings from recent literature, offering a multi-faceted perspective on adolescent behaviour in digital environments.

Adolescents engage with platforms like Instagram, TikTok, and Kampal not only for communication but as a mechanism to build and project identity (Boyd, 2014). Popularity metrics (e.g., likes, followers) intensify self-presentation anxieties, often resulting in behaviours such as social grooming and chronic impression management (Utz et al., 2012). Adolescents strive to align with classroom social norms, applying them within anonymous or semi-anonymous digital contexts (Bravo et al., 2024), potentially generating contagion effects (Marks et al., 2012).

Despite a proliferation of theoretical frameworks since 2010, empirical research remains scarce regarding the emotional tone of most-consumed content (Murillo-Borjas, 2022). Positive-valence content (e.g., lifestyle, travel, body image) dominates adolescent engagement (Peres et al., 2020; Lozano-Blasco et al., 2023), while negatively polarised content (e.g., depression, loneliness) correlates with psychological vulnerabilities (Balakrishnan & Griffith, 2017; Kumar et al., 2019).

Objectification theory (Fredrickson & Roberts, 1997) provides a lens through which frequent self-objectification among adolescents, particularly females, can be understood. Prolonged exposure to appearance-focused posts fosters body surveillance, body shame, and internalisation of an observer's perspective (Gioia et al., 2020; Boursier et al., 2020a, 2020b). This is particularly concerning given the association with psychological distress (Arroyo & Brunner, 2016; Trekels et al., 2018).

Digital platforms like Reddit exemplify both the empowering and dangerous facets of adolescent participation. Framed by the concept of the "prosumer" (Ritzer et al., 2012), adolescents act as both content creators and consumers, often navigating sensitive themes like mental health and suicide. While peer support in closed groups (e.g., Facebook communities) can foster resilience (Lerman et al., 2017), unregulated exposure to suicidal ideation online can have contagion effects, akin to the Werther phenomenon (Moir et al., 2023; Fratini & Hemer, 2020).

Individuals with suicidal thoughts may avoid official resources due to perceived coldness, instead favouring anonymous forums where engagement is immediate and human (Biddle et al., 2020). These platforms, however, are unpredictable. Community responses can either deter (lifeguards) or reinforce (trolls, enablers) suicidal ideation. Trolls, defined as users who deliberately provoke or escalate distress (Westerlund et al., 2015), often play a decisive role in outcomes, especially when individuals fear public shame if they "back down" from suicidal posts (Fratini & Hemer, 2020).

Engagement in high-visibility digital activities (e.g., viral challenges, influencer followership) may mimic addiction symptoms (Velozo & Stauder, 2018). Adolescents influenced by certain online figures are more prone to anti-social behaviours such as aggression and deceit. Additionally, excessive digital involvement, particularly driven by boredom, may foster compulsive patterns and digital dependency (Stockdale & Coyne, 2020).

2. Objectives

The primary aim of this study is to examine the polarity, subjectivity, and emotional alignment of adolescents' responses to mental health-related content on social media. By analysing linguistic and emotional patterns through digital text analysis tools, the research seeks to identify both risk indicators and supportive dynamics within these online interactions.

3. Methods

This study employed a mixed-methods digital discourse analysis to examine adolescent responses to a simulated suicide attempt posted on social media. The emotional and lexical content of these responses was analysed using two advanced tools: Voyant Tools, for lexical correlation analysis, and MeaningCloud, for sentiment analysis. The aim was to evaluate polarity (positive/negative), subjectivity, emotional agreement, and ironical tone across seven distinct phases representing individual to group-level interactions.

Data were drawn from open-ended responses to five experimental questions, presented across the seven phases. Voyant Tools enabled the detection of word co-occurrences and intensities of associations, while MeaningCloud allowed the classification of emotional orientation, providing insights into both individual empathy and collective sentiment dynamics.

4. Results

The analysis revealed a predominance of positive polarity across most phases, indicating empathetic engagement from adolescent participants. Terms such as "help", "support", and "psychologist" showed strong positive correlations ($r = 0.99$, $p < .001$), particularly during early phases.

Conversely, negative polarity was present in a minority of responses, often involving ridicule or reinforcement of suicidal ideation. Notably, the term "parents" was negatively correlated with words like "support", "divorce", and "autolesionarse" across multiple phases, suggesting a perceived emotional distance or lack of involvement from parental figures (e.g., $r = -0.25$, $p < .01$).

Strong thematic associations emerged around concepts of mental health, bullying, and self-objectification. For instance, "bullying" was highly correlated with "mental" and "incite", and "autolesionarse" with "school" and "sadness".

In early phases, participants frequently expressed concern and offered constructive advice (e.g., "she" + "help her", $r = 0.89$, $p < .001$). Later phases reflected greater emotional nuance and references to digital risks, privacy, and community responsibility. Roles resembling "lifeguards" and "trolls" were identified, echoing findings by Fratini & Hemer (2020) on online suicide reactions.

5. Conclusion

The findings illustrate the dual role of social media in adolescent mental health discourse—functioning both as a supportive environment and a potentially harmful space. While many adolescents displayed emotional awareness, empathy, and prosocial intentions, a smaller but concerning group demonstrated insensitivity, moral disengagement, or reinforcement of suicidal thoughts.

Negative sentiment and the minimised role of parental figures point to the need for improved emotional communication channels within families. The study underscores the importance of educational interventions, particularly in digital literacy, empathy training, and crisis response awareness, tailored for adolescents engaging in online peer interactions. Furthermore, the emotional dynamics observed suggest that platforms should integrate real-time support mechanisms to counter harmful behaviours and foster protective community responses.

References

Arroyo, A., & Brunner, S. R. (2016). Negative body talk as an outcome of friends' fitness posts on social networking sites: Body surveillance and social comparison as potential moderators. *Journal of Applied Communication Research, 44*(3), 216-235. https://doi.org/10.1080/00909882.2016.1192293

Balakrishnan, J., & Griffith, M. D. (2017). Social media addiction: What is the role of content in YouTube? *Journal of Behavioral Addictions, 6(*3), 364-377. https://doi.org/10.1556/2006.6.2017.058

Biddle, L., Derges, J., Goldsmith, C., Donovan, J. L., & Gunnell, D. (2020). Online help for people with suicidal thoughts provided by charities and healthcare organisations: A qualitative study of users' perceptions. *Social Psychiatry and Psychiatric Epidemiology*, *55*(9), 1157-1166. https://doi.org/10.1007/s00127-020-01852-6

Boursier, V., Gioia, F., & Griffiths, M. D. (2020a). Objectified body consciousness, body image control in photos, and problematic social networking: The role of appearance control beliefs. *Frontiers in Psychology, 11*, 147. https://doi.org/10.3389/fpsyg.2020.00147

Boursier, V., Gioia, F., & Griffiths, M. D. (2020b). Selfie-engagement on social media: Pathological narcissism, positive expectation, and body objectification—Which is more influential? *Addictive Behaviors Reports, Advance online publication*. https://doi.org/10.1016/j.abrep.2020.100263

Boyd, D. (2014). *It's complicated: The social lives of networked teens.* Yale University Press.

Bravo, A., Krause, R. W., Ortega-Ruiz, R., & Romera, E. M. (2024). How adolescents' popularity perceptions change: Measuring interactions between popularity and friendship networks. *Social Networks, 78*, 12-24.

Fredrickson, B. L., & Roberts, T. A. (1997). Objectification theory: Toward understanding women's lived experiences and mental health risks. *Psychology of Women Quarterly*, *21*(2), 173-206. https://doi.org/10.1111/j.1471-6402.1997.tb00108.x

Fratini, A., & Hemer, S. R. (2020). Broadcasting your death through livestreaming: Understanding cybersuicide through concepts of performance. *Culture, Medicine, and Psychiatry*, *44*(4), 524-543. https://doi.org/10.1007/s11013-020-09671-9

Gioia, F., Griffiths, M. D., & Boursier, V. (2020). Adolescents' body shame and social networking sites: The mediating effect of body image control in photos. *Sex Roles*. https://doi.org/10.1007/s11199-020-01142-0

Kumar, S., Natrajan, K., Bhadoria, A. S., & Das, A. (2019). Social media smartphone app and psychopathology—A case report. *Journal of Family Medicine and Primary Care*, *8*(8), 2738-2740. https://doi.org/10.4103/jfmpc.jfmpc_421_19

Lozano-Blasco, R., Mira-Aladrén, M., & Gil-Lamata, M. (2023). Social media influence on young people and children: Analysis on Instagram, Twitter and YouTube. *Comunicar, 31*(74), 125-137.

Marks, P. E. L., Cillessen, A. H. N., & Crick, N. R. (2012). Popularity contagion among adolescents. *Social Development*, *21*(3), 501-521. https://doi.org/10.1111/j.1467-9507.2011.00647.x

Moir, C. L., Tzani, C., Ioannou, M., Lester, D., Synnott, J., & Williams, T. J. V. (2023). Cybersuicide: Online-assisted suicide. *Journal of Police and Criminal Psychology*, *38*(4), 879-891.

Murillo-Borjas, G. A. (2022). *Social media content: Potential precursor of addiction and compulsive behaviors in adolescence* (Doctoral dissertation, California Southern University).

Peres, R., Talwar, S., Alter, L., Elhanan, M., & Friedmann, Y. (2020). Narrowband influencers and global icons: Universality and media compatibility in the communication patterns of political leaders worldwide. *Journal of International Marketing*, *28*(1), 48-65. https://doi.org/10.1177/1069031X19897893

Ritzer, G., Dean, P., & Jurgenson, N. (2012). The coming of age of the prosumer. *American Behavioral Scientist*, 56(4), 379–398.

Stockdale, L. A., & Coyne, S. M. (2020). Bored and online: Reasons for using social media, problematic social networking site use, and behavioral outcomes across the transition from adolescence to emerging adulthood. *Journal of Adolescence*, 79, 173–183. https://doi.org/10.1016/j.adolescence.2020.01.010

Utz, S., Tanis, M., & Vermeulen, I. (2012). It is all about being popular: The effects of need for popularity on social network site use. *Cyberpsychology, Behavior, and Social Networking*, *15*(1), 37-42.

Westerlund, M., Hadlaczky, G., & Wasserman, D. (2015). Case study of posts before and after a suicide on a Swedish internet forum. *The British Journal of Psychiatry*, *207*(6), 476-482.

WHEN CYBERBULLIES ARE GIRLS: A SURVEY WITH ADOLESCENTS

Veronica Guardabassi, Alessandro Maranesi, Benedetta Smargiassi, Elisa Cirilli, & Paola Nicolini
Department of Humanities, University of Macerata (Italy)

Abstract

New technologies have led to increased use of digital devices and a consequent risk of negative experiences in the online world, for example cyberbullying. Cyberbullying is a widespread phenomenon among adolescents and the majority of studies have identified males as the main perpetrators. However, girls may also be perpetrators of similar episodes, although their actions or motivations may be different from those of boys. Aiming to fill this gap in the literature, the current study consists of an exploratory investigation aimed at getting to know the cyberbullying girl from the adolescents' point of view. Middle and high school students (N = 927) completed a questionnaire about the characteristics of adolescents who engage in cyberbullying. They answered 15 open-ended questions about the interests, clothing, feelings and habits of cyberbullying girls. The content of each question was analysed and grouped into categories. Frequencies and percentages were calculated and discussed with the class groups involved in the research project. From the adolescents' representations, the cyberbullying girl seems to be a girl who uses a fake nickname to surf online (Instagram, 29.9%), does not have a specific outfit (42.6%) and follows a Mediterranean diet (28.9%), although she also eats fast food (26.3%). She watches violent series (31.8%) and have specific music tastes (52.6%). According to the participants, the girl cyberbully enjoys aggressive behaviour (61.3%), although she is afraid of situations that may challenge her (57.3%). Negative (31.6%) or popular (34.2%) people are seen as her role models. The class discussions support the results of the questionnaire and were useful to deepen the findings: the students revealed that the cyberbully girl eats dietetic food because she needs to be beautiful to be powerful, or that her aggressive behaviour is indirect, i.e. she uses the social network to spread gossip.

Keywords: *Cyberbullying, cyberbullying girl, adolescents, school, education.*

1. Introduction

The widespread use of digital technologies has contributed to the emergence of cyberbullying, a form of aggression carried out through electronic devices and characterized by repeated hostile actions intended to cause harm (Patchin & Hinduja, 2006). Compared to traditional bullying, cyberbullying often results in more severe consequences for adolescents' mental and physical health, including elevated levels of anxiety, depression, and emotional distress. A recent systematic review by Kasturiratna et al. (2025), encompassing 56 meta-analyses, identified females, school-aged youth, victims of traditional bullying, and frequent internet users as particularly vulnerable populations. Cyberbullying victimization is associated with detrimental psychological outcomes, lower academic achievement, and maladaptive coping strategies, although recent intervention programs have demonstrated encouraging results (Sorrentino et al., 2018).

In Italy, recent data point to a concerning rise in cyberbullying among adolescents. According to the ESPAD®Italia 2024 survey (CNR-IFC, 2024), over 1 million students aged 15 to 19 (47%) reported having been victims of cyberbullying in 2024 and approximately 800,000 students (32%) admitted to perpetrating cyberbullying, with higher rates among boys (35%) compared to girls (29%). Alarmingly, nearly one in four students (23%) reported occupying both roles - victim and perpetrator - a condition linked to more serious consequences, including interpersonal difficulties and engagement in risky behaviors. Gender trends have also shifted: while girls reported higher victimization rates in previous years (2021–2023), in 2024 boys surpassed girls in victimization prevalence. Insulting messages in group chats remain the most frequent form of cyberbullying, with boys engaging more often in direct threats and public insults on social media, and girls more frequently involved in indirect forms, such as online exclusion and unauthorized sharing of personal content (CNR-IFC, 2024).

Although the literature generally indicates that boys are more often the perpetrators of cyberbullying (Calmaestra et al., 2020; Horzum et al., 2019; Lee et al., 2017), some evidence suggests that girls also engage in cyberbullying behaviours (Khurana et al., 2015; Ibrahim & Vi, 2021), despite with a different form. According to findings by Saladino et al. (2020), male cyberbullies are more likely to engage

in behaviours such as insults, misinformation dissemination, and data theft, whereas female cyberbullies tend to exploit interpersonal trust to extract and later disclose personal information, or to socially exclude others from online groups and games. This kind of behaviour represent an indirect form of aggression (Underwood, 2003), that are more prevalent among girls than boys (Eisenberg et al., 1994). A research conducted among Italian adolescents highlights girls' involvement in relational bullying, supporting a parallel between traditional indirect aggression and certain forms of cyberbullying (De Vita & Burgio, 2023). Furthermore, this kind of aggression can be amplified in online environments, where anonymity and physical distance lower the barriers to aggression (Buzgon et al., 2022).

Based on these considerations, the present study has the purpose to investigate the role of girls as primary perpetrators of cyberbullying behaviours. Specifically, by directly involving adolescents in the action-research process, this specific project has the aim (1) to increase adolescents' awareness about the topic, which also represent preventive strategies (Saladino et al., 2020), and (2) to understand the underlying mechanisms and behavioural patterns associated with female cyberbullying.

2. Methods

2.1. Participants and procedure

This study is part of a bigger research project that involved 47 lower and upper secondary school classes from the provinces of Ancona, Fermo, Macerata, and Pesaro-Urbino. A total of 927 students participated in the study, including 473 boys and 452 girls (M_{age} = 14.96).

2.2. Measures

2.2.1. Questionnaire. After some queries about demographic information, such as year of birth and gender, participants provided their answers to the following 15 open-ended questions: What could be her nickname? How do you think she dresses? What kind of clothing does she prefer? What accessories? What does she eat? What online series does she follow? What music does she listen to? What sport does she play? What male friends does she hang out with? What female friends does she hang out with? What social networks does she use? What makes her laugh? What annoys her? What is she afraid of? What is she attracted to? What are the role models she looks up to? What words does she most often use?

2.2.2. Class discussion. After analyzing the questionnaire responses, the research team carried out feedback and discussions in the involved classes. In this phase, the results were presented and discussed, either in person or remotely, depending on the various stages of the ongoing pandemic during the research period. Presenting the results to the students who took part in the study allowed, on one hand, for an awareness-raising activity, and on the other, for a deeper analysis of the data collected from the overall questionnaire responses.

2.3. Data analysis

The content of each question was analysed and grouped into categories. Frequencies and percentages were calculated using SPSS and then discussed with the research class groups involved.

3. Results

The collected data highlight various aspects of the characteristics and behaviours associated with the phenomenon of female cyberbullying, as reflected in the responses of the participants. Regarding nicknames, 67.2% of respondents indicated the use of a nickname as a form of victim identification, with examples such as "Bella" (Table 1). In terms of clothing, the majority of respondents described the victim as dressing "normally" or "like others" (42.6%), while 32.5% indicated the use of sportswear. The victim's diet was predominantly described as healthy and typical of the "Mediterranean diet" (28.9%), with 26.3% indicating a diet characterized by fast food or ready-made foods (Table 1).

Table 1.

	N	%		N	%		N	%
What nickname could she have?			**How does she dress**			**What does she eat?**		
Nickname	623	67.2	Generic	395	42.6	Mediterranean cuisine	268	28.9
Real name (first and/or last name)	194	20.0	Sportswear	301	32.5	Fast food/ready-made/unhealthy food	244	26.3
I don't know	11	1.2	Branded clothing	127	13.7	Generic	238	25.7
Not applicable	76	8.2	Not applicable	77	8.3	Ethnic cuisine	24	2.6
No response	23	2.5	No response	23	2.5	Mixed	23	2.5
						Not applicable	100	10.8
						No response	30	3.2
Total	927	100	Total	927	100	Total	927	100

Regarding her interests (Table 2), participants said that they watched series with themes of violence, drugs, or action, such as "Suburra" (31.8%), listened Trap, Rap or Pop music (52.6%), practice individual sports (38.4%) or no one (27%).

Table 2.

	N	%		N	%		N	%
What TV series does she watch online?			**What music does she listen to?**			**What sports does she practice?**		
Drugs/violence/robbery/action	295	31.8	Specific genre of music	488	52.6	Individual sport	356	38.4
Romantic/comedy	166	17.9	Multiple genres of music	261	28.2	None	250	27.0
Horror/sci-fi/fantasy	127	13.7	Not applicable	146	15.7	Team sport	205	22.1
Mixed (multiple genres)	60	6.5	No response	33	3.5	Not applicable	71	7.8
Cartoons	32	3.5						
None	3	0.3						
Not applicable	187	20.2						
No response	57	6.1						
Total	927	100	Total	927	100	Total	927	100

Male friendship was with boys involved in crime or violence (33.3%) or with people of similar status (23.2%), whereas female friendships were with popular friends (26.6%). See Table 3.

Table 3.

	N	%		N	%
What male friends does she hang out with?			**What female friends does she hang out with?**		
Drugs/crime/violence	309	33.3	Similar (same status)	277	29.8
Similar (same status)	215	23.2	Older, wealthier, more popular	82	8.8
Older, wealthier, more popular	147	15.9	Younger, less wealthy, less popular	43	4.6
Younger, less wealthy, less popular	18	1.9	Drugs/crime/violence	247	26.6
None/few	92	9.9	None/few	94	10.1
Calm	18	1.9	Beautiful	27	2.9
Not applicable	96	10.4	Calm	20	2.2
No response	32	3.5	Not applicable	101	10.9
Total	927	100	Total	927	100

According to the participants (see Table 4 and Table 5), cyberbullying girls, who seem to prefer the use of multiple platform (54.4%) or Instagram (29.9%), enjoy aggression to their person victims (61.3%), probably for the fear to situation in which their role is questioned (57.3%) or to be excluded or hurt (41.6%).

Table 4.

	N	%		N	%		N	%
What social networks does she use?			**What entertains her?**			**What disturbs her?**		
Generic	504	54.4	Aggressiveness towards others	568	61.3	Situations/people that challenge her	531	57.3
Instagram	277	29.9	Healthy activities	138	14.9	Personal/family and relationship issues	78	8.4
TikTok	46	5.0	Unhealthy activities	41	4.4	Diversity	31	3.3
Porn/darkweb	9	1.0	Online activities	25	2.7	Nothing	26	2.8
None	2	0.2	Not applicable	119	12.8	Not applicable	223	24.1
Not applicable	56	6.0	No response	36	3.9	No response	38	4.1
No response	33	3.6						
Total	927	100	Total	927	100	Total	927	100

They seem to be attracted in doing negative behaviours (22.5%) and relationships with potential partner (32.7%). Her role models reflect individuals who are popular (34.2%) or have negative traits (31.6%), and the language used by the victim is often described as aggressive, characterized by insults and swear words (67,2%). See Table 5 and Table 6 for more details.

During the class discussion, the students showed a tendency to associate and overlap the behaviour of a bully with that of a cyberbully. Above all, they emphasise her physical characteristics, pointing to her as a beautiful girl who dresses fashionably and, not infrequently, provocatively. This allows her to subject boys to her will and to have girls in her retinue who, in order to be her friend, try to please her. Focusing on what a cyberbully's behaviour can be, the students highlight how she tends to denigrate the people she targets through repeated insults, mainly related to physical appearance or particular frailties she has become aware of: hers is exclusively a psychological violence. Despite the fact that the questionnaires show how the cyberbully tends to hide her identity behind a nickname, there is a tendency in the classroom to think that she is not afraid to show herself and when she wants to attack someone she does so openly. Many of these actions may in fact take place in groups created on instant messaging platforms such as whatsapp or

telegram, where all those who are part of them are known. Moreover, this is his way of showing off. An awareness arose about the origin of such behaviours, probably linked to family problems that have created insecurities in her and that are thus compensated for.

Table 5.

	N	%		N	%
What does she fear?			**What does attracts her?**		
Being excluded/hurt	386	41.6	Engaging in negative actions (aggressiveness)	209	22.5
Parents/institutions	224	24.2	Partner	303	32.7
Nothing	80	8.6	Nothing	17	1.8
Diversity	3	0.3	Power/wealth/fun	146	15.7
Not applicable	188	20.3	Not applicable	211	22.9
No response	46	5.0	No response	41	4.4
Total	927	100	Total	927	100

Table 6.

	N	%		N	%
What life models is she inspired by?			**What words does she predominantly use?**		
People/behaviors with negative traits	293	31.6	Insults/offenses/swear words	623	67.2
People/behaviors of wealth and popularity	317	34.2	Youth slang	153	16.5
Family/friends	39	4.2	I don't know	28	3.0
No life model	53	5.7	Not applicable	95	10.2
Not applicable	138	14.9	No response	25	2.7
No response	87	9.4			
Total	927	100	Total	927	100

4. Discussion

The study aims to understand the perspective of adolescents in order to define the profile of a girl who engages in cyberbullying behaviours. The emerging image is of a girl who conforms to stereotypical representations of women in society, such as a girl who loves dancing or is concerned about her diet and body image as well as to stereotypical representations of individuals involved in violent settings (Pasqui et al., 2019; Khoury-Kassabri et al., 2019). However, during class discussions, participants revealed that cyberbullying girls may be any girl who eats, listens to music and has interests similar to her peers. These answers demonstrate a deeper understanding of the complexity of the phenomenon, as evidenced by their observations regarding the underlying causes of these negative behaviours, e.g. fear of being hurt. The results of this study are very similar to those of Saladino et al. (2020) and to Eisenberg et al. (1994) considerations about female aggression. Indeed, also these adolescents suggest that girls tend to act in a more indirect way and exercise a kind of psychological power in which popularity play a key role. However, although adolescents have developed a clear idea of what cyberbullies are like, they also exhibit some misunderstanding. Firstly, they tend to conflate bullies and cyberbullies, suggesting a strong link between online and offline life (i.e, onlife: Floridi, 2017). Secondly, adolescents tend to associate cyberbullying more with boys than with girls, suggesting that there may be a gender bias that can lead to certain behaviours or perpetrators being overlooked.

4.1. Strengths, limits and future directions

Among the strengths of the study is the use of open-ended questions and classroom discussions: this method allows for a broader range of responses than those anticipated by the research team and captures more precisely the participants' perspective on the topic. The classroom debate helped clarify responses and understand the motivations behind the answers collected. A limit of this study can be the difficulty on categorization of responses into labels. However, the internal team's discussion and evaluation to define sufficiently representative labels make the study's results valuable for achieving its intended goals. Future studies can explore the connections between the behaviours of girls who act as cyberbullies and family or relational problems (a critical factor identified by Song et al., 2020), as well as examine risk factors or effective interventions (Craig et al., 2019; Zsila et al., 2019).

5. Conclusions

This study explores female cyberbullying from an adolescent perspective, highlighting the often-overlooked role of female perpetrators. It reveals that the "cyberbullying girl" is a peer with typical interests, yet capable of subtle online aggression. Despite limitations, the study offers valuable insights for educators and policymakers, showing the benefits of combining quantitative and qualitative methods. Future research should focus on motivations and prevention strategies, integrating these into school programs to reduce cyberbullying.

Aknowledgments

The research was funded by Regione Marche through the project “Osservatorio Inter-Universitario sul Bullismo - Oibul”. In the subsequent phase, this work has been funded by the European Union - NextGenerationEU under the Italian Ministry of University and Research (MUR) National Innovation Ecosystem grant ECS00000041 - VITALITY - CUP D83C22000710005.

References

Buzgon, J., Crothers, L. M., Schreiber, J. B., Schmitt, A. J., Kolbert, J. B., Wadsworth, J., ... & Steeves, T. (2022). Feminine Ideology, Body Appreciation, and Indirect Aggression in Girls. *Frontiers in Education*, *7*, 896247.

Calmaestra, J., Rodríguez-Hidalgo, A. J., Mero-Delgado, O., & Solera, E. (2020). Cyberbullying in adolescents from Ecuador and Spain: Prevalence and differences in gender, school year and ethnic-cultural background. *Sustainability*, *12*(11), 4597.

CNR-IFC. (2024). *ESPAD®Italia 2024: Cyberbullismo e adolescenti*. Retrieved from italienaren.org

Craig, S. L., Eaton, A. D., McInroy, L. B., D’Souza, S. A., Krishnan, S., Wells, G. A., ... & Leung, V. W. (2019). Navigating negativity: A grounded theory and integrative mixed methods investigation of how sexual and gender minority youth cope with negative comments online. *Psychology & Sexuality*, *11*(3), 161-179.

De Vita, A., & Burgio, G. (2023). Female bullying among adolescents in Italy: A national mixed-method research. *Encyclopaideia*, *27*(65), 61-77.

Eisenberg, N., Fabes, R. A., Murphy, B., Karbon, M., Maszk, P., Smith, M., ... & Suh, K. (1994). The relations of emotionality and regulation to dispositional and situational empathy-related responding. *Journal of personality and social psychology*, *66*(4), 776-797.

Floridi, L. (2017). *La quarta rivoluzione: come l'infosfera sta trasformando il mondo*. Raffaello Cortina Editore.

Horzum, M. B., Ayas, T., Randler, C., & Dusunceli, B. (2019). The effects of empathy and circadian preference on cyberbullying of adolescents in Turkey. *Biological Rhythm Research*.

Ibrahim, A. M., & Vi, T. P. (2021). The Internet and Adolescent Safety: Peer Influence and Gender Difference as Potential Risk-Factors of Cyberbullying among Nigerian Secondary School Adolescents. *International Journal of Media and Information Literacy*, *6*(1), 4-16.

Kasturiratna, K. T. A. S., et al. (2025). Umbrella review of meta-analyses on the risk factors, protective factors, consequences and interventions of cyberbullying victimization. *Nature Human Behavior*, *9*, 101-132.

Khurana, A., Bleakley, A., Jordan, A., & Romer, D. (2015). The protective effects of parental monitoring and internet restriction on adolescents' risk of online harassment. *Journal of Youth and Adolescence*, *44*, 1039-1047.

Lee, C., & Shin, N. (2017). Prevalence of cyberbullying and predictors of cyberbullying perpetration among Korean adolescents. *Computers in Human Behavior*, *68*, 352-358.

Patchin, J. W., & Hinduja, S. (2006). Bullies move beyond the schoolyard: A preliminary look at cyberbullying. *Youth Violence and Juvenile Justice*, *4*(2), 148-169.

Saladino, V., Eleuteri, S., Verrastro, V., & Petruccelli, F. (2020). Perception of cyberbullying in adolescence: A brief evaluation among Italian students. *Frontiers in Psychology*, *11*, 3112.

Song, H., Lee, Y., & Kim, J. (2020). Gender differences in the link between cyberbullying and parental supervision trajectories. *Crime & Delinquency*, *66*(13-14), 1914-1936.

Sorrentino, A., Baldry, C., & Cacace, S. (2018). Cyberbullying in Italy. In A. C. Baldry, C. Blaya, & D. P. Farrington (Eds.), *International Perspectives on Cyberbullying: Prevalence, Risk Factors and Interventions* (pp. 231-249). London: Palgrave Macmillan.

Underwood, M. K. (2003). *Social Aggression among Girls*. New York: Guilford Press.

Zsila, Á., Urbán, R., Griffiths, M. D., & Demetrovics, Z. (2019). Gender differences in the association between cyberbullying victimization and perpetration: The role of anger rumination and traditional bullying experiences. *International Journal of Mental Health and Addiction*, *17*(5), 1252-1267.

Khoury-Kassabri, M., Mishna, F., & Massarwi, A. A. (2019). Cyberbullying perpetration by Arab youth: The direct and interactive role of individual, family, and neighborhood characteristics. *Journal of interpersonal violence*, *34*(12), 2498-2524.

Pasqui, F., Poli, C., & Festi, D. (2019). Diet and Gender. *Health and Gender: Resilience and Vulnerability Factors for Women's Health in the Contemporary Society*, 103-112.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

TUITION WAIVERS AND EDUCATIONAL EQUITY: SUPPORTING FORMER YOUTH IN CARE IN HIGHER EDUCATION

Dale Kirby
Faculty of Education, Memorial University of Newfoundland (Canada)

Abstract

Youth with lived experience in the child welfare system face significant barriers to accessing and succeeding in higher education, resulting in socioeconomic and health disparities as compared to their peers. Tuition waiver programs are designed to reduce these barriers by mitigating financial obstacles to accessing post-secondary education. This study explored the effectiveness of such programs through interviews with 31 stakeholders, including former youth in care, institutional staff, and community professionals. Using an emergent theme content analysis framework, ten key themes were identified, highlighting critical challenges such as financial limitations beyond tuition, lack of program awareness, and the need for holistic wraparound supports. These findings emphasize the importance of integrating dedicated mentorship, culturally responsive support systems, and flexible success metrics into tuition waiver programs. This research provides practical insights that may be drawn on to improve the effectiveness of tuition waiver programs in promoting educational access for former youth in care.

Keywords: *Tuition waivers, tuition fees, former youth in care, higher education.*

1. Introduction

Youth with lived experience in the child welfare system encounter numerous obstacles to achieving educational milestones, such as completing secondary school or pursuing higher education. Attending college or university can offer former youth in care (FYIC) enduring advantages, such as establishing structure and routine, fostering broader social networks and community ties, improving the likelihood of meaningful employment, cultivating a sense of belonging, and acquiring critical life skills necessary for adulthood (e.g., independence, time management, communication, organization) (Rutman & Hubberstey, 2018).

Although education is universally acknowledged as a fundamental human right, FYIC frequently face overlapping forms of disadvantage. In Canada, this population tends to have lower educational achievement, higher unemployment rates, and poorer health and social outcomes than their peers in the general population (Nichols et al., 2017; Smith et al., 2015; Strand, 2014). Moreover, Black, Indigenous, and LGBTQ+ youth are disproportionately represented in the child welfare system, and their lack of access to higher education has far-reaching implications for individuals and society (Gahagan et al., 2024a, 2024b).

The Government of Canada (2018) has emphasized that "all young people deserve access to affordable quality education, no matter their circumstances" (p. 13). Completing secondary school and higher education significantly influences employment opportunities, income, social mobility, health outcomes, and overall quality of life (Francis & Wong, 2013; Lehmann, 2021). Tuition waiver programs for FYIC, designed to eliminate financial obstacles by covering part of the cost of higher education, aim to address these disparities both directly (e.g., reducing economic barriers) and indirectly (e.g., promoting social mobility and employability). These programs can play a key role in enhancing access to higher education for this historically marginalized group, potentially fostering greater diversity and inclusion within Canadian post-secondary institutions, not only among students but also in the pool of future educators (Harder et al., 2020; Payne, 2016; Unrau et al., 2012; Wimpenny & Savin-Baden, 2013).

The limited existing data indicate that former youth in care are less likely to have completed secondary school and thus face significant barriers to accessing higher education (Kirby, 2023; Kovarikova, 2018). Because former youth in care are one of the most underrepresented groups attending Canada's colleges and universities, some institutions have created tuition fee waiver programs as an intervention to help reduce the financial barriers faced by care-experienced youth. Although tuition waver programs have been established in Canada since the 1990s, no comprehensive evaluations of how they impact youth in care have been conducted.

2. Research questions

Since the establishment of the Atlantic Canada Tuition Waiver Working Group in 2021, our interdisciplinary research team has been working in partnership on a multi-year research project to examine how tuition waiver programs facilitate access to higher education for youth with experience in the child welfare system. Building on our recently published international scoping review of peer-reviewed research on tuition waiver programs (Gahagan et al., 2023), the most recently completed phase of our research, covered here, was guided by the following research questions: 1) what are some of the key components of tuition waivers programs for FYIC?; 2) how are tuition waiver programs, interventions, policies, or related programs addressing barriers to post-secondary education for FYIC?; 3) what are key measures of success for these programs and how should these be measured?; and 4) how can existing tuition waiver programs be improved to better facilitate access to post-secondary education for FYIC?

3. Theoretical framework

The foundational framework for this study is the ecology of inclusive education model devised by Anderson, Boyle, and Deppler (2014). This model is rooted in Bronfenbrenner's (1976) ecological systems theory and Bronfenbrenner and Morris's (2006) bioecological model of human development. The ecology of inclusive education provides a structured lens for examining environmental influences on learners, including those in higher education, by situating the learner at the core of the framework. Through these inter-related models, we can organize and comprehensively interpret of how various elements within an educational ecosystem interact and impact student experiences. Bronfenbrenner's earlier work described the learner's environment as a "nested arrangement of structures" (p. 5), conceptualizing it through five interconnected systems that can been seen as shaping inclusive education practices. These systems, micro-system, meso-system, exo-system, macro-system, and chrono-system, provide a valuable framework for analyzing and advancing inclusivity within educational setting

At the core, the micro-system encompasses direct interactions involving the learner, including their relationships with family, peers, and educators. These interactions are integral to the learner's developmental processes. Expanding outward, the meso-system highlights the interconnectedness between the components of the micro-system, such as the collaboration between schools and local communities. The exo-system refers to external structures, both formal and informal, that indirectly influence the learner's immediate environment, such as policies or organizational decisions impacting educational settings (Bronfenbrenner, 1976). The macro-system represents the overarching cultural, societal, and ideological contexts that frame the functioning of the other systems. Finally, the chrono-system adds a temporal dimension, acknowledging how time and life transitions affect the learner and their interactions with the other systems.

In the context of higher education, this ecological approach underscores the need to consider the intersectionality of these systems when fostering an inclusive environment. For instance, financial challenges faced by students often reflect decisions and resources at multiple systemic levels. Within the micro-system, these challenges are evident in the form of restricted access to personal or family financial resources. The exo-system plays a role through institutional policies and support programs shaped by leadership priorities, while the macro-system reflects the broader political, cultural, and economic contexts influencing higher education. The chrono-system highlights the dynamic nature of these factors as they evolve over time, continuously influencing students' educational experiences and opportunities for inclusion.

4. Methods

This research involved interviews with thirty-one individuals including former youth in care, institutional staff working with tuition waiver programs, and community-based professionals who support care-experienced youth. The interviews were conducted and recorded using Microsoft Teams and lasted an average of 30 min per interview. The transcribed interview data were open coded with data analysis conducted using MAXQDA software.

The interview data underwent a comprehensive and systematic analysis to identify, critically examine, and synthesize texts that were directly relevant to the study's research questions (Carter et al., 2015; Davies, 2000). This process utilized an emergent theme content analysis framework, which is recognized for its structured and analytical nature, allowing for a detailed exploration of the data (Bengtsson, 2016; Krippendorff, 2013). The collected texts were initially coded in an open-ended manner to ensure that no potential themes were overlooked. This open coding approach served as the foundation for an extended analytical process aimed at uncovering meaningful patterns and insights within the data.

Key themes and categories were iteratively constructed, tested, and validated to maintain the integrity and reliability of the analysis. Following Bengtsson's (2016) well-established four-stage framework for textual analysis, the methodology incorporated: a) decontextualisation, where meaning units or potential themes were identified and openly coded to capture their essence; b) recontextualisation, which involved a meticulous comparison of these themes against the original data to ensure consistency and relevance; c) categorisation, where identified themes and meaning units were condensed into coherent and distinct categories that could be further analyzed; and d) compilation, the final stage where the analyzed data were synthesized into a cohesive summary, allowing for validation and a deeper understanding of the findings. This robust and multi-layered process provided a comprehensive approach to understanding the complexities of the data and effectively addressing the research questions.

5. Results

Our analysis of interview data revealed ten interrelated themes highlighting the challenges and opportunities for former youth in care pursuing higher education. 1. Financial barriers extend beyond tuition waivers, as students struggle to cover essential costs like housing, transportation, and textbooks, which often deter them from fully participating in their studies. 2. Awareness and promotion of tuition waiver programs remain inadequate, with many eligible students unaware of the resources available, often discovering them too late to benefit fully. 3. Holistic wraparound supports are critical, encompassing mentorship, mental health resources, tutoring, and accommodations for individual needs to help students navigate academic and personal challenges. 4. Impostor syndrome and mental health issues are pervasive among students, stemming from feelings of inadequacy and lack of belonging, often amplified by their unique backgrounds. 5. High turnover in support staff disrupts the consistency of guidance and mentorship, leaving students without stable relationships to rely on during their academic journey. 6. Lack of long-term planning means many students enter post-secondary education without adequate preparation, as systemic issues fail to encourage early academic goal-setting and course selection. 7. Cultural and peer connections are vital to fostering a sense of belonging, yet many students feel isolated, particularly those from marginalized backgrounds. 8. Data collection and evaluation of tuition waiver programs are insufficient, hindering the ability to measure success and refine supports effectively. 9. Flexible measures of success are needed, recognizing achievements beyond academic performance, such as personal growth, life skills development, and community involvement. 10. Dedicated navigators and mentors are essential to provide personalized, consistent guidance, ensuring students can navigate institutional systems, access resources, and address their unique challenges effectively. These themes collectively underscore the multifaceted barriers faced by former youth in care and the importance of holistic, proactive solutions to support their success.

6. Implications of findings

The findings of this study significantly contribute to established knowledge on educational equity by shedding light on the unique challenges faced by former youth in care and the potential of targeted interventions, such as tuition waiver programs, to address systemic inequities. While existing literature highlights the underrepresentation of care-experienced youth in higher education, this study provides insight into the supports and obstacles that shape their academic journeys. By identifying critical themes such as the need for wraparound support, enhanced program awareness, and flexible success measures, our research bridges gaps in understanding and offers a foundation for actionable policy reforms. These findings not only validate the importance of financial and institutional support mechanisms but also underscore the value of holistic, equity-driven strategies in fostering educational access and success. As a result, this study provides an evidence-based framework for expanding and refining tuition waiver programs, ensuring that they effectively address the needs of one of society's most vulnerable populations, thereby advancing the broader goals of social and educational justice. This will be of interest to all those concerned with widening access to higher education to excluded populations.

Acknowledgments

This work was funded by the Social Sciences and Humanities Research Council of Canada, Partnership Development Grant (SSHRC Grant 890–2021–0105).

References

Anderson, J., Boyle, C., & Deppeler, J. (2014). The ecology of inclusive education: Reconceptualising Bronfenbrenner. In H. Zhang, P. W. Keung Chan, & C. Boyle (Eds.), *Equality in education: Fairness and inclusion* (pp. 23-34). SensePublishers.

Bengtsson, M. (2016). How to plan and perform a qualitative study using content analysis. *Nursing Plus Open, 2*, 8-14. https://doi.org/10.1016/j.npls.2016.01.001

Bronfenbrenner, U. (1976). The experimental ecology of education. *Educational Researcher, 5*(5), 5-15. https://doi.org/10.2307/1174755

Bronfenbrenner, U., & Morris, P. (2006). The bioecological model of human development. In R. M. Lerner & W. Damon (Eds.), *Handbook of child psychology: Theoretical models of human development* (6th ed., pp. 793-828). John Wiley & Sons, Inc.

Carter, D. P., Weible, C. M., Siddiki, S. N., & Basurto, X. (2015). Integrating core concepts from the institutional analysis and development framework for the systematic analysis of policy designs: An illustration from the US National Organic Program regulation. *Journal of Theoretical Politics, 28*(1), 159-185. https://doi.org/10.1177/0951629815603494

Davies, P. (2000). The relevance of systematic reviews to educational policy and practice. *Oxford Review of Education, 26*(3/4), 365-378. https://doi.org/10.1080/713688543

Francis, B., & Wong, B. (2013). *What is preventing social mobility? A review of the evidence*. Leicester: ASCL.

Gahagan, J., Slipp, N., Chowdhury, R., Kirby, D., Smith, S., McWilliam, S., Carter, N., Anderson, K., Chughtai, S., Robinson, M., & Mueller, R. E. (2023). Reducing barriers to post-secondary education among former youth in care: A scoping review. *International Journal of Educational Research Open, 5*(2023), Article 100303.

Gahagan, J., Kirby, D., Anderson, K., & Smith, S. (2024a, March 10). Canada is falling behind other countries in meeting the needs of former youth in care. *The Conversation*. https://theconversation.com/canada-is-falling-behind-other-countries-in-meeting-the-needs-of-former-youth-in-care-224238

Gahagan, J., Kirby, D., Robinson, M., & Chowdhury, R. (2024b, November 19). How a failure to support youth who were once in care may be fueling unemployment. *The Conversation*. https://theconversation.com/how-a-failure-to-support-youth-who-were-once-in-care-may-be-fuelling-unemployment-240956

Government of Canada, (2018). *Key health inequalities in Canada: A national portrait – Executive summary*. https://www.canada.ca/content/dam/phacaspc/documents/services/publications/science-research/key-health-inequalities-canada-national-portrait-executive-summary/hir-executive-summary-eng.pdf

Harder, A. T., Mann-Feder, V., Oterholm, I., & Rafaeli, T. (2020). Supporting transitions to adulthood for youth leaving care: Consensus based principles. *Children and Youth Services Review, 116*. https://doi.org/10.1016/j.childyouth.2020.105260

Kirby, D. (2023, May). *First voices of former youth in care: Perspectives on tuition waivers for post-secondary education*. Paper presented at the Annual Conference of the Canadian Society for the Study of Higher Education, Toronto, Ontario.

Kovarikova, J. (2018). *Review and practice for youth leaving care - White paper*. Child Welfare PAC. https://42bf8e9c-2414-4457-bac7-f47eccf53bff.filesusr.com/ugd/6548f4_7ba391d9a4b54e7a972c1314de2cefca.pdf

Krippendorff, K. (2013). *Content analysis: An introduction to its methodology* (3rd ed.). Thousand Oaks, CA: Sage.

Lehmann, W. (2021). Conflict and contentment: Case study of the social mobility of working-class students in Canada. *European Journal of Education, 56*(1), 41-52. https://doi.org/10.1111/ejed.12431

Nichols, N., Schwan, K., Gaetz, S., Redman, M., French, D., Kidd, S., & O'Grady, B. (2017). *Child welfare and youth homelessness in Canada: A proposal for action*. Toronto: Canadian Observatory on Homelessness Press. http://rightsofchildren.ca/wpcontent/uploads/2019/07/Child-Welfare-and-Youth-Homelessness-in-Canada.pdf

Payne, L. (2016). Student engagement: Three models for its investigation. *Journal of Further and Higher Education, 43*(5), 641-657. https://doi.org/10.1080/0309877X.2017.1391186

Rutman, D., & Hubberstey, C. (2018). Fostering educational success of children and youth in care: Perspectives of youth with experience living in care. *Children and Youth Services Review, 94*, 257-264. https://doi.org/10.1016/j.childyouth.2018.10.022

Smith, A., Peled, M., Poon, C., Stewart, D., & Saewyc, E. (2015). *We all have a role: Building social capital among youth in care*. Vancouver, BC: McCreary Centre Society. https://www.saravyc.ubc.ca/2015/04/30/we-all-have-a-role-buildingsocial-capital-among-youth-in-care

Strand, S. (2014). Ethnicity, gender, social class and achievement gaps at age 16: Intersectionality and "getting it" for the white working class. *Research Papers in Education, 29*(2), 131-171. https://doi.org/10.1080/02671522.2013.767370

Unrau, Y. A., Font, S. A., Rawls, G. (2012). Readiness for college engagement among students who have aged out of foster care. *Children and Youth Services Review, 34*(1), 76-83. https://doi.org/10.1016/j.childyouth.2011.09.002

Wimpenny, K., & Savin-Baden, M. (2013). Alienation agency and authenticity: a synthesis of the literature on student engagement. *Teaching in Higher Education, 18*(3), 311-326. http://dx.doi.org/10.1080/13562517.2012.725223

MIDDLE LEADERSHIP AND INCLUSIVE EDUCATION IN PORTUGUESE SCHOOLS ABROAD: CASES FROM CAPE VERDE AND MOZAMBIQUE

Ana Paula Silva[1], Teresa Santos[2], & Alcina de Oliveira Martins[2]
[1]Instituto de Educação, CeiED, Universidade Lusófona – Centro Universitário de Lisboa (Portugal)
[2]Faculdade de Psicologia e Educação, CeiED,
Universidade Lusófona – Centro Universitário do Porto (Portugal)

Abstract

Our study explores the intersection of Portugal's cooperation policies with the PALOP (Portuguese-speaking African Countries) and inclusive education, focusing on the role of middle leadership in fostering inclusive practices. Since the independence of these former Portuguese colonies following the 1974 democratic revolution, Portugal has established a network of 27 schools in 7 countries across Africa, Asia, and Oceania, all managed under the Portuguese Ministry of Education. These schools aim to contribute to local development while implementing Portuguese educational policies. In recent decades, the Portuguese education system has undergone significant reforms, emphasizing school autonomy and leadership. Middle leaders, in particular, have emerged as key actors in promoting professional development for teachers, improving teaching quality, and advancing inclusive education. Guided by the theory of practice architectures, this study investigates the practices of middle leaders in two Portuguese public schools abroad: one in Cape Verde and one in Mozambique. The goal is to identify how local practices enable or constrain the implementation of inclusive education policies and to uncover the contextual factors shaping these practices. Using qualitative and exploratory methodology, we analyse the "sayings," "doings," and "interactions" of local actors to understand the dynamics of middle leadership in these settings. We aim to determine whether the implementation of Portuguese educational policies in these schools fosters the emancipation of local citizens or perpetuates forms of neocolonialism under the guise of development aid.

Keywords: *Middle leadership, inclusive education, Portuguese schools in Cape Verde and Mozambique, (de)colonization, development aid and neocolonialism, emancipation versus acculturation.*

1. Introduction

The increasing establishment of Portuguese schools in the African countries of Portuguese official language (PALOP) has attracted our attention. Currently, there are 27 Portuguese schools abroad, distributed as follows: three in Cape Verde, one in Guinea-Bissau, three in São Tomé and Príncipe, fourteen in Angola, four in Mozambique, one in Macau, and one in East Timor. Of these, 19 are private and 8 are public schools. While private schools mainly adopt the Portuguese curriculum, public schools are entirely governed by the Portuguese Ministry of Education, with oversight in all aspects, including curriculum, school organisation (administrative structure, regulations, and leadership), infrastructure, and financing.

Grounded in an analysis of the role of middle leaders in the execution of inclusive education policies, this study aims to contribute to a critical debate on the challenges and contradictions within the cooperation policies between Portugal and the PALOP countries. Portuguese schools in these countries are often framed as instruments of cooperation for development, but they also reflect transnational dynamics that reconfigure Portuguese influence in the African context.

The focus on middle leaders within these schools is due to their strategic position within the educational system. As Gurr (2024, p. 2) notes, "middle leaders in schools will typically have a formal leadership role alongside a substantial teaching role." These leaders are pivotal in enacting educational policies, serving as intermediaries between school administration and teaching staff, while having direct access to students and their families. They play a critical role in translating educational policies into practice, fostering pedagogical innovation, and ensuring quality teaching. In an era of increasing school autonomy and accountability, middle leaders are crucial for the successful implementation and sustainability of education reforms (Costa et al., 2001; Barroso, 2005; Ventura et al., 2006; Lima, 2011; Bastos, 2019).

A key question arises: to what extent do these schools foster inclusive education with a social impact, or do they, instead, perpetuate dependency and cultural hegemony? Educational cooperation may function as a soft power, maintaining Portugal's cultural and linguistic presence in the PALOP countries. Despite the intentions of Portuguese schools to support progress in those countries, there are concerns that their curriculum and framework may uphold colonial legacies by prioritising Portuguese values, language, and culture. This could lead to the marginalisation of local cultures and knowledge systems, further entrenching unequal power dynamics.

2. Design

To analyse the role of middle leaders, we employ the theory of practice architectures (Mahon et al., 2017; Edwards-Groves, 2018; Wilkinson et al., 2024), which explores the economic-material, socio-political, and cultural-discursive arrangements influencing the promotion of inclusive education in schools. This theoretical framework helps examine the roles of middle leaders in fostering inclusive education through three key arrangements:

- **Economic-material arrangements:** Middle leaders advocate for the resources needed to ensure that infrastructure and materials support accessibility and inclusion.
- **Socio-political arrangements:** Middle leaders play a key role in implementing inclusion policies, translating legislation into practice, and representing teachers and students within governance structures.
- **Cultural-discursive arrangements:** They influence school values, raise awareness of diversity, integrate inclusive content into the curriculum, and support teachers in adopting inclusive pedagogical practices.

This framework positions middle leaders as essential mediators in fostering inclusive education.

From a post-colonial and decolonial perspective (Melber et al., 2024), it is vital to question whether these institutions promote inclusive educational development or, inadvertently, perpetuate dependency, and cultural hegemony and contribute to perpetuating social re-existing structures and dynamics.

2.1. Objective

This study is driven by the research question: How do middle leaders contribute to enacting inclusive education practices in two Portuguese schools in Cape Verde and Mozambique? Accordingly, its overarching objective is to examine the role of middle leaders in these schools in fostering inclusive education and identifying strategies and practices that promote a more inclusive learning environment.

On the other hand, as we also inscribe our reflection on the broader problem of development aid, we also ask to what extent these schools contribute to social transformation, intending to identify those schools' impact on the society they serve.

2.2. Methods

The study employed a qualitative, exploratory methodology, enabling the attribution of meaning to phenomena and a deeper understanding of their contexts (Creswell, 2014). Semi-structured online interviews were conducted with teachers in middle leadership roles to capture their perspectives and experiences regarding inclusive education. The interviews focused on key themes, including teaching roles, hierarchical structures, communication, perceptions, and contextual factors. The interviews captured participants' perceptions regarding their teaching roles, hierarchical structure, communication, collaboration, and contextual factors.

Content analysis (Bardin, 2010) was used as the data analysis technique, facilitated by the Qualitative Data Analysis Software (WebQDA). Ethical considerations and data protection measures were upheld from the initial contact with the school boards, who granted authorisation for the study. All ethical considerations were met, ensuring anonymity by assigning each teacher a code (P1–P11).

2.3. Context

2.3.1. The Escola Portuguesa de Moçambique (EPM). EPM was established in 1999 under a Cooperation Agreement between Portugal and Mozambique. Its main objectives were to promote the Portuguese language and culture, expand basic and secondary education, and provide access to schooling for both Portuguese and Mozambican students (Dec-lei nº 241/99 de 25 de junho).

EPM operates with cultural, pedagogical, administrative, and financial autonomy, executing the Portuguese curriculum. It also serves as a teacher training and resource centre. Funded by the Portuguese State and student tuition fees, its teaching staff includes local and Portuguese teachers, with the latter receiving relocation and residence allowances.

Currently, 24 years after its founding, EPM has 1,610 students and 147 teachers. The majority of students are Mozambican (51%), followed by Portuguese (47%) and Brazilian (8%). The remaining students come from various nationalities, ranging from neighbouring South Africa to the United States and Cuba, among others (CAP, 2024). The tuition fees paid by these students vary between €295 (pre-school) and €230 (other cycles). Depending on the number of siblings attending the school, families can benefit from a reduction in fees (EPM-CELP, 2025).

2.3.2. The Escola Portuguesa de Cabo-Verde (EPCV). EPCV was established by Decree-Law No. 213/2015, following a 2012 education cooperation protocol between Portugal and Cape Verde. The initiative aimed to promote the Portuguese language and culture globally while strengthening ties with Portuguese-speaking countries.

Like EPM, EPCV operates with administrative, financial, and pedagogical autonomy, formalised through an autonomy contract. As part of a new generation of Portuguese public schools abroad, it has flexibility in curriculum management and class organisation to adapt to local needs.

The school director oversees all administrative, financial, pedagogical, and cultural aspects. The pedagogical council, chaired by the director and composed of middle leaders, coordinates educational supervision, student guidance, and teacher training.

EPCV is funded similarly to EPM, with Portuguese staff receiving the same financial support. Currently, 12 years after its founding, EPCV has 996 students and 87 teachers. It has not yet been possible to collect the data regarding the students' nationalities and tuition fees.

3. Discussion

The sample of 11 interviewees comprises teachers from various educational levels. The majority—five—teach in the first cycle of basic education, four in the second cycle, one in the third cycle, and one in pre-school. Regarding their roles, four are year coordinators, two are coordinators of class directors, two are department coordinators, two are class directors, and one is a sub-coordinator of the curricular department. In terms of experience in their current roles, three have been in post for 11 years or more, three for 5–10 years, three for 2–4 years, and two for a year or less. Concerning their teaching experience in Portuguese schools in the PALOP, five have worked for 11 years or more, two for 5–10 years, three for 2–4 years, and one for a year or less. Thus, the sample comprises teachers with diverse educational backgrounds, roles, and professional experience.

Regarding economic and material arrangements, the interviewees' responses did not focus on financial incentives, such as the remuneration support provided by Portuguese schools in the PALOP. Instead, they emphasised intrinsic and relational motivations, highlighting the importance of a collaborative work environment and recognition of individual contributions. The middle leaders valued the enjoyment of their work, the leadership of teams, and the role of bridging communication between "the management board and the teachers" (P6). They also emphasised their contribution to student development, through "the constant transmission and exchange of knowledge and values between several generations" (P1). Additionally, they highlighted the significance of conflict resolution and the promotion of a positive and respectful school atmosphere, as noted by P6: "cordiality, positive, collaborative work, and respect for the individuality of all those involved." These factors emerged as key motivators for their engagement in middle leadership roles.

Concerning socio-political arrangements, middle leaders recognised their role as essential in maintaining educational quality and administrative efficiency. They reported responsibilities in coordinating, supervising, and monitoring school activities, particularly in the pedagogical-didactic domain, student guidance, and teacher performance evaluation. Their role as intermediaries within the hierarchical structure was evident, as they received instructions from senior management while guiding teachers and students. Their contributions to fostering a collaborative and positive learning environment were widely acknowledged, with some respondents stressing the importance of "articulation between other teachers, students, and guardians, as well as parental involvement (…) to improve conflict management and raise awareness of the importance of school" (P7). However, they also identified challenges related to communication and bureaucracy. While email was a widely used and efficient method, some noted that the volume of emails was overwhelming (P3), and additional communication tools such as WhatsApp, phone calls, and meetings were necessary. Despite recognising the benefits of meetings in facilitating discussions, some respondents found them inefficient due to "deviations and a loss of time" (P5). Furthermore, bureaucratic procedures and excessive administrative tasks were cited as barriers, with P2 and P8 mentioning that "too many tasks are going on at the same time."

In cultural-discursive arrangements, most respondents felt positively regarded within their school communities by students, colleagues, senior management, and families, though this perception was not unanimous. They reinforced the importance of collaboration, effective communication, and strong relationships for successfully carrying out their roles. However, significant challenges persisted, particularly the lack of specific training for middle leadership roles and time constraints. Many interviewees expressed concerns that these limitations hindered their ability to fulfil their responsibilities effectively. One respondent pointed out "the absence of formal preparation and excessive workload can make the function overwhelming" (P4). These findings underscore the need for institutional support to create a more cohesive and integrated work environment.

Given the sources of job satisfaction highlighted by participants, ongoing recognition and support for middle leaders are crucial to support and enhance satisfaction. Many respondents expressed a sense of fulfilment with their role in shaping students' educational experiences and fostering strong connections within the school community. Their work plays therefore a pivotal role in promoting success and fostering inclusive school environments. As Wilkinson et al. (2024) have demonstrated, middle leadership is instrumental in articulating the various dimensions of school structures to create more inclusive educational spaces that benefit the entire school community.

However, the findings did not reveal notable contextual differences between the two schools studied. Although middle leaders consistently emphasised the quality of education provided and the capacity to adapt curricula to local contexts, the study did not capture how educational inclusion is enacted, nor did it clarify whether these schools foster emancipation or acculturation. Nevertheless, given that these institutions were established for "the dissemination of the Portuguese language and culture worldwide," it is plausible that acculturation is a more prominent outcome. On the other hand, considering the tuition fees paid by families, and although the majority of students at EPM are Mozambican, we question whether the educational inclusion policy will have a social impact in these contexts, given that the tuition fees paid per student at EPM are considerably higher than the minimum wage, which ranges from €75 (fishing of Kapenta) to €215 (large mining companies) (República de Moçambique, 2024). These data indicate that the Mozambican students at EPM come solely from middle and high-income families.

4. Conclusions

Middle leaders emerge as fundamental pillars in the implementation of educational policies. These leaders are key to ensuring the sustainability of educational reforms and promoting an inclusive and high-quality school environment, benefiting the entire school community.

In the specific case of the two schools under analysis, although the collected data did not show significant contextual differences, the testimony of the middle leaders reaffirms the commitment to quality and the adaptation of pedagogical practices to the needs of students. However, the perception of inclusion as emancipation versus acculturation does not yet emerge clearly in the preliminary results, indicating an area that requires continuous attention and renewed research efforts.

However, based on the data about EPM, we can hypothesise that the lack of evidence collected regarding the difficulties faced by middle management in promoting inclusive education, specifically the absence of references to the conditions of the students, arises from the socio-cultural proximity between the professionals and the students attending the school. This hypothesis seems to be reinforced by the relationship we have established between the tuition fees at EPM and the minimum wage of the Mozambican population. The educational service analysed appears to be inaccessible to the most disadvantaged segments of Mozambican society. Therefore, we can affirm that this service serves to maintain a social structure and its power relations. This is an analysis we will further develop in the ongoing research.

References

Barroso, J. (2005). *Políticas educativas e organização escolar*. Lisboa: Universidade Aberta.

Bardin, L. (2010). *Análise de Conteúdo*. Lisboa: Edições 70.

Bastos, S. A. M. P. (2019). *Autonomia e lideranças intermédias: relevância das estruturas intermédias.* [Dissertação de mestrado não-publicada]. Universidade Católica Portuguesa.

CAP. (2024). Demografia. *O Pátio*, n.º 124, p. 8.

Costa, J. A., Neto-Mendes, A., & Sousa, L. (2001). *Gestão Pedagógica e Lideranças Intermédias na Escola: estudo de caso no TEIP do Esteiro*. Aveiro: Universidade de Aveiro.

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches* (4th ed.). Thousand Oaks, CA: Sage.

Edwards-Groves, C. (2018). *The Practice Architectures of Pedagogy: Conceptualising the Convergences between Sociality, Dialogue, Ontology and Temporality in Teaching Practices*. InTech. doi:10.5772/intechopen.72920.

EPM-CELP. (2025). *Serviços de Administração Escolar*. Retrieved on March 12, 2025, from https://www.epmcelp.edu.mz/index.php/espacos-e-servicos/serv-administracao-escolar#propinas

Gurr, D. (2024). Teacher and Middle Leader Research: Considerations and Possibilities. *Education Sciences, 14*(8), 875. https://doi.org/10.3390/educsci14080875

Lima, L. (2011). Políticas educacionais, organização escolar e trabalho dos professores. *Educação: Teoria e Prática* (21/38), 1-18.

Mahon, K., Kemmis, S., Francisco, S., & Lloyd, A. (2017). Introduction: Practice Theory and the Theory of Practice Architectures. In K. Mahon, S. Francisco, & S. Kemmis (Eds.), *Exploring Education and Professional Practice* (pp. 1-30). Singapore: Springer.

Melber, H., Kothari, U., Camfield, L., & Biekart, K. (Eds.). (2024). *Challenging Global Development: Towards Decoloniality and Justice*. Palgrave Macmillan. https://library.oapen.org/handle/20.500.12657/85040

Portugal. (1999). Decreto-Lei nº 241/99, de 25 de junho. *Diário da República, I Série-A*.

Portugal. (2015). Decreto-Lei n.º 213/2015, de 29 de setembro. *Diário da República, I Série*.

República de Moçambique. (2024). Diploma Ministerial n.º 30/2024, de 22 de Maio. *Boletim da República, Série I, n.º 99*. Imprensa Nacional de Moçambique.

Ventura, A., Castanheira, P., & Costa, J. A. (2006). Gestão das escolas em Portugal. *Revista Electrónica Iberoamericana sobre Calidad, Eficacia y Cambio en Educación*, (4/4e), 128-136.

Wilkinson, J., MacDonald, K., Keddie, A., Gobby, B., Eacott, S., Niesche, R., & Blackmore, J. (2024). School transformation in minoritized settings: a practice architectures lens. *International Journal of Leadership in Education*, 1-19. https://doi.org/10.1080/13603124.2024.2342296

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

QUALITY OF LIFE OF PARENTS WITH CHILDREN WITH AND WITHOUT DISABILITIES DURING COVID-19 RESTRICTIONS: AN EXPLORATORY STUDY

Lefkothea Kartasidou, Maria Platsidou, Eleni Kyriakidou, Aristi Trokana, Georgia Diamantopoulou, & Pagona Leonidou
Department of Educational and Social Policy, University of Macedonia (Greece)

Abstract

The present study examines family functioning with a particular emphasis on the quality of life of parents during the implementation of restrictive measures aimed at preventing the spread of COVID-19. This period was characterized by several notable changes, including reduced mobility, diminished social interactions, alterations to daily routines due to the suspension of activities such as organized sports, the shift to distance learning and telecommuting, and temporary work interruptions. These circumstances suggest that the pandemic may have served as a potential influencing factor on parents' quality of life. The primary objective of this research is to investigate and compare the quality of life of parents with children with disabilities to that of parents with children without disabilities during the early stages of the pandemic. A total of 242 parents participated in the study, including 101 parents of children with disabilities and 141 parents of children without disabilities. Following a quantitative research methodology, the study employed two instruments for data collection: (a) the WHOQOL-BREF questionnaire (Ginieri-Coccossis, Antonopoulou & Christodoulou, 2001) and (b) a custom-designed questionnaire consisting of five Likert-scale statements that assessed participants' emotional responses over the previous month during the implementation of COVID-19 containment measures. Data were collected via Google Forms during the final ten days of the restrictive measures, covering a period of up to one month prior. Analysis revealed a statistically significant difference between the two groups in the social relationships subscale, with parents of children with disabilities reporting lower mean scores. Correlations between the two questionnaires suggest that the family unit played a critical role in managing the various challenges encountered during the early stages of the pandemic.

Keywords: *Quality of life, disability, parents, Covid-19.*

1. Introduction

Quality of life is a critical indicator of overall well-being, especially in times of crisis. COVID-19 has profoundly changed societies worldwide, as all people have faced serious health, social and economic challenges, that have affected their quality of life. School closures, reduced social interactions and the imposition of long-term social distancing have a negative impact on the psychological, physical and mental health of children and adults (Wang et al., 2020). The prolonged lockdown coupled with the absence of extracurricular activities led to increased feelings of isolation, anxiety, and frustration. Families changed their daily routines, as many parents became unemployed or were forced to work online to take care for their children who stayed home for long periods due to the quarantine.

This period of restrictive measures not only strained family relationships but also highlighted the essential role of social connectedness and structured routines in maintaining overall well-being. Although maintaining family routines was a significant challenge during the COVID-19 pandemic, these routines proved crucial in supporting individual and family well-being in the midst of health, economic, and social stress (Bates et al., 2021). All of these changes make it imperative to understand the consequences for individuals and families, particularly those with disabilities.

In particular, people with disabilities faced increased challenges to their full participation in the community due to pre-existing inequalities which were highlighted by the pandemic (Pikoulis et al., 2024). Carers of people with intellectual disabilities experience accumulated stress and therefore more likely to develop mental health problems than carers of typically developing children (Singer, 2006). Furthermore, during the COVID-19 pandemic, families with a disabled member were more likely to experience difficulties accessing their basic needs (Streuli et al., 2023).

While previous research has documented the prevalence of difficulties experienced by people with disabilities during COVID-19, there are few studies in Greece that have examined the quality of life of families with children with and without disabilities and have understood how the pandemic has affected them in particular.

2. Aim of the study – research questions

The aim of the study was to investigate and compare the quality of life of parents of children with disabilities with that of parents of children without disabilities during the early stages of the pandemic. Specifically, the following research questions were formulated: a) Is there a statistically significant difference in the 4 dimensions of quality of life of parents with children with disabilities compared to parents with children without disabilities during the early stages of the pandemic? b) Is there a correlation between the responses to the two questionnaires of parents with children with disabilities compared to parents with children without disabilities during the early stages of the pandemic?

3. Method

This study uses quantitative research methods, which focus on understanding social phenomena by collecting information for large numbers of people and generalizing across groups of people.

3.1. Participants

The sample was collected randomly by distributing the Google Form questionnaire to parents of children with and without disabilities. A total of 242 people aged between 22 and 66 took part in the survey, including 101 parents of children with disabilities and 141 parents of children without disabilities. The majority of participants were female (84.5%) and reported being married (74.8%). Furthermore, 81% of the participants live in Thessaloniki, Athens or another large city. When asked if their profession had been affected by Covid-19, most participants (64.9%) answered negatively, and most participants (81.4%) said that their family members hadn't been affected by Covid-19.

3.2. Measures

The research team designed an online survey that included demographic questions and two data collection instruments: (a) the WHOQOL-BREF questionnaire (Ginieri-Coccossis et al., 2001) and (b) a custom-designed questionnaire. The WHOQOL-BREF questionnaire (Ginieri-Coccossis et al., 2001) is the development of the Greek version of the WHOQOL-100 measuring quality of life. It consists of 26 questions covering four dimensions: physical health, psychological health, social relationships and environment. In this survey, the questionnaire was adapted by adding the phrase "during the period of Covid-19" at the end of the 26 statements. The custom-designed questionnaire contains five statements relating to the support of family members, the external help and medical care available to them, and the satisfaction of basic family needs. Participants were asked to select the response that best described their emotional reactions during the implementation of COVID-19 containment measures over the previous month, using a five-point Likert scale.

3.3. Procedure – data analysis – ethics

The study was conducted during the last ten days of the restrictive measures in May 2020, and for a period of up to one month prior, only via the internet, to ensure the safety of the participants. A google form questionnaire was created and the link was distributed to Greek parent associations with children with disabilities, schools and social media, as well as to other parent associations without children with disabilities. Parents were informed that their participation was voluntary and anonymous, and that the information collected would be confidential and used for research purposes only. Informed consent was obtained from respondents prior to the start of the survey. The data collected were coded and analyzed using the SPSS 28.0 statistical package. Descriptive statistics, correlations and t-tests were calculated to check the differences between the two groups, parents of children with and without disabilities.

4. Results

4.1. Descriptive statistics

This exploratory study focuses on the differences between the quality of life of parents of children with disabilities and that of parents of children without disabilities during the COVID-19 pandemic. The descriptive statistics of the custom-designed questionnaire (see Table 1) highlight the difference between mean scores of statements 1, 3, 4 and 5 to statement 2 (M: 2,37, SD:1,38), which refers to the external help available to the family during the pandemic. On the contrary, the mean score of Statement 1 (My family members support each other during the COVID-19 period) (M: 4,57, SD: 0,73) is the highest, indicating that most participants relied on internal family support during the pandemic.

Table 1. Descriptive statistics of the custom-designed questionnaire.

Questions	Min.	Max.	Mean	Std. Deviation
S1. My family members support each other during the COVID-19 period.	1	5	4,57	,732
S5. The parents in the family can take care of each child's individual needs during the COVID-19 period.	1	5	3,90	1,079
S3. My family can manage its financial expenses during the COVID-19 period.	1	5	3,87	1,172
S4. My family has access to medical care during the COVID-19 period.	1	5	3,51	1,308
S2. My family has external help available during the COVID-19 period.	1	5	2,37	1,388

Concerning the 4 dimensions of quality of life (WHOQOL-BREF questionnaire) (see Table 2) participants scored higher on psychological health (*M*: 3,09, SD: 0,46) and lower on physical health (*M:* 2,66, SD: 0,41). Moreover, the high standard deviation of social relationships' dimension (*M:* 3,04, SD:0,76) indicates that participants' emotional responses are spread out over a wider range.

Table 2. Descriptive statistics of 4 dimensions of quality of life (WHOQOL-BREF questionnaire).

QoL Dimensions	Min.	Max.	Mean	Std. Deviation
Psychological health	1,50	4,33	3,0930	,46965
Environment	1,63	4,50	3,0739	,51182
Social relationships	1,00	4,67	3,0427	,76671
Physical health	1,57	3,57	2,6659	,41870

4.2. Inferential statistics

Regarding the first research question, a statistically significant correlation was found between the 4 dimensions of quality of life ($p<0.01$). The statistical analysis revealed interesting results about parents with children with disabilities and parents with children without disabilities. It seems that parents of children with disabilities reported lower mean scores on the WHOQOL-BREF questionnaire. More specifically, the largest difference between the two groups was found in the social dimensionn (see Table 3).

Table 3. Comparison of the two groups at the 4 dimensions of quality of life (WHOQOL-BREF questionnaire).

QoL Dimensions	Children with Disabilities	Mean	Std. Deviation
Physical health	Yes	2,5983	,41488
	No	2,7143	,41615
Psychological health	Yes	3,0545	,45467
	No	3,1206	,47979
Social relationships	Yes	2,8812	,82001
	No	3,1584	,70664
Environment	Yes	2,9554	,49705
	No	3,1587	,50707

To address the second research question about the relationship between the responses of parents of children with disabilities and those of parents of children without disabilities during the early stages of the pandemic, a correlation analysis between the two questionnaires was conducted (see Table 4). Our results showed strong positive correlations between physical health, psychological health, social relationships and environment, suggesting that these aspects of well-being are closely linked. In particular, the very high correlation between mental health and environment (r=0,488, p<0,001) suggests a strong link between individuals' perceptions of their environment and their mental well-being. The results suggest that both physical health and social support play a crucial role in psychological well-being, as evidenced by the strong positive correlations between physical and psychological health (r =0,572, p< 0.01) and between social relationships and psychological health (r =0,423, p<0.01). Further analysis shows that parents' ability to meet their children's individual needs (Statement 5) is highly correlated with physical and psychological health, social relationships and environment. In addition, statement 1 of the custom-designed questionnaire has a strong correlation with the social dimension of the QoL questionnaire (r=0,351, p<0,001).

Table 4. Correlations.

	Physical health	Psychological health	Social relationships	Environment	S1	S2	S3	S4	S5
Physical health		,572**	,360**	,400**	,187**		,280**	,148*	,267**
Psychological health	,572**		,423**	,488**	,209**	,173**	,210**	,229**	,326**
Social relationships	,360**	,423**		,406**	,351**	,181**	,115	,203**	,363**
Environment	,400**	,488**	,406**				,285**	,313**	,352**
S1	,187**	,209**	,351**			,195**		,142*	,336**
S2		,173**	,181**		,195**			,243**	,193**
S3	,280**	,210**		,285**				,394**	,466**
S4	,148*	,229**	,203**	,313**	,142*	,243**	,394**		,360**
S5	,267**	,326**	,363**	,352**	,336**	,193**	,466**	,360**	

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

4.3. Reliability

The reliability of the scales measured with Cronbach's Alpha is for the WHOQOL-BREF questionnaire, α=.812 and for the Custom-designed questionnaire, α=.617, indicating acceptable to high internal consistency.

5. Discussion

The current study focuses on the emotional responses of parents of children with and without disabilities during the early stages of the COVID-19 pandemic. The findings of this study are discussed in relation to the research questions. In relation to the *first research question*, it is important to highlight that all dimensions of quality of life are highly correlated and therefore interrelated. Parents of children with disabilities scored lower than parents of children without disabilities in all 4 subscales of the WHOQOL-BREF questionnaire: physical, mental health, social relationships and environment. The analysis highlighted that the social subscale showed the greatest difference between the two groups, with parents of children with disabilities reporting lower mean scores. This may indicate that there was limited external help available to the families at the time. This finding is in line with previous studies indicating that the reduced social support experienced by parents of children with disabilities during the COVID-19 pandemic negatively affected the overall quality of their family life (Rakap et al., 20-22).

With regard to the *second research question*, there is a strong correlation between the responses of the participants in the two groups to specific questionnaires. Specifically, the social dimension appears to be highly correlated with Statement 1, which refers to the internal support of family members during the COVID-19 restrictions. The results show that families acted as a vital support system for the social needs of their members during the pandemic period, which is consistent with the findings of other family-focused studies (Prime, Wade & Browne, 2020).

It appears that families rely on their own strengths to survive during these difficult times. This study highlights the importance of raising awareness among families on how to cope with the challenges that arise during global crises such as the COVID-19 pandemic (Busaad & Alnaim, 2021). In addition, the low score on available external help highlights the lack of adequate support policies during crises for all families and especially for those with children with disabilities. Other researchers have also focused on families with children with disabilities due to the lack of tailored services, highlighting the need for tailored formal support during emergencies (Hochman et al., 2022).

6. Conclusion

In conclusion, further research is recommended in order to compare the emotional responses of participants from different countries considering the 4 dimensions of quality of life, at different stages of the pandemic crisis. From an analytical point of view, it would be interesting to examine the effect of demographic characteristics on the results and to compare them with studies that focused on the post- COVID-19 period. The studies that have focused on issues related to the COVID-19 period have highlighted the important role of family and school in terms of communication and cooperation. The above results have important implications for psychology and education as they show the importance of support systems that must always be in place.

References

Bates, C. R, Nicholson, L. M., Rea, E. M., Hagy, H. A., & Bohnert, A. M. (2021). Life Interrupted: Family Routines Buffer Stress during the COVID-19 Pandemic. *Journal of Child and Family Studies*, *30*(11), 2641-2651. doi: 10.1007/s10826-021

Busaad, Y., & Alnaim, M. (2021). Parents' perceptions regarding the effects of COVID 19 on their children with and without disabilities. *International Journal of Instruction*, *14*(4), 997-1012. https://doi.org/10.29333/iji.2021.14457a

Ginieri-Coccossis, M., Triantafillou, E., Tomaras, V., Soldatos, C., Mavreas, V., & Christodoulou, G. (2012). Psychometric properties of WHOQOL-BREF in clinical and health Greek populations: incorporating new culture-relevant items. *Psychiatriki*, *23*(2), 130-142.

Hochman, Y., Shpigelman, C. N., Holler, R., & Werner, S. (2022). "Together in a pressure cooker": Parenting children with disabilities during the COVID-19 lockdown. *Disability and Health Journal*, *15*(3), 101273. https://doi.org/10.1016/j.dhjo.2022.101273

Pikoulis, E., Vardakastanis, I., Karamagioli, E., Kallimani, E., & Stoupa, E. P. (2024). Inclusion of People with Disabilities in Disaster Risk Management after the COVID-19 Pandemic: an exploratory study in the Greek context. *GreeSE – Hellenic Observatory Papers on Greece and Southeast Europe 197, Hellenic Observatory*, LSE.

Prime, H., Wade, M., & Browne, D. T. (2020). Risk and resilience in family well-being during the COVID-19 pandemic. *American psychologist*, *75*(5), 631. https://doi.org/10.1037/amp0000660

Rakap, S., Vural-Batik, M., Kaklkan, S., Karnas, M., Sari, H., & Bayarakda, U. (2022). The hidden (overlooked) impact of living through a pandemic: How parents of children with disabilities fared during COVID-19? *Frontiers in Education, 7*. https://doi.org/10.3389/feduc.2022.827230

Singer G. H. (2006). Meta-analysis of comparative studies of depression in mothers of children with and without developmental disabilities. *American journal of mental retardation: AJMR*, *111*(3), 155-169. https://doi.org/10.1352/0895-8017(2006)111[155:MOCSOD]2.0.CO;2

Streuli, S., Garfein, R. S., Gaines, T., & Fielding-Miller, R. (2023). COVID-19 disproportionately impacts access to basic needs among households with disabled members. *Disability and Health Journal*, *16*(2), Article 101443. https://doi.org/ 10.1016/j.dhjo.2023.101443

Wang, G., Zhang, Y., Zhao, J., Zhang, J., & Jiang, F. (2020). Mitigate the effects of home confinement on children during the COVID-19 outbreak. *The Lancet, 395*(10228), 945-947. doi: 10.1016/S0140-6736(20)30547-X

RETHINKING ACADEMIC REVIEW PROCESSES: INSTITUTIONAL AGILITY IN THE ERA OF AI-DRIVEN CHANGE

Michael G. Wagner
Department of Digital Media, Drexel University (USA)

Abstract

This paper aims to stimulate discussion about the growing misalignment between traditional academic governance and the rapid pace of AI-driven change in higher education. Drawing on recent literature and case studies, it examines how existing governance structure — from curriculum approval to peer review processes — struggle to keep pace with technological advancements. Through synthesis of emerging approaches to academic governance, including agile frameworks and decentralized decision-making, the paper explores potential pathways for institutions to become more responsive while maintaining academic quality. This review contributes to an urgent conversation about adapting institutional governance for an AI-transformed educational landscape.

Keywords: *Institutional agility, academic governance, review processes, higher education reform, organizational change.*

1. Introduction

In an era of unprecedented technological acceleration, marked most dramatically by the emergence of generative artificial intelligence and, universities face mounting pressure to become more agile in their governance processes, spanning both internal institutional decisions and broader academic practices like peer review.

This article examines recent academic research on the tension between traditional academic governance and the need for responsiveness, with special attention to the disruptions posed by AI system. It aims to open a discussion of three core questions: (1) What specific limitations do traditional governance structures, from curriculum committees to peer review systems, face in responding to AI-driven change? (2) Which emerging agile governance models hold the most promise for higher education? (3) What implementation challenges must be addressed to ensure both institutional responsiveness and academic rigor?

Through synthesis of key arguments about traditional processes, analysis of proposed models for adaptive governance, and examination of innovative case studies, this paper aims to identify what is known, where gaps exist, and how theory can inform a shift toward more agile academic governance in an era where technological change is not merely rapid but exponential.

2. Impact of traditional governance on responsiveness

Conventional academic governance structures—including faculty senates, curriculum committees, and bureaucratic administrative hierarchies—can hinder an institution's ability to adapt quickly to change. This limitation has become problematic in the context of AI-driven transformation, where the pace of change often outstrips traditional decision cycles.

Many governance processes were designed when stability and consensus were valued over speed, resulting in sluggish responsiveness to external changes. Verma (2024) observes that purely hierarchical decision models struggle with fast-moving shifts in technology, student demographics, and economic conditions, while more agile governance models enable universities to "respond swiftly" to such factors.

Earlier scholars had noted that the changing environment of higher education — increased accountability demands, industry partnerships, and competition — requires shorter decision timeframes than traditional governance typically allows (Kezar, 2004). Tensions often arise when urgent innovations are needed: senior administrators may view the normal shared governance process as "slow-walking" critical initiatives, such as integrating AI tools into teaching and research, even as faculty defend these processes for ensuring due diligence (Prejean, 2019). The literature consistently shows that traditional governance, while ensuring quality and inclusivity, dampens institutional agility, particularly in responding to technological disruptions.

3. Challenges in traditional academic processes

Several core academic processes exemplify the rigidity of traditional governance, a rigidity that has become particularly problematic in the context of rapid technological advancements. The emergence of sophisticated AI tools has further highlighted and exacerbated existing procedural bottlenecks in several key areas.

3.1. Curriculum approval processes

Curriculum approval processes, already known for their lengthy timelines, now face the additional challenge of keeping pace with AI-driven changes in disciplinary knowledge and professional practice. Revising or launching academic programs typically requires multiple committee reviews, departmental votes, and accreditor consultations, a process that can stretch over months or years, during which the technological landscape may shift dramatically.

A recent case study at a UK university found that approving or re-validating a single degree program took about 18 months from proposal to final sign-off (du Main, 2024), a timeframe during which entirely new AI capabilities might emerge and reshape the field. Many institutions compound this problem with infrequent curriculum committee meetings and sequential layers of approval. While the traditional curriculum approval process aims to ensure thoroughness and quality control, it appears increasingly misaligned with the pace of AI-driven innovation.

3.2. Peer review processes

The scholarly peer review system faces mounting challenges in the AI era. Traditional peer review timeframes, spanning several months from submission to publication, have become increasingly problematic as AI accelerates the pace of research and discovery. One survey of authors in the biological sciences found an average peer review cycle of around 14 weeks, whereas authors felt the process should take about half that time (Nguyen, 2015a).

The system has been described as "under stress," with reviewer fatigue and lengthy backlogs now compounded by the need to evaluate AI-assisted research and AI-generated content. Calls to reform this system have recently intensified, with proposals for open or dynamic peer review models that could better accommodate the pace of AI-driven research while maintaining rigorous quality control.

3.3. Institutional decision-making processes

Institutional decision-making processes face significant temporal challenges in the AI era. Strategic decisions in universities traditionally go through layers of consultation and governance boards, an approach particularly problematic when responding to AI-driven changes that may alter teaching methods, research practices, or administrative processes within weeks or months.

Leadership studies note that many universities operate as "organized anarchies," with diffuse authority and lengthy deliberation, a dynamic observed in Cohen et al.'s 1972 garbage-can model but now particularly challenged by the pace of AI advancement. Higher education's shared governance model, involving faculty, administrators, and sometimes students, struggles to accommodate the urgent action needed to address AI-driven transformation. Prejean et al. (2019) observe that academia's bureaucratic management style stands in "stark contrast" to agile organizations, highlighting how routine decisions can impede rapid response to technological change.

4. Toward agile and adaptive governance frameworks

In the past decade, and with increasing urgency in the AI era, research has proposed agile academic governance frameworks aimed at making universities more responsive and innovative. These models emphasize flexibility, decentralization, continuous feedback, and rapid iteration — characteristics vital in responding to AI-driven change.

Decentralized decision-making has emerged as a key principle. Rather than routing all decisions through a top-heavy hierarchy or large committees, agile governance distributes authority to smaller teams or units. This approach becomes valuable when responding to AI-related changes, as it empowers those closest to the technological implementation to make timely adjustments. Verma (2024) suggests that distributing decision-making authority and embracing flexibility significantly enhances universities' responsiveness to technological change. Leadership focuses more on facilitation than control, encouraging faculty and staff to experiment with AI integration within a clear strategic vision.

Iterative curriculum development represents another vital adaptation. Instead of large-scale curriculum overhauls every few years, an agile framework promotes rolling curriculum updates that can keep pace with AI advancement. The curriculum design sprint model, where faculty and stakeholders convene in short, focused workshops, offers one approach. At De Montfort University (UK), small teams redesigned curricula in an intensive three-day process, allowing the institution to revalidate 76 programs in just 3 months — a task that traditionally would have taken well over a year (du Main, 2024).

Dynamic and open peer review systems have gained relevance in AI-accelerated research. Open Peer Review (OPR) is one model gaining traction, wherein reviews are transparent and feedback can occur publicly and post-publication (Nguyen, 2015b). Platforms like F1000Research publish articles first and then invite ongoing peer review, allowing for immediate dissemination of findings and iterative revision, particularly valuable for AI-related research requiring rapid validation.

Flexible governance structures have become essential in the AI era. Agile models favor flattened structures or matrix teams over siloed departments to promote cross-disciplinary innovation and faster decision cycles, particularly important for implementing AI-driven changes that often cross traditional boundaries. Some universities have created ad hoc task forces that can quickly address emerging issues, such as developing AI policies. Another approach treats governance itself as iterative: policies can be enacted on a pilot basis, evaluated, and adjusted based on feedback, particularly suited to managing rapid technological change.

5. Case studies: Benefits and risks of alternative approaches

Empirical studies and pilot programs have showed both the potential benefits and risks of moving toward more agile governance. These studies can provide guidance towards a successful transition into an AI driven academic environment.

5.1. Curriculum approval processes

The curriculum overhaul at DMU (UK) provides insights particularly relevant to AI-era adaptation. Using design sprint methodology, the university dramatically reduced time-to-implementation for new curricula, accomplishing in one academic term what typically takes multiple years (du Main, 2024). Despite initial concerns, the rapid process-maintained quality through additional faculty training and expert coaching, including specific support for integrating emerging technologies. The case shows that institutions can maintain high standards while accelerating change to keep pace with technological advancement.

Two U.S. business schools reimagined traditional curriculum committees as active stakeholders in an iterative development cycle, allowing rapid incorporation of AI-driven changes into their programs (Bohler, 2024). Benefits included improved student outcomes in pilot courses, as the agile approach enabled quick adjustments to teaching strategies. However, the strain on faculty time, especially given the effort required to stay current with emerging technologies, raised concerns about sustainability and highlighted the need for adequate support systems.

5.2. Peer review processes

Experiments with open peer review systems have gained significance in the AI era. Platforms like F1000Research and eLife allow visible reviewer comments and post-publication review, which is particularly valuable for evaluating rapidly strengthening AI-related as well as AI-assisted research. Early evidence shows obvious benefits in faster research dissemination and enhanced transparency. However, surveys reveal mixed reactions among researchers, with some expressing concern about maintaining rigorous evaluation standards for AI-related work.

5.3. Institutional decision-making processes

The COVID-19 pandemic provided an unexpected case study in adaptive governance with lessons for managing AI-driven change. A multi-campus study (Dunens, 2022) found that institutions empowering small leadership teams and expediting decision channels coped more effectively with the crisis. Decision speed did not necessarily undermine sound analysis when teams remained focused and collaborative — lessons that now inform approaches to managing AI-driven transformation while maintaining institutional integrity.

6. Implementation challenges and considerations

Transitioning to an agile academic governance framework suited to the AI era presents significant challenges in three key areas:

Faculty workload and buy-in take on extra dimensions with AI-driven change. Beyond the demands of continuous development work, faculty face the challenge of staying current with rapidly evolving AI technologies. Time constraints, already a significant barrier to curricular innovation (Price, 2022), become more acute when combined with new technological integration demands. Even with development sessions or stipends, some faculty may resist changes they perceive as undermining academic autonomy. Successful implementation requires dedicated time for technology exploration, recognition for innovative teaching, and a culture that values both technological advancement and traditional academic excellence.

Quality assurance faces particular challenges in an AI-accelerated environment. Traditional governance processes include multiple checkpoints to catch errors and uphold rigor. In an agile framework responding to rapid technological change, those checkpoints might be fewer or faster. The DMU curriculum sprint succeeded by involving QA personnel in sprint teams and combining validation events to ensure comprehensive review within compressed timelines (du Main, 2024). The literature emphasizes continuous evaluation: rather than one-time approvals, programs could be monitored via defined metrics and short feedback cycles, allowing rapid response while maintaining standards.

Policy and structural modifications must account for technological change pace. Agile governance may conflict with existing institutional policies or government regulations, particularly around AI integration. Universities need to update their bylaws and accreditation criteria to accommodate rolling updates while maintaining appropriate oversight. Governance charters themselves may need rewriting to allow rapid response to technological opportunities while preserving academic integrity. Leadership must often drive a cultural shift alongside formal policy changes (Verma, 2024), communicating a vision that embraces both technological innovation and academic excellence.

7. Research gaps and future directions

While scholarly exploration of agile academic governance has expanded, several gaps remain relevant to the AI era. First, longitudinal and comparative studies on agile governance outcomes are needed in the context of rapid technological change. Many published case studies report short-term successes in speed or stakeholder satisfaction, but the long-term impact on student learning, research productivity, and institutional effectiveness remains unclear. Critical questions include whether agile curriculum processes lead to better integration of AI technologies and improved graduate competencies, and if accelerated peer review enhances scientific quality or merely speeds publication.

Second, research must examine how to balance agility with traditional academic values in an AI-driven environment. Higher education cherishes values like academic freedom, shared governance, and scholarship quality — their intersection with rapid technological adaptation demands theoretical work integrating governance theory with both agile methodology and technological change management. Such research could draw on organizational science frameworks to articulate models that preserve core academic values while enhancing responsiveness to AI-driven change.

Finally, change management strategies for implementing agile governance in an AI-accelerated environment require further study. The challenges show that adopting agility represents a transformation of institutional culture in response to technological change. Key questions include: What training helps faculty and administrators thrive in an AI-augmented, agile governance environment? How can academic leaders cultivate an institutional mindset that views technological change as opportunity rather than threat? These questions become increasingly urgent as AI continues to transform higher education.

8. Conclusion

Colleges and universities are facing many challenges: new technology (like AI), changing public expectations, and limited funds. This makes flexible leadership more important than ever. Traditional governance structures, while ensuring stability and quality, often limit responsiveness in an era where AI technologies can transform disciplines overnight.

Scholars and practitioners have charted alternative pathways: from curriculum approval sprints and iterative program design to novel peer review models and decentralized decision-making structures. Evidence suggests that agile academic governance can bring substantial benefits, including faster implementation of AI-driven innovations and more dynamic scholarly communication, while requiring careful attention to faculty workload, quality assurance, and policy updates.

A theoretical foundation for agile governance has emerged, drawing from educational research and lessons from other sectors, highlighting the importance of feedback loops, stakeholder empowerment, and technological adaptation. Early adopters show that academic rigor can be maintained even as decision cycles accelerate, provided that transparency and collaboration are built into the process (du Main, 2024; Verma, 2024).

The literature points toward a future where academic governance is more adaptive and evidence-informed — characteristics essential for thriving in an AI-transformed educational landscape. Universities that evolve their governance frameworks are better positioned to meet coming challenges, from integrating artificial intelligence to responding to global crises, while upholding their mission of advancing knowledge. The agile academic governance framework stands as a promising paradigm for the AI era, but one that must balance innovation with inclusion and speed with deliberation.

Acknowledgments and AI Disclosure Statement

AI tools were used in the development of this paper. Claude 3.5 Sonnet assisted with the final editing of the text, while ChatGPT-01 Pro Mode evaluated the logical flow of the arguments presented. However, all arguments and ideas in this paper were conceived and developed by the human author.

References

Bohler, J., Larson, B., Davis, C., Krishnamoorthy, A., Bohler, J. A. (2024). In T. Janicki (Ed.), *Using Agile Methods for Course and Curriculum Development in Higher Education* (vol. 2024). Baltimore, MD: ISCAP Conference. https://iscap.us/proceedings/2024/

Cohen, M. D., March, J. G., & Olsen, J. P. (1972). A garbage can model of organizational choice. *Administrative Science Quarterly, 17*(1), 1-25.

du Main, L., & Allman, Z. (2024). *Making Curriculum Development a Sprint not a Marathon. When Quality Assurance Meets Innovation in Higher Education*. The Quality Assurance Agency (QAA) [Online]: Available at: https://www.qaa.ac.uk/docs/qaa/members/when-quality-assurance-meets-innovation-in-higher-education.pdf?sfvrsn=51beb681_8 (pp. 14-16).

Dunens, E. (2022). Adaptive governance during the COVID-19 pandemic: A multi-campus study. *Journal of Higher Education Policy and Management, 44*(3), 245-260.

Kezar, A., & Eckel, P. D. (2004). Meeting Today's Governance Challenges: A Synthesis of the Literature and Examination of a Future Agenda for Scholarship. *The Journal of Higher Education, 75*(4), 371-399.

Nguyen, V. M., Haddaway, N. R., Gutowsky, L. F., Wilson, A. D., Gallagher, A. J., Donaldson, M. R., Hammerschlag, N., & Cooke, S. J. (2015a). How long is too long in contemporary peer review? Perspectives from authors publishing in conservation biology journals. *PloS one, 10*(8), e0132557.

Nguyen, V. C., Pham, T. H., & Tran, Q. T. (2015b). Open peer review: The future of scholarly publishing? *Journal of Information Science, 41*(5), 637-650.

Prejean, L., Dutta, D., & Hsu, P. (2019). Agile management in higher education: A literature review. *Journal of Higher Education Theory and Practice, 19*(6), 23-36.

Price, I., & Regehr, G. (2022). Barriers or costs? Understanding faculty resistance to instructional changes associated with curricular reform. *Canadian medical education journal, 13*(3), 113-115. https://doi.org/10.36834/cmej.74041

Verma, S. (2024). Decentralized decision-making in universities: Enhancing responsiveness through agile governance. *International Journal of Educational Management, 38*(2), 198-217.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

INTRODUCING DESIGN THINKING TO IDENTIFY TEACHER AND STUDENT NEEDS

Sophie Farag
Department of English Language Instruction, The American University in Cairo (Egypt)

Abstract

In a university setting, teachers noticed that students in an intensive English program had low motivation and commented that they felt that they were still in school. In another instance, teachers showed signs of burnout and complained that the workload was too much and that the students were too demanding of their time. In a third instance, staff were stressed and tired all the time. To address these problems, teachers and administrators worked together and followed the design thinking process to identify the cause of each problem, and to come up with effective solutions. According to Stanford University, "Design thinking is a methodology for creative problem solving." It is a human-centered approach focusing on the needs of the user. Design thinking (DT) has been growing in popularity among educators as an instructional tool to teach students teamwork and problem solving. However, DT can also be used by administrators and educators to solve problems, address needs, and redesign programs and curricula. The five stages of DT are as follows: 1) "Empathize" by conducting interviews and research to gain insights into the specific needs of the people who are experiencing the problem, the users; 2) "Define" the problem and identify the needs. 3) "Ideate" for innovative solutions and select the optimum solution; 4) "Prototype" the solution; and 5) "Test" the solution by getting feedback from the users in order to make modifications. Following this process allows for an in-depth understanding of the needs faced by those experiencing the problem. By using DT, educators and administrators can uncover hidden challenges and feel empowered to discover creative solutions. In this session, the presenter will demonstrate how DT can be used as a framework to identify and address the needs of students, teachers, and staff in educational settings. Examples of the problems, the steps followed, and the solutions reached will be shared. The presenter will share practical recommendations, and engage the audience in a discussion to explore further applications of DT. Participants will gain practical insights into incorporating the DT methodology into their everyday life. Questions from the audience will be welcome.

Keywords: *Design thinking, leadership, management, problem-solving.*

1. Background

Problem solving is a skill that is necessary in the workplace, and it is essential when dealing with challenges, such as stress and dissatisfaction, whether it be among students, instructors, or staff in an academic setting. This paper will discuss several case studies, such as that of staff who are stressed and dissatisfied with the culture of the department, students with low motivation, and teachers who show signs of burnout. To address each of these problems, teachers and administrators worked together and followed the design thinking process to empathize and identify the causes of each problem, and to come up with effective solutions tailored to the specific needs of the people who were experiencing the problem.

2. Design thinking (DT)

2.1. Design thinking background

According to Stanford d.school (2018), "Design thinking is a methodology for creative problem solving." It is a human-centered approach focusing on the needs of the user. Design thinking (DT) originally started in the business world and is used in many industries and disciplines (IDEO Design Thinking, n.d.) The DT methodology has been growing in popularity among educators as an instructional tool to teach students teamwork and problem solving skills, in addition to creativity and innovation (Bruijnes et al., 2024). However, DT can also be used by administrators and educators to develop more empathy when solving everyday problems, addressing needs, and redesigning programs and curricula, thereby becoming "design-inspired leaders" (Gallagher & Thordarson, 2018).

2.2. Design thinking stages

According to the Stanford d.school, the five stages of DT are as follows:

1. "Empathize" by conducting interviews and research to gain insights into the specific needs of the people who are experiencing the problem, the users.
2. "Define" the problem and identify the specific needs.
3. "Ideate" for innovative solutions and select the optimum solution.
4. "Prototype" the solution by creating a draft.
5. "Test" the solution by getting feedback from the users in order to make modifications.

Following this process allows for an in-depth understanding of the needs faced by those experiencing the problem. By using DT, designers can uncover hidden challenges and feel empowered to discover creative solutions.

3. Design thinking applications

Design thinking can be used by administrators and educators to identify the problems faced by the staff and students and to come up with innovative solutions that address the specific issues.

3.1. Solving staff problems

One such example occurred when staff in an academic department at a university were showing signs of burnout and increased levels of stress and dissatisfaction. The design thinking challenge was initiated by the department administration as they wanted to create a motivating environment for their employees. They believed that motivation impacts the productivity of faculty, staff, and students, and that motivated community members can have a positive effect on others. A sample challenge statement for this situation is as follows: How might we design a human-centered work environment that inspires motivation in a culture where success is highly valued.

The participants in the design challenge were employees from within the department and they were divided into several small groups. Each group was assigned a coach to walk them through the stages of DT to design solutions for this statement. The five stages of DT were followed.

3.1.1. Empathize. This stage of the process allows the participants (designers) to gain a common and deep understanding of the problem by analyzing the challenge statement. This is achieved by identifying the keywords from the challenge statement and discussing the deep meaning of these words and concepts.

Example 1. Word analysis of the challenge statement.

How might we design a human-centered work environment that inspires motivation in a culture where success is highly valued.

Words and their meaning as identified by the participants

- human-centered: sense of belonging to a group, diversity, recognizing needs, emotions
- motivation: showing appreciation for one another, team work, community, fulfillment, balance
- culture: clear goals, clear direction, beliefs
- success: result-oriented, competitive, do your best, number 1

The next step is to prepare interview questions that target the concepts expressed in the challenge statement, such as how they feel about the work-life balance, their sense of belonging to the department, the value of their contributions, the extent of appreciation for their efforts, the strength of the relationships, and suggestions for changing or improving the work environment. The participants conducted interviews with people working in the department and took notes on the information they gained.

3.1.2. Define. After the interviews, the designers meet to share their findings, and they take it in turns to tell the rest of their team about the stories they got from their interviewees. This allows all the team members to learn from each other. They "unpack" the interviews by writing short notes on each point that came up in the stories. They compile the notes, reorganize the ideas, and group the related concepts into clusters.

Example 2. Unpacking and organizing information from the interviews into three clusters.

1. Motivating environment	2. Relationships	3. Balance
• Good boss (friend, helps retain employees) • Has the sense of "we" • Feeling appreciated • Motivating environment impacts own happiness • Good manager: encouraging, not critical; values development of staff • Feeling heard	• Fewer opportunities to meet have impacted relationships • Desire staff appreciation initiatives • Want the return of monthly meetings • Want a physical place for informal meetings with co-workers	• Connected all day, every day • Physically exhausted • Wish for more realistic deadlines • More "me" time • Better work-life balance • More attention to physical well-being

Drawing on the insights gathered from the interviews, the participants prepare their problem statement which outlines the main challenges they will focus on. They use the following template: ___ (User) needs a way to ____ (verb) because … (insight: why the problem is important?) (Gibbons, 2019).

Example 3. Problem statement.

Our user needs a way to connect with others, achieve work-life balance, and foster a sense of belonging because she feels isolated and burned out, and desires a motivating work environment that supports personal and professional growth.

Using the ideas from the initial challenge statement word analysis (example 1), the findings from the interviews (example 2), and the details of the specific problem statement (example 3), the participants come up with a series of How Might We questions to generate creative solutions (Rosala, 2021). These questions follow the template: How might we … (find solutions to each problem identified). They should focus on the problems identified, be open-ended and broad enough to allow for a variety of creative solutions, and should not guide the participants towards specific solutions.

Example 4. How Might We statements.

1. How might we enhance the work environment for our user so she can reduce feelings of isolation and connect with others?
2. How might we help our user achieve work-life balance?
3. How might we help our user achieve a sense of belonging?
4. How might we foster a motivating work environment and reduce burn out?
5. How might we achieve a work environment that supports personal and professional growth?

3.1.3. Ideate. The third step in the design thinking process is to brainstorm for creative solutions to each of the How Might We questions. This stage can be challenging as we seek creativity and innovation, and participants are encouraged to come up with as many ideas as possible, to refrain from judging the ideas, and to seek new and unusual ideas. It is advised to begin this brainstorming individually, and then to share suggestions with the group and try to build on the ideas of others to come up with even more ideas. One activity that can facilitate this is putting yourself in the shoes of a different person or a different company. In this activity, participants take on different roles and consider how they would solve the problem if they were … the department chair, a student, a faculty member, the CEO of a company, etc. The solutions the team generate are then compiled.

The team work together to narrow down and select the most impactful solutions. To make it easier to manage all the information, the ideas are clustered into themes.

Example 5. Samples of brainstorming ideas clustered into themes.

Theme: Sharing
Arrange regular activities for staff to bond and develop relationships, such as ice breaker activities, organized discussion groups, activities for different interests and hobbies, time to share feelings and thoughts, weekly informal social gatherings, coffee hours, walk and meet, scheduled breaks.

Theme: Motivating space
Make available suitable areas for staff meetings and activities: open spaces, outdoor working spaces, comfortable office design, lounge area, welcoming space with refreshments.

Theme: Communication
Organize regular surveys to gauge motivation levels, share experiences, get input on future plans, exchange feedback, conduct colleague evaluations, plan occasions to express gratitude and appreciation to colleagues.

Theme: Social gatherings
Extend the relationships outside the office by organizing trips, sports competitions, family gatherings, visits to concerts, retreats, celebrations of special occasions.

Participants then select the solutions they wish to take to the next stage. To determine the most widely supported ideas, they can vote for their top 2-3 solutions using stickers. The ideas that receive the highest number of votes are chosen to move forward to the prototyping phase. If resources are limited, priority can be given to solutions that are both impactful and relatively easy to implement.

3.1.4. Prototype. This stage requires the designers to create a draft of the solutions that they want to implement. This could include a physical or digital prototype, a video, a sketch of a space, a schedule of events, a poster or flyer advertising an event, etc. The participants chose to create a list of activities to implement immediately, and it was agreed that the ideas will be revisited in two months to assess their success and make any additions or modifications as necessary.

Example 6. Draft plan of activities.

Theme: Sharing
Arrange weekly informal social gatherings: every Thursday from 1-2 pm.
Every week, two staff members will organize a topic for discussion or an activity. A signup sheet will be created to document the names of the organizers and the planned activity.

Theme: Motivating space
Reserve the department meeting room every Thursday from 1-2 pm. Put in a request for colorful cushions and several additional chairs, in addition to tea and coffee supplies.

Theme: Communication
Create a message board to encourage the sharing of ideas and suggestions.

Theme: Social gatherings
Schedule a monthly outing to celebrate special occasions on the third Saturday of each month. Reminders will be posted on the newly created message board.

3.1.5. Test. The final stage of the DT process is to present the solution to different people from the user base to get feedback on what they like and elicit suggestions for modifications. The team shared the draft plan of activities with their department and collected feedback to answer the following questions: What worked well and should be kept in the plan? What new ideas should be added? The suggestions were then evaluated by the team and they agreed on the modifications to be made. The plan was updated accordingly.

3.2. Reflections

It was interesting to note that, in this example, the majority of the solutions generated focused on social interaction and the work environment. There was little focus on the work load or the type of tasks required, which was surprising. This served as a significant reminder of the value of a positive environment where employees feel supported and valued. The proposed solutions were relatively easy to execute as many of them simply required some reorganization and time investment. This example shows the value of following the DT process and spending time empathizing with the user to ensure the correct problems are identified. The following two examples also support this concept.

3.3. Solving Student Problems

In the above example, DT was used to solve problems faced by staff. The DT process can also be used to solve problems faced by students. In a university setting, teachers noticed that students in an intensive English program had low motivation and often commented that the program made them feel that they were still in school. The students were together for five classes per day, and, initially, administrators

made assumptions that the students would want to attend classes with different groups of students in order to feel more like university students. This schedule redesign had been attempted in previous years but had proved to be logistically challenging. After following the DT process explained above, it became clear from the empathy interviews that the students cherished the friendships they made when they attended all their classes with the same group of students. They did, however, want class timings that matched those of their friends in other programs, more opportunity to meet other students so they felt less isolated, and a schedule involving changing classroom which allowed them to feel they were entering a new environment.

3.4. Solving Instructor Problems

DT is also useful in solving instructor challenges. In a language program, teachers showed signs of burnout and complained that the workload was too much and the students were very weak and needed a great deal of individual attention. Assumptions were made that the teachers would want to reduce the number of assessments, discuss the cut off scores for accepting students into the program, or teach different subjects. After following the DT process, it turned out that they really wanted more opportunities to share ideas with colleagues and discuss creative ways to solve problems. They also wanted to reduce the number of program-wide deadlines so they could have more freedom in pacing and setting their own deadlines so they could better address the weaknesses of their students.

4. Conclusion

The DT framework offers a structured, yet flexible framework that can be used to tackle any problem in any context. Examples of problem statements include everyday problems faced in the classroom, such as How might we improve student engagement, or improve team communication skills. The problems can also be broader, involving a whole department or school, such as How might we modify teaching techniques to adapt to the age of AI. Following the steps of design thinking can make it easier to make sense of complex problems.

References

Bruijnes, M., van Ewijk, A., Sluijs, J., & Veenhoven, J. (2024, September 16). *Design thinking in academic education*. Retrieved January 9, 2025, from: https://www.uu.nl/en/education/educational-development-training/knowledge-dossiers/knowledge-dossier-teaching-in-higher-education/design-thinking-in-academic-education

Gallagher, A., & Thordarson, K. (2018). *Design thinking for school leaders: Five roles and mindsets that ignite positive change* (pp.1-19). ASCD. Retrieved from https://files.ascd.org/staticfiles/ascd/pdf/siteASCD/publications/books/Design-Thinking-For-School-Leaders-Sample-Chapters.pdf

Gibbons, S. (2019, March 24). *User need statements: The 'define' stage in design thinking*. Retrieved January 9, 2025, from: https://www.nngroup.com/articles/user-need-statements/

IDEO Design Thinking. (n.d.). *History*. Retrieved January 10, 2025, from: https://designthinking.ideo.com/history

Rosala, M. (2021, January 17). *Using "how might we" questions to ideate on the right problems*. Retrieved January 8, 2025, from: https://www.nngroup.com/articles/how-might-we-questions/

Stanford d.school. (n.d.). *Get started with design thinking*. Retrieved January 10, 2025, from: https://dschool.stanford.edu/resources/getting-started-with-design-thinking

PROSPECTS FOR THE USE OF ARTIFICIAL INTELLIGENCE IN RUSSIAN HIGHER EDUCATION

Valentina Gerasimenko, & Maria Ulyanova
Faculty of Economics, Lomonosov Moscow State University (Russia)

Abstract

Scholars extensively discuss the role of artificial intelligence (AI) in higher education during at least last decade. The integration of AI into educational process at the beginning was affordable to limited number of higher education institutions (HEIs), in many cases introduced through the collaboration with world leading IT companies, such as IBM, Google, etc. At the beginning, HEIs implemented AI mainly in distant education, and implication of AI in higher education included following common directions: assessment and evaluation, adaptive content and personalization, tutoring. Therefore, most of scholars studied how the AI could be integrated into educational process from the universities' side. However, now given that many of AI applications becomes more and more affordable to students, universities have to revise the approach to assignments and evaluation. The study systemizes the experience of leading Russian universities during the last few years in integrating AI tools into the activities of students and employees and reveals the prospects for its further use. The AI activities of following universities were analyzed: Lomonosov Moscow State University, Higher School of Economics, ITMO, Bauman Moscow State Technical University, Moscow State Pedagogical University, Moscow Institute of Physics and Technology, and Presidential Academy. Russian HEIs face two challenges associated with AI, firstly, to train teaching staff to use AI, and secondly to regulate the use of chatbots with generative artificial intelligence in student's assignments and thesis. Most of universities motivate students to use generative tools based on AI to collect and analyze data in their thesis, which saves time for creative problem solving as study revealed. At the same time, students are required to double-check information from AI services and supplement it with sources that are more reliable. If students use generative tools in their thesis, they are required to reference it. Universities prohibit plagiarism and cheating, but not AI as such. Although, most of universities use anti-plagiarism software to identify student papers that used AI tools, they have not introduced separate regulations on the use of AI in theses. The further spread of AI tools requires changing approaches to assessing the work of university students.

Keywords: *Human resources development, management in education, Artificial Intelligence, thesis regulation.*

1. Introduction

The rapid evolution of artificial intelligence (AI) is reshaping higher education, presenting both opportunities and challenges for universities worldwide. Implementation of AI tools customized to special needs of educational process required and still requires substantial investments; therefore, initially it was limited to a few institutions, often through collaborations with leading IT companies such as IBM, Google, etc. At the beginning of this journey, higher education institution (HEIs) was integrating AI mainly in distant education. Implication of AI was focusing on these common directions: assessment and evaluation, adaptive content and personalization, tutoring. Universities, which could afford investing in AI, offered better learning experience to their student and were more competitive. It was also easy to control how students were using all of AI tools. However, the appearance of ChatGPT in November 2022 has disrupted "status quo" of educational process. We witness an explosive dissemination of AI tools. It took only five days for ChatGPT to rich one million user mark (Statista, 2023). Now, AI tools are increasingly accessible to students, prompting a reevaluation of university approaches to assignments and evaluations.

There are two major challenges for universities in connection with AI. The first one comes from the transformation of labor market caused by increasing automation of routine and non-routine tasks. Investments in AI would increase world GDP by 14% which is equivalent to $15,7 trillion according to PWC research (PWC, 2017). The increasing number of jobs connected with AI requires HEIs to prepare students to use AI in their future jobs. The second challenge is the increased digitalization of education,

including distant learning, and increased accessibility of AI for students and for teachers as well. While students adopt new technology very quickly enjoying benefits it may provide teachers and administrators stay behind. The survey conducted among students and staff of two Russian leading universities Higher School of Economics and ITMO revealed that about 60% students use AI for writing thesis, while only 40% of teaching staff uses it for generating syllabus and 20% for composing assignments (YandexEducation, 2024).

The increasing use of AI in higher education generate many concerns amongst academia. Most frequently cited risks of introducing AI include (Lukichyov, Chekmarev, 2024; YandexEducation, 2024):

- Cheating by submitting assignments generated by AI.
- Complete substitution of humans by AI in education process.
- Increased inequality by uneven access to AI technology.
- Ethical considerations, as generative models could learn using dubious information.

To mitigate such risks, universities need to introduce special policies on AI use in education, research and administrative processes. Increased AI's accessibility requires universities also to change their strategies regarding assignments and evaluations.

This study examines how leading Russian universities have integrated regulation of AI use in academic and administrative work, identifies future applications, and addresses the challenges of training staff.

2. Background

In Russian universities, the early stages of AI integration in higher education have focused on enhancing educational processes through automized and personalized assessment feedback tools, creation of adaptive content to individual students, and real-time support tutoring systems. Nowadays more and more Russian universities acknowledge the benefits of AI use in their activities.

Russian universities are receiving substantial support in the implementation of AI from both the government and the business sector. The government has allocated significant funding (around 7,7 bln rubbles) for the development of AI research centers at several leading universities within the framework of federal project “Artificial intelligence”. Additionally, business are actively collaborating with universities to integrate AI technologies into various sectors, further enhancing Russia’s AI capabilities. For instance, AI Alliance in Russia, established in 2019 by leading tech companies like Yandex, Sberbank, Gazprom Neft, etc. support universities in developing AI education. The Alliance was granted by the Russian Ministry of Higher and Science the right to accredit educational programs to ensure that they meet high standards and align with industry needs. Additionally, the Alliance conducts rankings of universities, based on the quality of AI education. This dual support from government and from business is crucial for advancing AI research and education in Russia.

Universities also receive support on institutional level. Regulation of AI use in education exists at the federal level in Russia. The new Russian standard, (GOST R 71657-2024) outlines the use of AI in education, specifically for creating scientific publications. It allows AI to be used in data collection, analysis of scientific publications, and formulation of publication titles, but prohibits AI from being listed as an author. The standard emphasizes ethical use and requires that AI does not replace human creative research activities. This standard was adopted in 2024 and came into effect on January 1, 2025. Competences in digital literacy are also being included in federal education standards.

All of this support the development of AI by Russian universities.

3. Methods

This study examines approaches to regulate the use of AI by Russian universities using case study approach. Following Russian universities were analyzed in this study: Lomonosov Moscow State University (MSU), Higher School of Economics (HSE), ITMO, Bauman Moscow State Technical University (BMSTU), Moscow State Pedagogical University (MSPU), Moscow Institute of Physics and Technology (MIPT), and Presidential Academy (RANEPA). These universities ranked top by two Russian ratings: “100 Best universities for Artificial Intelligence (AI) in Russia” by EduRank (2025) and “Best Russian Universities for preparing AI specialists” by The AI Alliance Russia (2024).

The analysis in this study was based on the information available on universities’ web sites. Information on AI regulation was collected using news, published regulatory documents and information for students. This study was mainly focus on regulation of AI use by students. According to the Federal Law No. 273-FZ of December 29, 2012 “Law on Education in the Russian Federation” all Russian universities are obliged to publish comprehensive information about their activities.

This study focuses mainly on regulatory side of implementation of AI in educational process and does not discuss the usefulness of various AI tools.

4. Results

Russian universities are proactively implementing AI technologies across their operations. This process is unfolding into two key directions: the development and implementation of educational programs in the field of AI to prepare professionals, and the integration of AI tools into educational, research, and administration to enhance overall efficiency. In 2023 almost 45% of all Russian universities has offered various programs in artificial intelligence, covering around 43 thousand students at full-time and 689 thousand students at short-term programs (RBC, 2024). Every 5th student in Russia takes course connected to AI. For example, at Lomonosov Moscow State University every student has to take at least one course on AI during studies. This rule applies to bachelor and masters' students. In this article, we explore issues related to the use of AI in university activities rather than professional training of AI specialists.

4.1. Areas of AI implementation in higher education

Most researches and universities agree on four major areas in which AI could be used in higher education, including (YandexEducation, 2024):

- Assistance to students, which includes help with learning process; personalization of educational content according to special needs of each student; tutoring to help students build their educational tracks, monitor success and remind of important dates.
- Assistance to teaching staff in designing courses' content, task and assignments, evaluating students' works and exams.
- Assistance to researchers in creating research designs, preparing report and trend watching.
- Assistance to administrators in education and admission management, creating analytics and managing documentation.

Russian universities have actively integrated artificial intelligence (AI) into their educational programs. Among the first to make significant steps in this direction are the following HEIs:

MSU: In 2020 MSU AI Institute was established to conduct fundamental and applied research in AI, including interdisciplinary projects using machine learning methods. AI Institute also run vocational educational courses on NLP, computer vision, and generative models. Many departments train professors and administrative staff to use AI in their work.

HSE: In the spring of 2024, HSE allowed the use of the YandexGPT language model for humanities majors when writing thesis papers (YandexEducation, 2024). HSE also has launched training programs and plans to train around 20% of employees (Vedomosti, 2024).

Consortium of leading universities, including HSE, MIPT, ITMO and Innopolis, in cooperation with IT companies Sber and Yandex have launched in 2024 AI360 bachelor program for training AI specialists.

ITMO University: The university actively uses machine learning tools and launched the SMILE cloud service for automating the construction of models of technological and business processes. ITMO also offers courses on data analysis using Python.

MIPT: The university is renowned for its strong programs in computer science and physics. MIPT allows the use of AI technologies in writing thesis, however, no regulation on this exists.

BMSTU: Bauman University since 2021 has launched sixteen AI applications study programs both on bachelor's and master's level, with about 400 students enrolled. BMSTU allows students to use AI "reasonably" in preparing their thesis with obligatory stating they were created using AI. No regulation on AI use in students' works exists (Vedomosti, 2024).

Innopolis University: Established the AI Institute in 2020.

MSPU: Allowed students to use AI-based generative tools for thesis papers, requiring them to verify the information from AI services (Tivyaeva et al., 2024).

RANEPA: In 2024, about 750 students at RANEPA underwent professional retraining in machine learning and AI. RANEPA mainly focuses on detection of AI-generated student work using anti-plagiarism software, rather than stimulating the use of AI in integrative manner (Vedomosti, 2024).

4.2. Barriers to AI implementation in Russian universities

The penetration of AI tools in mentioned above four areas vary within Russian universities. Russian leading universities identify several barriers to implementing AI in their activities:

- Insufficient digital infrastructure. For example, HSE notes a lack of infrastructure, especially in universities that are just beginning to adopt AI (RBC, 2024).

- Lack of financial investment and process restructuring. Innopolis University emphasizes the need for significant financial investments and restructuring of internal processes to integrate AI.
- Shortage of qualified personnel. Expert point out a shortage of specialists with relevant digital competences to develop and support AI systems (Cnews, 2022).
- Ethical and legal issues. HSE and other universities stress the importance of addressing ethical and data protection concerns when implementing AI.

Additionally, there is a notable lack of awareness among university faculty about the available AI tools and the opportunities for their use in the educational process. This gap in knowledge hinders the effective integration of AI technologies into teaching practices and curricular, further complicating the adoption of AI by universities.

Therefore, regulation should be focused on the increasing of AI literacy among students and universities' employees. AI literacy is a part of broader Media and Informational Literacy (Mansoor at al., 2024). AI literacy encompasses several key components that enable individuals to understand, use, and critically evaluate artificial intelligence technologies. These include knowledge and understanding of AI tools, usage and application, creation and evaluation, AI ethics and self-management (Carolus et al., 2023). Many researchers agree that developing AI skills is not considered part of AI literacy for non-programmers, the ability to understand and evaluate AI tools is more important. Additionally, researches specify skills of data handling, which include understanding the nature of data, its collection, processing, and analysis methods. This skill also includes prompting which determines the quality of query and ability to comprehend the logic behind the final result (Forbes, 2024). One of the tools for assessing AI literacy levels is the Meta AI Literacy Scale (MAILS), developed by Carolus et al. (2023), which universities can utilize to evaluate the effectiveness of their AI strategies.

4.3. Regulation of AI use by Russian universities

A content analysis of websites from Russia's leading AI-focused universities revealed that only a small proportion have implemented relevant policies and regulatory frameworks.

The first to introduce AI-policies on university level were MSPU and HSE. In August 2023, MSPU became the first Russian institution to formally permit students to use AI-generated tools for thesis preparation, establishing guidelines to ensure ethical implementation (Tivyaeva et al., 2024). HSE in June 2024 has implemented an ethical and educational policy regarding the use of artificial intelligence (AI) in academic work. This policy provides clear guidelines on when and how AI tools can be utilized in independent assignments. It also specifies situations where students must inform their instructors about the use of AI-generated content.

At Moscow State University no internal MSU regulations are explicitly stated, but the university's participation in the AI Alliance aligns with ethical principles such as data security and AI transparency. Additionally, AI regulation is mainly introduced on department levels. For example, Faculty of Economics in 2024 made changes to the Regulation of student's final thesis. This document allows students to use generative language models, which should be clearly stated in references.

5. Discussion

The academic community agrees that the emergence of accessible AI tools necessitates a reevaluation of the educational process and the role of educators. Universities face the critical challenge of enhancing AI literacy among faculty members and adapting educational materials and assessment tools to integrate AI. This will require universities to invest resources, including efforts to bridge the gap with students who are often more advanced in AI usage than educators.

The role of universities is to teach students how to effectively apply AI in their professional activities, freeing up time for creative tasks rather than routine ones. The application of AI tools should be done in an ethical manner. One of the major ethical concern is the use of AI-generated text in academic submissions. Existing universities' policies allow the AI use with proper citations, however prohibit plagiarism. Modern anti-plagiarism software can identify student papers that most likely used AI tools. At the same time, new better tools appear that allows hiding the use of AI in generated texts. Instead of participating in such chase, universities should think of how to change assignments. For example, professors are more relying on oral answers and presentations than written assignments.

Another ethical implication of using AI covers issues with equal accessibility to AI tools and transparency of information (Liheng, Zhonggen, 2023). Universities that lag in implementing AI in education due to insufficient funding, poor management decisions, and other factors risk widening the gap with leading institutions and exacerbating inequality in AI access. On the other hand, the integration of AI tools in education must adhere to the principle of informational transparency. This means researchers bear the responsibility of verifying AI-generated content. Such accountability also falls under institutional regulations within universities.

6. Conclusion

The study results show that the focus of attention in AI implementation in higher education has shifted over the past few years. While previously the primary emphasis was on developing curricula to train AI specialists, there is now a growing need to educate instructors and students across all disciplines on using AI in their professional fields. The accessibility of AI tools is prompting universities to reassess their assessment practices and the very nature of student independent work. Most surveyed universities acknowledge the importance of AI applications in student research and do not prohibit their use. While AI regulation policies remain in their infancy, we can anticipate that this emerging process will spread to all Russian universities.

References

Aymaletdinov Timur, How to Understand AI, Forbes, (09.11.2024), Retrieved March 15, 2024, from https://www.forbes.ru/mneniya/524718-kak-ponat-ii-pat-klucevyh-navykov-dla-uspesnoj-raboty-s-iskusstvennym-intellektom

Carolus, A., Koch, M. J., Straka, S., Latoschik, M. E., & Wienrich, C. (2023). MAILS - Meta AI literacy scale: development and testing of an AI literacy questionnaire based on well-founded competency models and psychological change-and meta-competencies. *Computers in Human Behavior: Artificial Humans*, *1*(2), 100014. doi: 10.1016/j.chbah.2023.100014

Chart: Threads Shoots Past One Million User Mark at Lightning Speed. Statista (Jul 7, 2023). Retrieved March 13, 2024, from https://www.statista.com/chart/29174/time-to-one-million-users/

EduRank. (2025). *100 Best universities for Artificial Intelligence (AI) in Russia*. Retrieved March 10, 2024, from https://edurank.org/cs/ai/ru/

Higher School of Economics. News (27.06.2024). Retrieved March 15, 2024, from https://www.hse.ru/news/expertise/937067191.html

How Russian universities are implementing AI. Vedomosti. (2024, November 6). Retrieved March 15, 2024 from https://www.vedomosti.ru/technology/articles/2024/11/06/1073238-kak-rossiiskie-vnedryayut

HSE experts identify problems in AI education. RBC News, (25.10.2024) Retrieved March 14, 2024, from https://www.rbc.ru/society/25/10/2024/67190aed9a794770c6e7701c

Leading Russian Universities, Sber, and Yandex to Launch First Bachelor's AI Degree. Snob. (2024, June 19). Retrieved March 16, 2024 from https://snob.ru/news/vedushchie-vuzy-rossii-sber-i-iandeks-zapustiat-pervyi-bakalavriat-dlia-sozdatelei-ii-tekhnologii-budushchego/

Liheng Yu, & Zhonggen Yu (2023). Qualitative and quantitative analyses of artificial intelligence ethics in education using VOSviewer and CitNetExplorer, *Frontiers in Psychology*, *14*. https://doi.org/10.3389/fpsyg.2023.1061778

Lukichyov, P. M., & Chekmarev, O. P. (2024). Risks of artificial intelligence in higher education. *Russian Journal of Innovation Economics*, *14*(2), 463-482. https://doi.org/10.18334/vinec.14.2.120731

Mansoor, H. M. H., Bawazir, A., Alsabri, M. A., Alharbi, A., & Okela, A. H. (2024). Artificial intelligence literacy among university students — a comparative transnational survey. *Front. Commun.*, *9*, 1478476. doi: 10.3389/fcomm.2024.1478476

Russian AI lacks specialists, Cnews, (11.04.2022). Retrieved March 12, 2024, from https://www.cnews.ru/news/top/2022-04-11_rossijskij_iskusstvennyj

Sizing the prize. What's the real value of AI for your business and how can you capitalise? PWC Report. (2017). Retrieved from https://www.pwc.com/gx/en/issues/analytics/assets/pwc-ai-analysis-sizing-the-prize-report.pdf

Tivyaeva, I. V., Mikhailova, S. V., & Kazantseva, A. A. (2024). Regulating the use of generative artificial intelligence tools in graduate qualification papers. *MCU Journal of Philology. Theory of Linguistics. Linguistic Education*, *2*(54), 202-218. https://doi.org/10.25688/2076-913X.2024.54.2.15

YandexEducation, Higher School of Economics. (2024). *Report "Artificial Intelligence and Higher Education: Opportunities, Practices and Future"*. Retrieved from https://disk.yandex.ru/d/b45m7TMG49mSUg

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

SWITCHING COSTS IN SCHOOL CHOICE SYSTEMS

Matías Morales Cerda
Tulane University (USA)

Abstract

Chilean households value academic quality and have access to detailed information about schools' characteristics. However, they seldom react to relative changes in the quality of schools and their potential competitors by switching schools. Why do students not switch more often despite their ability to do so each year? I document that families' preferences for schools exhibit inertia, which deters them from switching. To quantify this inertia, I estimate a discrete choice model combining rich administrative data and two sources of identification. First, some students are forced to switch because of schools' grade level configuration, which disrupts their inertia. Second, the introduction of a centralized assignment mechanism reduced search costs earlier for some students than for others. I find that families are willing to switch only if the destination school is substantially better than their current school. Further, I investigate the microfoundations of this inertia by surveying a random sample of parents. My findings indicate that attributes that develop through the schooling experience and that are difficult to modify through market forces or policy interventions, such as the learning environment and personal relationships, are relevant. This implies that the demand for schools is to some extent captive, which dilutes the incentives for schools to compete in attracting enrollment and could limit quality improvements in school choice systems.

Keywords: *School choice system, switching costs, peer effects, deferred acceptance algorithm.*

1. Introduction

School choice systems, which allow students to choose their school each year, have been growing in popularity around the world (Patrinos et al., 2009). In such systems, the freedom to choose –and switch– schools is the key channel of demand-side pressure for schools to compete with each other to attract enrollment (Friedman, 1962). If families hesitate to switch when their schools worsen or when potential competitors improve, then the demand becomes captive and the incentives for all schools to improve (and thus retain or attract other schools' students) are diluted. As a consequence, this could limit overall quality in school choice systems. Given the growing ubiquitousness of policies granting room for choice, understanding the extent to which households are willing to switch schools is key to judge the potential success of these policies in improving the quality of education.

2. Objectives

In this paper, I document that families' preferences for schools exhibit inertia, which deters them from switching schools. I formalize the above argument by drawing an analogy with the literature on switching costs (or inertia), which investigates, in different contexts, why agents do not react to changes in the market environment that would benefit them (Farrell and Klemperer, 2007). In schooling, inertia might arise because students form relationships that are deleterious to break or because searching for a new school is costly (if parents have to gather information or fill out paperwork). If these costs are high, they might deter families from leaving poorly performing schools or seeking to enroll in better ones. On top of weakening the incentives to compete, the presence of inertia could explain why families do not necessarily choose the "best" schools, an observation that the literature has attributed to a lack of preferences for quality (Abdulkadiroğlu et al., 2020) or inaccurate information about what the best schools are (Ainsworth et al. (2022), Allende et al. (2019)).

3. Methods

I proceed in five steps. First, I present descriptive evidence on the existence of inertia. I show that every year a minor share of students chooses to switch schools, that the probability of switching does not change after changes in the relative quality of their schools and the (geographically) closest competitor, and that the introduction of a website that alleviated search costs increased mobility. In the second step, I study the consequences of switching for cognitive and noncognitive outcomes. This step is key because a school choice system requires that families be willing to switch schools (to strengthen demand-side pressure on schools); if the costs of doing so outweigh the benefits, encouraging mobility might hurt switchers. I find weakly positive effects of voluntary switches. Third, I explore the consequences of school mobility for nonswitchers. This is relevant because having new peers each school year might affect performance in ways that are not immediately obvious. In addition, any policy aimed at encouraging mobility should take into account the potential externalities for nonswitchers; I find that these are negative but mild. Steps 1, 2 and 3 pose a puzzle: families could be better off by switching schools while inducing only mild externalities for the students who receive new classmates. Why, then, do they not switch more often? In the fourth step, I offer an explanation by investigating the factors that drive families to seek a new school. To do so, I estimate a demand for schools that incorporates inertia combining a discrete choice model with data on students' choices and schools' attributes. Finally, to decompose inertia in different potential sources, I show the results of directly surveying a random sample of parents to inquire about their reasons for not switching.

In the first step, I show descriptive evidence of the presence of inertia in the Chilean school system. First, I show that a every year only a minor share of students switch schools. Second, I show that the marginal effects on the probability of switching after changes in the cognitive and noncognitive outcomes of the closest competitor schools are precisely estimated zeros. In other words, students do not react to changes in the market environment even though, in principle, switching to better-performing schools would make them better off. Third, I estimate an event study leveraging the staggered roll-out of a school choice system that alleviated search costs by centralizing in a single web-platform all the information and paperwork that families had had to collect on their own before its introduction. I find that switching rates increased by 1.5 percentage points in grades in treated administrative regions over the rates in untreated ones. This suggests that part of the inertia is due to search costs.

In the second step, I study the consequences for switchers in terms of both cognitive and noncognitive outcomes. Answering this question is challenging because of the unobserved nature of the underlying switching decision process and the likelihood that it might be related to the very outcome on which its impact is being measured. For example, if students whose parents advocate for a better education are more likely to switch schools, a positive effect of switching may arise due to parental support, thereby biasing the effect of switches. I overcome this challenge in two ways. First, I leverage the fact that some Chilean schools have grade configurations that do not offer 9th grade, forcing their 8th-grade students to switch schools. Being enrolled in a school that does not offer the following grade increases the probability of switching schools only for those in such schools while not necessarily impacting students' outcomes per se. Second, I leverage the fact that the centralized school choice system (CSCS) allocates students to schools using the deferred acceptance algorithm with embedded lotteries when there are ties among applicants at oversubscribed schools. This allows me to recover the probability of a student's being offered a seat at a new school, conditional on which such offers are independent of unobserved determinants of outcomes (Abdulkadiroğlu et al., 2017).

4. Discussion

I find that, two years after switching, students forced to switch (but allowed to choose where to re-enroll, given the school choice system) perform approximately 0.2σ lower than students who are not forced to switch schools on cognitive outcomes and approximately 0.14σ lower in noncognitive outcomes. However, I find that, one year after the switch, students who voluntarily switch schools perform 0.3σ better in reading (and not different in math) than those who also applied to switch but were denied a seat in a new school by chance. Heterogeneity analyses indicate that the positive effects in reading are stronger among students who performed above average before voluntarily switching than among nonswitcher students who also performed above average. Similarly, noncognitive outcomes remain unchanged across the four alternative available measures. In this case, the heterogeneity analysis indicates that self-esteem deteriorates considerably among students who scored above average in this dimension before switching. Taken together, these results suggest that the consequences of switching schools are, at the very least, not harmful for voluntary switchers.

In the third step, I study the consequences for nonswitchers, i.e., those who remain in their current schools and experience the arrival of new classmates. Addressing this question presents the challenge that the proportion of new entrants is likely correlated with unobserved determinants of school quality, which, in turn, can affect students' outcomes. As a consequence, any cross-sectional estimation of the effect of the share of new entrants on outcomes comparing students facing different shares in different schools would be biased in the direction of the correlation between the share of new entrants and the unobserved determinants of students' outcomes. To address this issue, I build upon Hoxby (2000) and exploit the variations in the new entrants share within the same school to compare students at different grade levels who are similar in observed characteristics and school environment but who face different exposure levels to new classmates. Such variation can be considered idiosyncratic after I control for a rich set of individual characteristics.

I find that turnover has a small negative impact on the cognitive outcomes of nonswitcher students. An increase equivalent to one standard deviation in the share of new entrants leads to a decrease of 0.007σ and 0.015σ in math and reading test scores, respectively. Additionally, turnover hinders noncognitive outcomes, with effects ranging between 0.004 and 0.02σ (depending on the noncognitive dimension) following an increase of one standard deviation in the share of new classmates. The heterogeneity analyses reveal that the negative effects are concentrated among students with lower baseline performance, and for cognitive outcomes, this effect is more pronounced among girls. In the case of noncognitive outcomes, the negative impact is stronger for boys. The composition of the share of new entrants proves to be a key factor, as the better (worse) the outcomes of new students, the more positive (negative) are the effects on both cognitive and noncognitive outcomes of nonswitcher students. Additionally, when a higher proportion of new entrants is of a disadvantaged background, the negative effects on nonswitcher students become more pronounced.

These three preceding steps pose a puzzle: why despite the potential benefits of switching to preferred school's students do not switch more often? In the fourth step, I study the causes of school mobility by estimating a demand for schools with switching costs. The inclusion of these costs captures the idea that students become locked in after enrolling in a given school and, thus, deter them from switching. I incorporate two sources of inertia to account for the fact that, after considering other relevant schools' observed attributes (e.g., alternative measures of quality or peer SES), students might hesitate to switch schools. The first source arises from the hassle of having to look for alternative schools, visit them to find out about educational projects and complete paperwork (a search cost). The second source captures a bundle of other potential sources of inertia such as leaving friends or specific teachers behind (a fixed cost). Both of these costs might deter families from switching schools even if there are better alternatives available, if they are informed about these, and they value academic and non-academic quality.

To separately identify these two sources of inertia, I extend the argument in Luco (2019) to the Chilean school system context. In particular, different Chilean students face different switching costs depending on two dimensions. The first dimension is whether students have to actively choose a school; this dimension generates two groups of students. The first group is composed of those entering the system for the first time (i.e., rising 1st-grade students) and those transitioning to a grade level that their status-quo school does not offer (most of them in 8th grade due to the common 1st-to-8th-grade configuration in Chile); I call these active students. The second group is composed of students already enrolled in the system who can passively remain in their status quo by default (e.g., students in 4th grade in a school that offers 5th grade); I call these passive students. The second dimension is whether students apply to switch schools through the centralized school choice system, which, given the roll-out of the system, depends on the grade in which the student is seeking to enroll and the administrative region in which the school is located. The intersection of these two dimensions generates four types of students: passive students exposed to the CSCS; passive students not exposed to the CSCS; active students exposed to the CSCS; and active students not exposed to the CSCS.

Passive students both exposed and not exposed to the CSCS can avoid both the search and the fixed costs by remaining in their status quo schools. Active students exposed to the CSCS can avoid only the search cost, as the CSCS eliminates the hassle of having to collect information on different alternative schools but no other costs associated with leaving a school, such as leaving behind a community. If the fixed costs are high enough, passive students subject to the CSCS will remain in their status quo schools. Thus, comparing the choices of this group with those of active students subject to the CSCS identifies the fixed costs. On the other hand, active students not exposed to the CSCS incur both costs upon (obligatorily) switching schools. Thus, the comparison of the choices of this group and those of active students exposed to the CSCS identifies the search costs.

The demand estimates show that, after I account for a set of relevant schools' attributes such as peers' socioeconomic characteristics, out-of-pocket fees and academic and nonacademic quality, families derive high disutility from switching schools. Specifically, the search cost equals 0.2σ of the school average test score in math (1.4σ of a noncognitive test). In other words, families are willing to "pay" the search cost only if moving from a median school to one in the 60th percentile of the school-average math test score distribution. These estimates are higher for disadvantaged students (0.33σ), which implies that this group of the population does not exercise choice effectively. Overall, these results imply a weak demand-side pressure channel over schools to improve quality, provided that families' school choices show substantive inertia. To obtain an idea of what schools' responses are to this inertia, I calculate value added among schools that offer primary only versus those that offer secondary only. The former, which face arguably less pressure to offer quality (as their students must switch at the end of 8th grade and, thus, they face no incentives no retain them) provide significantly less value added than the latter, which face more pressure (as these must attract and retain them.)

In the fifth step, I address two potential concerns about my switching costs estimates. First, the fixed cost is a bundle of multiple factors –e.g., friendships, school community and its environment– that are impossible to disentangle with the administrative data only (this concern is common in the switching costs literature but is often disregarded). Second, its quantification depends on an inference from parents' revealed preferences for schools' attributes that might be imperfect if parents' choices are constrained for any reason. To deal with these concerns, further decompose the sources of inertia in its microfoundations, and directly quantify switching costs, I conduct a survey on a random sample of parents of students in primary education.

To nonswitchers, I ask them to choose reasons for not switching schools among a closed set of possible reasons. I find that distance to school, academic quality and the educational project (presented to parents as the "learning environment, educational project and values") are the three main reasons cited. However, parents also rank the "specific teachers" (65%) and "friendships" (45%) as important factors. These are all attributes that develop with the schooling experience and that are difficult to change by market forces or policy interventions. For switchers, I ask them to evaluate the importance of different attributes when choosing a new school. I find that the most important ones are academic quality and the educational project. Finally, I quantify switching costs building upon Becker et al. (1964). I present hypothetical schools to both groups of parents to infer their "willingness to switch" by sequentially improving these alternative –but otherwise very similar– schools on three dimensions: increasing values of academic outcomes, a discrete improvement in nonacademic outcomes, and increasing amounts of lump-sum cash transfers. I find that even when parents are offered sizable hypothetical improvements in academic outcomes or lump-sum cash transfers, they are unwilling to switch. However, they do seem willing to switch in exchange for improvements in nonacademic outcomes.

References

Abdulkadiroğlu, A., Angrist, J. D., Narita, Y., & Pathak, P. A. (2017). Research design meets market design: Using centralized assignment for impact evaluation. *Econometrica, 85*(5), 1373-1432.

Abdulkadiroğlu, A., Pathak, P. A., Schellenberg, J., & Walters, C. R. (2020). Do parents value school effectiveness? *American Economic Review, 110*(5), 1502–1539.

Agarwal, N., & Somaini, P. (2018). Demand analysis using strategic reports: An application to a school choice mechanism. *Econometrica, 86*(2), 391-444.

Ainsworth, R., Dehejia, R., Pop-Eleches, C., & Urquiola, M. (2022). Why do households leave school value added "on the table"? the roles of information and preferences,". *American Economic Review*.

Allende, C., Gallego, F., & Neilson, C. (2019). *Approximating the equilibrium effects of informed school choice.* Technical report.

Becker, G. M., DeGroot, M. H., & Marschak, J. (1964). Measuring utility by a single-response sequential method. *Behavioral science, 9*(3), 226-232.

Beuermann, D. W., Jackson, C. K., Navarro-Sola, L., & Pardo, F. (2023). What is a good school, and can parents tell? evidence on the multidimensionality of school output. *The Review of Economic Studies, 90*(1), 65-101.

Brummet, Q. (2014). The effect of school closings on student achievement. *Journal of Public Economics, 119*, 108-124.

Burgess, S., Greaves, E., Vignoles, A., & Wilson, D. (2015). What parents want: School preferences and school choice. *The Economic Journal, 125*(587), 1262-1289.

Dub´e, J.-P., Hitsch, G. J., & Rossi, P. E. (2009). Do switching costs make markets less competitive? *Journal of Marketing research, 46*(4), 435-445.

Farrell, J., & Klemperer, P. (2007). Coordination and lock-in: Competition with switching costs and network effects. *Handbook of industrial organization*, *3*, 1967-2072.

Friedman, M. (1962). *Capitalism and freedom*. The University of Chicago Press.

Gilraine, M., Petronijevic, U., & Singleton, J. D. (2021). Horizontal differentiation and the policy effect of charter schools. *American Economic Journal: Economic Policy*, *13*(3), 239-276.

Handel, B. R. (2013). Adverse selection and inertia in health insurance markets: When nudging hurts. *American Economic Review*, *103*(7), 2643-2682.

Hanushek, E. A., Kain, J. F., & Rivkin, S. G. (2004). Disruption versus tiebout improvement: The costs and benefits of switching schools. *Journal of public Economics*, *88*(9-10), 1721-1746.

Hastings, J., Horta¸csu, A., & Syverson, C. (2017). Sales force and competition in financial product markets: the case of Mexico's social security privatization. *Econometrica*, *85*(6), 1723-1761.

Hastings, J., Kane, T. J., & Staiger, D. O. (2009). Heterogeneous preferences and the efficacy of public school choice. *NBER Working Paper*, *2145*, 1-46.

Hill, D. V., Hughes, R. P., Lenard, M. A., Liebowitz, D. D., & Page, L. C. (2023). New schools and new classmates: The disruption and peer group effects of school reassignment. *Economics of Education Review*, *92*, 102316.

Hoxby, C. M. (2000). Peer effects in the classroom: Learning from gender and race variation. *National Bureau of Economic Research, Working Paper*, 7867.

Jackson, K. (2010). Do students benefit from attending better schools? Evidence from rule-based student assignments in Trinidad and Tobago. *The Economic Journal*, *120*(549), 1399-1429.

Kapor, A. J., Neilson, C. A., & Zimmerman, S. D. (2020). Heterogeneous beliefs and school choice mechanisms. *American Economic Review*, *110*(5), 1274-1315.

Luco, F. (2019). Switching costs and competition in retirement investment. *American Economic Journal: Microeconomics*, *11*(2), 26-54.

Patrinos, H. A., Osorio, F. B., & Gu´aqueta, J. (2009). *The role and impact of public-private partnerships in education*. World Bank Publications.

THE RIGHT TO BASIC EDUCATION IN SOUTH AFRICA: EQUALITY DISCRIMINATION BY THE STATE

René Elmari Viviene Pillay
In private capacity (South Africa)

Abstract

One of the effects of apartheid is inequality in the South African educational system. The Republic of South Africa's Constitution guarantees everyone the right to a basic education. However, the State did not make provision for free basic education for everyone but rather made provision for a market-related system of fees, wherein those who cannot afford the fees are protected against discrimination by providing free education. This resulted in disparities and inequality in the state school system, wherein ex-model C schools, now called higher quintile 4 and 5 schools, in affluent communities, could afford paying higher school fees as compared to low quintile 1, 2 and 3 schools in poorer rural communities. These lower quintile schools in many rural areas did not benefit from the apartheid regime in terms of infrastructure and resources. Many of these schools are still struggling due to past inequalities in apartheid South Africa and are battling to supplement state funding due to the low socio-economic status of parents in the community. The State is still experiencing challenges with infrastructure and the provision of adequate resources to fulfill this fundamental right to basic education more than thirty years after apartheid was abolished. The inability of parents or legal guardians to pay school fees has, arguably, led to a violation of the right to basic education by the State. Of great concern are the other fundamental rights that are affected by the right to basic education not being realized and consequently keeping the affected learners in their socio-economic state without the possibility of transformation and opportunities out of poverty. It must be emphasized how crucial it is to recognize the importance of the right to basic education in relation to other fundamental rights, considering that it is an empowerment right. The aim of this paper is to illustrate from a legal perspective, against the backdrop of relevant legislation, court cases, academic literature and internet sources that the State's failure to provide free basic education to all learners amounts to unfair discrimination.

Keywords: *Right to basic education, fundamental rights, inequality, discrimination, social transformation.*

1. Introduction

In terms of article 28 of The UN Convention on the Rights of the Child (1989) state parties are obligated to ensure that primary education is mandatory and available free to all. Section 29(1)(a) of the Republic of South Africa's Constitution (1996) (Constitution) states that each person has the right to basic education which includes adult basic education. The South African government (State) is obligated to not impede upon learners' access to the right to basic education and must put measures in place for basic education to be available for all learners (Arendse, 2011). The South African Schools Act 84 of 1996 (Schools Act) builds on the Constitution and is the legislation that is used to regulate the education system (Strohwald, 2024). Section 5(1)(a) of the Schools Act directs that all public schools must admit learners and serve their educational requirements without any unfair discrimination.

This paper addresses the following research questions: Has the State fulfilled its obligation to ensure that the right to basic education in terms of section 29(1)(a) of the Constitution is met for all learners? Has the State fulfilled its duty to provide free basic education for all?

2. Methodology

The researcher conducted a literature review analyzing secondary data such as legislation, policies, and court cases. The material reviewed was to establish what the core content of the right to basic education is, analyze and consider the criticism against the quintile ranking system in the South African school system, consider the reported effects on learners' rights, and ascertain whether the State is unfairly discriminating

against learners on the grounds of race and socio-economic circumstances and to establish if the provision of education is free.

3. Literature review

3.1. The core content of the right to basic education

The minimum core content is described as the substance of a right, without this pivotal element the actual significance of the human right is lost (Arendse, 2011). On the international platform, The Committee on Social, Economic and Cultural Rights (CESCR) in their General Comment No. 13, established the 4-A Scheme that states that education must be available, accessible, acceptable, and adaptable (Arendse, 2011). The concepts of being available and accessible refer mainly to the rights to basic education, whereas being acceptable and adaptable refers to rights in education (Arendse, 2011). Economic and physical obstacles must not affect accessibility to education and there should not be discrimination to access the right (Strohwald, 2024). According to Strohwald (2024), there is a link between economic accessibility and the absence of discrimination in that fees and indirect costs related to basic education, for example, uniforms and transport fees, impede learners from education, it boils down to economic inaccessibility, meaning the impoverished are discriminated against which violates their right to basic education. Physical access to the school is also needed therefore the school should be, for example, a safe distance from where the learners reside (Strohwald, 2024).

According to Ally and Kazim (2024), although the South African Constitutional Court had been hesitant to recognize a minimum core context of socio-economic rights, the courts have not rejected a minimum core approach to basic education. In the South African case of AB v Pridwin Preparatory School (2020), the courts expressly recognized that the state is mandated to make provision for education of a certain quality or standard. Basic education should at least include textbooks, furniture for classrooms, ample and adequate educators, basic infrastructure, transport for learners, and nutrition (Ally and Kazim, 2024).

3.2. The constitution and equality

Section 9(1) of the Constitution states that each person is equal before the law and equally entitled to be protected by and benefit from the law. Section 9(3) of the Constitution prohibits unfair discrimination by the State, directly or indirectly, on various grounds listed which includes race. In the case of Harksen v Lane (1997), the Constitutional Court set out a two-stage investigation to determine unfair discrimination, firstly, whether the differentiation amounts to discrimination and secondly, does the discrimination amount to unfair discrimination. Unfairness will be presumed if discrimination is based on one or more of the grounds listed in section 9(3) of the Constitution. However, if it is non-listed ground, the onus will be on the complainant to prove the unfairness. The focus of this test will be to determine how the complainant and others who are similarly affected are impacted by the discrimination.

The right to basic education is “immediately realisable”, meaning that the right is unqualified and not subjected to the State having to implement reasonable legislation or further measures to realize the right and the right can only be limited in terms of section 36(1) of the Constitution (Governing Body of the Juma Musjid Primary School v Essay 2011).

3.3. The South African school system

Section 34(1) of the Schools Act directs that to repair the historical disparities of the apartheid education system, and to guarantee that the rights of learners are properly exercised, public schools must be funded from public revenue by the state in an impartial manner (Van Dyk & White,2019). In terms of section 35 of the Schools Act, the goal of the National Norms and Standards for School Funding (NNSSF) is to improve fairness when funding the schools and therefore rank schools creating categories consisting of quintiles 1 to 5 (Van Dyk & White, 2019). The School’s Act does not make provision for free basic education for all learners, it is only free depending on the learners’ socio-economic circumstances (Strohwald, 2024). The quintile placement is determined by the unemployment and literacy rate of the community in the area where the school is situated, with a quintile 1 suggesting an impoverished school, and a quintile 5 ranking suggesting an affluent or well-off school (Van Dyk & White, 2019). It would therefore make sense that the schools in the impoverished areas should receive a higher amount of state funds as opposed to the schools in the wealthier areas and the expectation was that this approach should result in equality and fairness when funds are allocated between the different classified schools, however, the quintile system is not as effective as it set out to be (Van Dyk & White, 2019). The Schools Act also stipulates that schools are categorized as either a no-fee-paying school or a fee-paying school, provision is made for exemption applications by parents who are unable to pay the fees in a quintile 4 or 5 school (Strohwald 2024). I will proceed to discuss the criticism against the quintile ranking system.

3.3.1. Criticism against the quintile ranking system. The South African Constitution sets out to transform our society by bestowing the right to basic education but up until this day quintile 1, 2 and 3 learners, mostly made up of black and/ or poor learners, remain disadvantaged by not having access to adequate education (Arendse, 2019). A lack of funding influences the delivery of adequate education (Van Dyk & White 2019). With adequate education I mean the basic core content of the right to basic education.

The first issue with the quintile system is that the higher quintile schools have governing bodies (SGB's), who are permitted to determine the school fees per learner, and those schools have more affluent parents who can afford to pay high amounts in school fees which results in social, material and organizational benefits, compared to the lower quintile schools (Van Dyk & White, 2019). Extra resources can be raised by fee-paying schools through fundraising and obtaining donations and sponsorships; whilst this is not allowed for non-fee-paying schools (Maistry & Africa, 2020). Even though quintile 5 schools' funding from the state is less, quintile 1 schools remain in a worse position concerning school resources and composition (Van Dyk & White, 2019).

The second issue is that the public school system is only seen as either well-resourced and privileged or poorly resourced and underprivileged and with closer inspection one may find that quintile 2, 3 and 4 schools require more resources than quintile 1 schools, which proposes that the ranking system is placing quintile 2 to 4 schools in the wrong quintiles (Van Dyk & White, 2019). Quintile 4 schools are equivalent to or marginally above the national average of the percentage of underprivileged families, even though it is given far less funds than the quintile 1 to 3 schools (Van Dyk & White, 2019). There is a pressing need to reclassify schools in the ranking system to guarantee that those that require more from the funds allocations are placed in the right quintile rank to receive enough funding for their shortcomings (Van Dyk & White, 2019).

The third issue is that even though the state must fund and maintain the facilities, maintaining schools is frequently neglected with overcrowded schools as one of the main issues in a lot of the rural schools (Van Dyk & White, 2019). It is reported that there are no good systems in place to do maintenance inspections and that they are done in an impromptu way when broken down or damaged equipment requires attention and that the funds from the Department of Education for maintaining schools were not enough (Van Dyk and White, 2019). The schools that are funded by school fees can supplement the maintenance expenses from those funds, but the no-fee schools are not able to maintain their schools as needed (Van Dyk and White, 2019). The different financial abilities of quintile 1 and 5 schools are an indication of how the quintile system is ineffective in solving the equity dilemma faced in the schooling system (Van Dyk and White, 2019).

Charging school fees and their relation to free basic education is important because fees directly impact whether a learner can access basic education (Strohwald, 2024).

3.3.2. The aftermath of the quintile ranking system on learners. Arendse (2019) picked up a pattern in her analysis of quality that Black and/or impoverished learners do not have equal access to quality education post-apartheid. Her reasons being first, after analyzing local and international standardized assessments, that Black and/ or impoverished learners do considerably worse than their White and/ or more socio-economically better off Black counterparts and secondly, several of the previously disadvantaged schools (especially the ones in the previous Bantustan territories) are still impacted by inadequate infrastructure by way of poor provision or entirely lacking, of school buildings and furnishings, libraries, laboratories, textbooks and school transport for learners.

Spaull (2015) points out that the constituencies of the different school systems greatly differ with the previously disadvantaged black schools still being racially the same in other words it remains Black post-apartheid and still mainly impoverished; whilst the previously advantaged White and Indian schools are racially more blended with nearly all the learners from middle and upper-class socio-economic backgrounds, regardless of race. He is further of the opinion that due to the connection between race, geographical location, and poverty, poor Black children from rural areas are particularly disadvantaged and have very little possibility if any of improving in terms of social mobility (Spaull, 2015). The effect that the right to basic education has on other fundamental rights and that it is considered a transformative instrument for social transformation (Arendse, 2019). The Governing Body of the Juma Musjid Primary School v Essay (2011) case states that the objective of the right to basic education includes developing someone's personality, talents, and what they are mentally capable of achieving and providing a foundation for a lifetime of learning and employment opportunities. Arendse (2011) notes that the reason for basic education to be free is because if it is guaranteed, it leads to the fulfillment of other human rights which empowers people to play a meaningful part in society.

3.3.3. Infringements experienced by learners. The South African courts had a crucial role thus far in the interpretation of the right to basic education (Strohwald, 2024). Various organizations such as the

Legal Resources Centre, Equal Education, Equal Law Centre, Section27 and the Centre for Child Law have instituted court cases that have played an important part in addressing violations of the right to basic education (Strohwald, 2024). I will procced to mention a few of these cases.

In the case of Minister of Basic Education v Basic Education for All (2016) the Supreme Court of Appeal found that there was a violation of Limpopo learners' constitutional rights namely the right to basic education, equality, and dignity as a result of the National Department of Basic Education and the Limpopo Department of Education not providing all learners with the prescribed textbooks before teaching the courses commenced. In the unreported case of Khula Community Development Project v Head of the Department, Eastern Cape Department of Education (2022) the court again had to decide on the Eastern Cape Provincial Government's failure to allocate textbooks and stationery to numerous schools in Eastern Cape (Strohwald, 2024). The reason for the failure advanced by the Department was insufficient financial resources and the court's response to such claims was that the state's budgetary constraints are no excuse for violating their constitutional obligations; the court also highlighted the right to basic education's ability to transform our society (Strohwald, 2024).

The Legal Resource Centre on their website on 19 December 2024 welcomed a ruling handed down by the High Court on 17 December 2024 that directed that the Eastern Cape Department of Transport must provide transport to those learners qualifying for such in the 2025 school year. The judge mentioned that thousands of poor learners, especially in the rural areas of the Eastern Cape, had to travel far distances over often dangerous terrain to attend school. Financially, the families of these learners are not able to solve the transportation problem. The court found that the state's failure to provide all qualifying learners with scholar transport is unconstitutional and invalid. Approximately 40, 000 learners are affected by this judgement.

The Daily Maverick dated December 2024 reported that the Department of Education (DBE) noted in its annual report that the targeted number of new schools that were supposed to be built through the Accelerated Schools Infrastructure Delivery Initiative (ASIDI) was not achieved. This program was started in 2011 to deal with critical infrastructure problems in schools with a focus on the replacement of schools built with improper materials, for example, mud, to provide reliable water and sanitation and to guarantee accessibility to electricity in schools that were identified to lack such basic services. According to Daily Maverick 2024, the DBE also mentioned that the School Infrastructure Backlog Grant (SIBG) is facing a cutback of R179.8- million, which affects completing the planned projects and resulting in them being held over to the next financial year with finalization thereof dependent on available funds. Matshidiso Lencoasa, a budget analyst at the public interest law centre Section27, mentioned that budget cuts played an important role in DBE's inability to build schools, she also indicated that with the current level of funding the 2030 target will most likely not be met. She mentioned that going forward the Treasury will lessen the allotted budget to the provincial equitable share, which will result in a decrease in the availability of resources to effectively realize the 2030 goals, let alone to fulfill the Basic Education Minister's pledge to eradicate pit latrines by 2025.

4. Conclusion

My conclusions are as follows, the minimum standards for the right to basic education, which are set by international and national law, are still not being met in some previously disadvantaged schools, hence the court cases that are still to this day being instituted by civil rights organizations time and again. The learners affected by these infringements are mainly Black and from poor socio-economic circumstances (Maistry & Africa, 2020). The studies of Spaull (2015) show that parents in better socio-economic conditions have been able to send their children to higher quintile schools where a better level of education is provided. Higher quintile schools can provide adequate education that meets at least the minimum standards because of the school fees that they can request from parents compared to certain of the lower quintile schools that do not get the minimum standard of education because of the parents' poor socio-economic conditions (Maistry & Africa, 2020). In my opinion, there is unfair discrimination by the State on the grounds of race and socio-economic conditions concerning adequate basic education for learners that is linked to the implementation of the quintile ranking system by the State, which has caused a divide between rich and poor which can be directly linked with the quality of basic education that could be bought for one's child. I am of the view that the State has not fulfilled its duty to provide free basic education as envisioned by the UN Convention of the Rights of Child (1989) nor the right to basic education in terms of section 29(1)(a) of the Constitution is being realized for all learners in our country, instead adequate basic education comes with a price tag. I agree with Maistry and Africa (2020), that schools are being treated like businesses in South Africa and that the State provisioning and the quintile ranking model need to be critically reviewed, particularly because of the model's consequences.

References

AB v Pridwin Preparatory School. (2020). 5 SA 327 (CC)

Ally, N., & Kazim T. (2024). Lessons from the "minimum core" approach to the right to basic education in South Africa. *African Human Rights Law Journal*, *24*(1), 179-208.

Arendse, L. (2011). The obligation to provide free basic education in South Africa: an international law perspective. *Potchefstroom Electronic Law Journal*, *14*(6), 97-217.

Arendse, L. (2019). The South African's Constitution's empty promise of "radical transformation": unequal access to quality education for black and/or poor learners in the public basic education system. *Law, democracy and development*, *23*(1), 100-147.

Constitution of the Republic of South Africa 1996

Convention on the Rights of the Child, Nov. 20, 1989, 1577 U.N.T.S. 3.

Governing Body of the Juma Musjid Primary School v Essay, (2011). 8 BCLR 761 (CC)

Harksen v Lane, (1997). 1 SA 300 (CC)

Khula Community Development Project v Head of the Department of Education (unreported) case no. 611/2022 (22 March 2022)

Legal Resources Centre. (2024, December 19). *Hope for 2025: High Court Orders Department to Provide Transport.* Retrieved March 5, 2025, from https: // lrc.org.za/ scholar-transport-hope-for-2025/

Maistry, S. M., & Africa, I. E. (2020). Neoliberal stratification: The confounding effect of the school poverty quintile ranking system in South Africa. *South African Journal of Education*, *40*(4), 1-8.

Minister of Basic Education v Basic Education for All. (2016). 4 SA 63 (SCA)

Pongweni, T. (2024, December 5). Only one state school built in 2024 – DBE's alarming infrastructure performance revealed. *Daily Maverick*. Retrieved February 19, from https://www.dailymaverick.co.za/article/2024-12-05-schools-infrastructure-backlog-grows-as-missed-targets-and-budget-stall-progress

South African Schools Act 84 of 1996.

Spaull, N. (2015). Schooling in South Africa: How low-quality education becomes a poverty trap. *South African child gauge*, *12*(1), 34-41.

Strohwald, A. (2024). The right to basic education as primary driver of transformation in South Africa: considering cooperation. *Obiter*, *45*(3), 595-609.

Van Dyk, H., & White, C. J., (2019). Theory and practice of the quintile ranking of schools in South Africa: A financial management perspective. *South African Journal of Education*, *39*(Supplement 1), s1-19.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

CONCEPTUALISING THE SCIENCE KITCHEN AS A MAKERSPACE

Jaana Taar, Kristi Paas, & Tiina Vänt
School on Natural Sciences and Health, Tallinn University (Estonia)

Abstract

The Science Kitchen, a newly launched learning environment at Tallinn University in Estonia, seeks to connect the everyday knowledge and practical activities of home economics with scientific content. With its emphasis on STEAM (science, technology, engineering, arts, and mathematics) learning and hands-on experiences, the makerspace concept offers a promising approach to enhance the development of the concept of The Science Kitchen. Makerspaces have gained significant attention as learning environments that foster the development of twenty-first-century skills. These spaces provide diverse opportunities for learners of different ages to engage in hands-on learning and solve tasks as creators rather than as consumers. Although the concept is used in various formal and informal educational settings, there are variations in its definitions and dimensions. This article explores the definitions and nature of makerspaces by relying on scientific studies. A systematic literature review was conducted to identify relevant themes, limiting the search to makerspaces in formal learning. A qualitative content analysis was performed for eighteen relevant articles to systematically categorise and interpret the descriptions and meanings of the makerspace concept. The results reflect the key terms (e.g. *doing* and *tools*) used concerning makerspace learning environments, opening up various aspects associated with makerspaces. On the basis of the results, The Science Kitchen concept is defined as a makerspace, which could be used to develop meaningful STEAM-oriented activities in a given learning environment.

Keywords: *Makerspace, science kitchen, learning environment, home economics, STEAM.*

1. Introduction

The Cambridge Dictionary defines makerspace as a ‘place where people can come together to create or invent things, either using traditional crafts or technology’. Relying on this definition, the elements necessary for the environment to be classified as a makerspace are difficult to describe. Initially, the term makerspace was applied in 2005 when the Maker Movement applied the DIY (Do It Yourself) approach to computers and electronics, among others (Dougherty, 2012), relating it closely to new technologies and digital tools. However, as the makerspace concept became more widespread, it no longer necessitates a predefined set of tools; instead, it now emphasises providing a publicly accessible creative environment that supports exploration, making, and tinkering (Rosa, Ferretti, Guimarães Pereira, Panella, & Wanner, 2017).

Makerspaces initially originated in universities (Taylor, Hurley, & Connolly, 2016) or started as self-organised community-driven organisations. However, today, the adoption of this innovation by educational institutions, libraries, museums, and even industrial estates is rapidly increasing, leading to the emergence of a new category of institutionalised makerspaces. Depending on the mission, values, and culture of their host institutions, such makerspaces differ in their aims and organisations. For example, Özkil, Jensen, and Hansen (2020) introduced makerspaces that function as student-run facilities focused on self-initiated learning, as opposed to makerspaces that act as an integrated part of a certain curriculum. Likewise, alternative and/or slightly different concepts are used in parallel, including FabLabs (Gershenfeld, 2008), hackerspaces (Moilanen, 2012), and creative workshops (Saorín et al., 2017). Vuorikari, Ferrari, and Punia (2019) divide makerspaces into four types according to intentions and space for learning. On the vertical axes, they divide makerspaces into whether or not learning is intentional (as defined through learning outcomes). On the horizontal axes, they divide makerspaces as physical spaces with a range of fabrication tools devoted to making or spaces where making activities are carried out in an ad hoc environment, such as a mobile cart or a ‘pop-up’ kit. Our study focuses on intended learning in a set physical learning environment.

Makerspaces are utilised for interdisciplinary applications to help learners coordinate different disciplines. These environments are promising in terms of enriching learners with integrated knowledge in STEAM (science, technology, engineering, arts, and mathematics). By contrast, STEAM invites learners to think and learn through experience (Soomro, Casakin, Nanjappan, & Georgiev, 2023). In addition, makerspaces help learners develop twenty-first-century skills (critical thinking, creativity, communication, collaboration, and problem-solving) by fostering creative processes using active and collaborative learning through various tools (Rosa et al., 2017).

At this point, we rely on the promising positive impacts of makerspaces and focus on the definitions and characteristics that make academic, learner-centred makerspaces. So far, we have not managed to access any report on makerspaces concerning home economics or the food education context. However, home economics content (International Federation of Home Economics, 2008) fits well with 'a creative and uniquely adaptable learning environment with tools and materials, which can be physical and/or virtual, where students have an opportunity to explore, design, play, tinker, collaborate, enquire, solve problems and invent' (Loertscher, Preddy, & Derry, 2013). Home economics functions as an intermediary between STEAM practices and the makerspace learning environment, offering authentic, real-world contexts for learning. The Science Kitchen, a newly launched learning environment at Tallinn University in Estonia, seeks to connect the everyday knowledge and practical activities of home economics with scientific content. Its main goal is to enable learners to apply the knowledge and skills they acquire to real-life situations. With its emphasis on STEAM learning and hands-on experiences, the makerspace concept offers a promising approach to enhance the development of The Science Kitchen concept.

2. Methods

This paper shares the results of a systematic literature review of scientific peer-reviewed articles, including research and review articles, to identify topical content. An online literature search was conducted using e-databases available for registered library users at Tallinn University. The search terms 'makerspace' AND 'learning environment', 'makerspace' AND 'cooking', and 'makerspace' AND 'food' were used in two databases. Overall, 112 scientific articles were available with full access on the Web of Science and EBSCO Host e-databases, and 18 relevant papers remained eligible for inclusion after careful readings (coded as A1, A2, etc.). Articles focused only on virtual learning environments, libraries, or museum makerspaces, or on early childhood education were excluded from the analysis. In addition, the chosen articles were limited to makerspaces in formal learning contexts.

Qualitative content analysis (Schreier, 2012) was used to systematically categorise and interpret the descriptions and meanings of the makerspace concept in the topical articles from learners' and educators' points of view. The analysis was performed using inductive reasoning, by which themes emerged from the data through careful examination and constant comparison. The data were coded under named themes and divided into categories, if needed. As the aim of this study was to gain a broad understanding of different aspects of makerspaces, the themes and categories were revealed on a descriptive level rather than the proportions of the elements in more detail.

3. Results

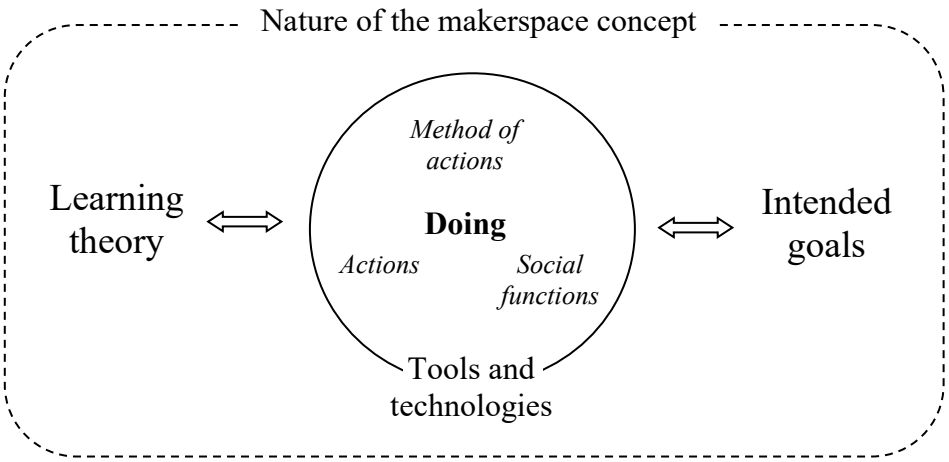
The analysed articles represent various learning stages, from elementary and primary schools to colleges and universities. Moreover, the teacher's and learner's perspectives were revealed. Various aspects of makerspaces have been studied in the analysed articles, which focused largely on twenty-first-century skills or, more specifically, on creativity and collaboration. From the teacher's perspective, professional development aspects and student assessment became visible. Typical of the makerspace concept, we see a majority of craft-, information technology-, and engineering-specific articles, although a drama-focused makerspace activity could also be named as a counterbalance. We present the results of the analysis in Figure 1, which shows the key components of a makerspace and their interactions.

The analysis revealed that makerspace was defined in only half of the articles. In some articles, the essence of the environment was described only in the Introduction section. However, the *nature of the makerspace concept* was identified in all articles. Mainly, makerspaces were identified as learning environments and, in one article, as teaching venues. In addition to the formal educational viewpoint, makerspaces are viewed as open-access workshops in an informal setting. In all the articles, makerspaces were defined as physical, multifunctional, and creative environments. Moreover, the social aspect of makerspaces as collaborative workspaces was highlighted.

The *learning theory* behind makerspaces creates a framework for the environment setup and actions performed in that environment. In the articles, the learning theory emphasises learners' active participation and knowledge construction. From the descriptions, it can be seen that both constructivism

and constructionism have been associated with such learning environments. Two articles take learning on a social level, prioritising 'social tools, and the dialectical relationship between self and the environment' (A18). Thereby, social constructivism and the sociocultural learning approach have also been highlighted. In addition, not all articles reflected the learning theory associated with the activities that take place in makerspace environments.

Figure 1. Schematic overview of the results.



The activities in the makerspaces were described in more detail. All aspects of the activities formed the theme of *doing* (see Figure 1), which included three categories: *action*, *method of action*, and *social functions*. Makerspace *actions* include learners' experimentation and exploration, both at the action and idea levels. These are the basis for idea generation and knowledge creation. Makerspaces expect learners to participate in designing, creating, building, tinkering, and iterating with materials in some other ways. Often, this includes prototyping and testing. Learners apply their skills and knowledge in makerspaces. In specific makerspaces, they play, hack, and perform other digital activities.

The descriptions of the *method of action* reflect the development of twenty-first-century skills. In makerspaces, problem-solving tasks are central. Learners develop their projects or engage in project-based learning. Creative ways of working with knowledge and tools are expected, and critical thinking is practiced by learners. The makerspace concept is quite often associated with STEM pedagogy. Eight articles described how STEM (and one, how STEAM) was implemented in the activities by integrating various subjects. The *social functions* in the makerspace activities become visible through the collaborative nature of the actions. Teamwork, shared work, and collaboration are mentioned as the means of working in makerspaces. Learners share their ideas, brainstorm, discuss possibilities and obstacles, listen to each other, and reflect.

Lists of available *tools and technologies* in makerspaces were discussed briefly. Most articles identified various digital tools, such as computers, three-dimensional printers, and digital fabrication technologies, as a necessary part of their makerspaces. Other machines, such as laser cutters, sewing machines, manufacturing tools, and general power tools, were mentioned significantly less. Materials and crafting tools were listed only in a few articles that focused more on craft content. In addition to the lists of needed tools and technologies, the makerspace environment must be flexible for users. For example, one article (A14) suggested that furniture must have wheels to enable easy reorganisation of the environment. In addition to physical tools, the makerspace environment also expects well-phrased guides and work instructions for learners. Learning challenges, thinking strategies, and concepts supported learners' actions and discussions throughout the tasks.

The *intended goals* of the makerspaces were discussed on various levels. In some articles, broad expectations were identified as the aims or impact of learning in a given makerspace, such as promoting twenty-first-century skills, working with complex real-world problems, increasing learners' motivation, and deepening learners' understanding of the basic concepts and principles. Makerspaces are intended to support the development of transferable knowledge and skills, cultivate the exchange of ideas, and focus on collaborative problem-solving. In other articles, more specific goals were phrased, including time management or supporting an understanding of the operating principles of technology. In any case, makerspaces promote innovation in education, both by raising learning to a new level and by supporting innovative solutions and outcomes.

4. Discussion

With our gained knowledge on the various natures of the makerspaces described in the analysed articles, we found that the commonality of and key insight into these natures are that learning in such environments is deeply embedded in the act of making. Rather than functioning as adjuncts to formal instruction, these environments promote experiential, embodied learning where knowledge is constructed through iterative design, experimentation, and reflection, as described by, for example, Loertscher et al. (2013). Makerspaces cultivate a learning culture that embraces failure, encourages help seeking, and fosters curiosity. Furthermore, these provide opportunities for participants to engage in generative and iterative problem-solving, with sometimes even never-before-considered materials and collaborators. This makes makerspaces unique environments where something new is always learned. This aligns with Dougherty's (2012) view of maker learning as rooted in a growth mindset—one that tolerates failure and embraces uncertainty, in contrast to fixed, risk-averse learning models. The collaborative, open-ended nature of making also exposes learners to novel materials and perspectives, enabling generative problem-solving across disciplinary boundaries and empowering learners to develop transferable competencies.

Some school subjects, such as home economics, may serve as natural bridges between traditional instruction and makerspace-style learning. As a largely practical subject with a less rigid structure compared with other school subjects, home economics offers an ideal springboard for integrating real-life tasks with opportunities for exploration and knowledge building. Similarly, in The Science Kitchen, we aim to turn the regular home economics kitchen into a makerspace, depending on learners' and lessons' needs. Thereby, in accordance with the model of Vuorikari et al. (2019), The Science Kitchen, as a makerspace, is a multifunctional physical environment with various tools and where learning is linked with the intended learning outcomes defined, for example, as part of a curriculum (e.g. for students) or qualification programme (e.g. for in-service teachers). We view it as a key site for pedagogical innovation that aligns well with the maker ethos. The most critical aspect lies in the methods (including the well-phrased instructions, given concepts, and thinking strategies) used to support learners' abilities to act, notice, analyse, and construct knowledge while fully empowering the educational potential of the makerspace environment. Without intentional pedagogical strategies, the transformative possibilities of makerspaces may remain underutilised.

In summary, makerspaces represent more than physical environments for crafting, as they are dynamic learning ecosystems that promote creativity, agency, and future-ready skills (including twenty-first-century skills) through hands-on, enquiry-driven experiences. In doing so, makerspaces offer a compelling model for preparing learners to navigate complex, evolving futures.

5. Conclusion

Although we did not manage to find a makerspace similar to The Science Kitchen from the literature, we gained confidence that a kitchen as an environment and home economics as a content fit well with the aims of makerspaces. With supportive measures, such as a learning approach and written and physical tools, a learning environment that supports learners' engagement in experimentation and knowledge construction can be created.

When used as a makerspace, The Science Kitchen acts as a multifunctional learning environment where social constructivism is applied to design STEAM-related experimentations and explorations that expect scientific observations and applying previous knowledge and skills for creating knowledge in a given learning situation. Learners in The Science Kitchen apply critical thinking when dealing with real-life-related problems and tasks. The given tasks encourage collaboration, sharing of experiences and ideas, discussions, and interactions with tools, in addition to people. The Science Kitchen has basic classroom and study kitchen equipment. It also has laboratory equipment, such as a microscope, sensors, and a thermal camera. In addition to physical tools, predefined STEAM learning tasks bring together interdisciplinary content to support knowledge construction. Thereby, The Science Kitchen, as a makerspace, adopts a new methodology of integrated learning by bridging home economics and STEAM.

Acknowledgments

The Tallinn University Science Kitchen concept as a makerspace is developed under the SHAREE project, which has received funding from the European Union's Horizon Europe widening participation and spreading excellence program under grant agreement No 101159193.

References

Dougherty, D. (2012). The maker movement. *Innovations: Technology, Governance, Globalization*, *7*(3), 11-14.

Gershenfeld, N. (2008). *Fab: The coming revolution on your desktop—From personal computers to personal fabrication.* New York, NY: Basic Books.

International Federation of Home Economics. (2008). *Home economics in the 21st century position statement*. Retrieved April 12, 2025, from https://www.ifhe.org/fileadmin/user_upload/Publications/IFHE_Position_Paper_HE_21st_Century.pdf

Loertscher, D. V., Preddy, L., & Derry, B. (2013). Makerspaces in the school library learning commons and the uTEC maker model. *Teacher Librarian*, *41*(2), 48-51.

Moilanen, J. (2012). Emerging hackerspaces—Peer-production generation. In I. Hammouda, B. Lundell, T. Mikkonen, & W. Scacchi (Eds.), *Open source systems: Long-term sustainability. OSS 2012. IFIP advances in information and communication technology* (Vol. 378, pp. 94-111). Berlin, Heidelberg: Springer. https://doi.org/10.1007/978-3-642-33442-9_7

Özkil, A. G., Jensen, L. S., & Hansen, C. A. (2020). What difference does an academic makerspace make? A case study on the effect and outreach of DTU Skylab. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, *34*, 327-340. https://doi.org/10.1017/S0890060420000438

Rosa, P., Ferretti, F., Guimarães Pereira, Â., Panella, F., & Wanner, M. (2017). *Overview of the maker movement in the European Union*. Luxembourg: Publications Office of the European Union.

Saorín, J. L., Melian-Díaz, D., Bonnet, A., Carrera, C. C., Meier, C., & De La Torre-Cantero, J. (2017). Makerspace teaching-learning environment to enhance creative competence in engineering students. *Thinking Skills and Creativity*, *23*, 188-198.

Schreier, M. (2012). *Qualitative content analysis in practice*. London: SAGE Publications Ltd. https://doi.org/10.4135/9781529682571

Soomro, S. A., Casakin, H., Nanjappan, V., & Georgiev, G. V. (2023). Makerspaces fostering creativity: A systematic literature review. *Journal of Science Education and Technology, 32*, 530-548. https://doi.org/10.1007/s10956-023-10041-4

Taylor, N., Hurley, U., & Connolly, P. (2016). *Making community: The wider role of makerspaces in public life*. Retrieved April 20, 2025, from http://www.nick-taylor.co.uk/wp-content/uploads/taylor-chi16-making-community.pdf

Vuorikari, R., Ferrari, A., & Punie, Y. (2019). *Makerspaces for education and training—Exploring future implications for Europe, EUR 29819 EN*. Luxembourg: Publications Office of the European Union. https://doi.org/10.2760/946996

COMPETENCE MANAGEMENT IN REMOTE HEALTHCARE

Sonja Kari, Nina Helander, & Jussi Myllärniemi
Faculty of Management and Business, Tampere University (Finland)

Abstract

This study aims to build a competence development model for nurses who work in remote healthcare. Since COVID-19 pandemic forced the field of healthcare to figure out new solutions to execute efficient patient care safely and with as little patient contact as possible, remote care took a major leap forward. Remote care works in a hybrid operating environment, where different participants work remotely from each other. With the help of competence management, possible knowledge gaps can be recognized and narrowed down. With the means of information and knowledge management, and competence management process, competence needs can be recognized. Efficiently used, the competence development model can be used to further recognize and develop competencies that nurses in remote care need.

Keywords: *Competence management, remote care, hybrid operating environment, competence development model.*

1. Introduction

Healthcare is a field that goes through major changes all the time. Challenges in healthcare come from different directions, when population is ageing, prevalence of chronic diseases is increasing, and the structure of diseases is changing. (Fukada, 2018, p. 1; Paunu and Helander, 2023, p. 213) The traditional hospital-centric care is moving towards more virtual and distributed care that takes advantage of the latest technologies, for example artificial intelligence, data analytics, home-based healthcare, and 3D printing (Wehde, 2019, p. 24). This means that technological solutions can be used to answer the challenges that healthcare is facing, when continuous data collection and exchange between patients and healthcare professionals reduces the need for physical visits in physical buildings (Paunu and Helander, 2023, p. 213).

In this study, we aim to answer the research question: *How the competence management of nurses can be supported in remote care?* Through an action-oriented case study, we form a competence development model to be used in remote care to sufficiently monitor and develop needed competencies. Current state of competence development and competencies needed are based on interviews (n=10) with the nurses who regularly work remotely from the patients.

2. Competence management in remote healthcare

Competencies can be defined as the ability to apply knowledge and skills to different contexts, such as work, leisure and learning (Ala-Mutka, 2011, p. 18). It is a way to put in practice one's knowledge, know-how, and attitudes, inside a specific context (Berio and Harzallah, 2005, p. 21). Competence evolves through learning and making use of acquired knowledge and skills (Medina and Medina, 2015, pp. 280, 285; Konttila *et al.*, 2019, p. 746). Competence management involves the specification of an organization's competence needs, competence sourcing, the identification of competence gaps, and developing competence through training and coaching (Lindgren *et al.*, 2004, p. 436). It constitutes of, for example, selection, training and development, performance measurement, and internal promotion (Medina and Medina, 2015, p. 286).

Remote care is quite a new field, where nurses work without face-to-face contact (Lau, Bartle-Clar and Bliss, 2019, p. 134). It is strongly multidisciplinary practice that includes, for example, innovative methods of practice, resourcefulness, limited clinical diagnostic support, and knowledge of public health (Smith *et al.*, 2008, pp. 159–160). Before COVID-19, the use of digital applications in medicine were restricted to the use of electronic health records (EHRs), but lately it has been allowed to expand the use of technological devices in medicine. Nowadays, different devices include for example smartphones, mobile wireless devices, wearable devices, health portals, and implantable devices. (Eurlings *et al.*, 2019, p. 6;

Konttila *et al.*, 2019, p. 746) Monitoring symptoms remotely has the potential to improve patients' quality of life, reduce costs, and enable timely and early treatment in situations where the need for care is increasing due to advancing illness (Walker *et al.*, 2019, p. 78; Scalvini *et al.*, 2020, p. 155).

In remote care, the competencies can be seen as the skills, knowledge, and abilities required for nurses to effectively deliver healthcare services to patients remotely (Melnyk *et al.*, 2014, p. 7). These competencies include various aspects, for example technological proficiency, assessment and triage, communication skills, problem-solving, collaboration and teamwork, and professional development (Kajander-Unkuri *et al.*, 2014, p. 799; Melnyk *et al.*, 2014, p. 7; Fukada, 2018, pp. 1, 3–4; Oyewunmi, 2018, pp. 430, 440; Vydrová and Bejtkovský, 2018, p. 23; Konttila *et al.*, 2019, p. 746; Mrayyan *et al.*, 2023, p. 6). Remote care works in a hybrid operating environment with nurses and doctors, patients, and service providers, which integrates physical and virtual care with telemedicine technologies and allows a better control of hospitals' occupancy (Pilosof *et al.*, 2023, p. 1). Competence in nursing is complex, relative, and variant, and a hybrid environment emphasizes all of these aspects when working through third-party systems (Nabizadeh-Gharghozar *et al.*, 2021, p. 2).

3. Research context and method

Empirical data was collected from the Finnish Heart hospital in Tampere and Hämeenlinna during early summer 2024. The research material consisted of 10 interviews with remote care nurses. At the same time, the literature of remote care, hybrid operating environment, and competence management was studied. The literature review formed theoretical background for this study, and the empirical research, which was done as interviews (n=10) and analysed with the means of qualitative content analysis, helped to bring the theory into practice. Combined, theoretical and empirical research formed answers to how the competence management of the nurses can be supported in remote care. Based on the analysis, a competence development model was formed.

With literature review, the purpose is s to show how the phenomenon under study has been studied in the past and how the current study is related to previous studies (Hirsjärvi *et al.*, 2009, p. 258). It is used to show the understanding of the field and its key theories, ideas, and concepts (Saunders *et al*, 2019, p. 74). On the other hand, research interview is a conversation between two or more people, where the interviewer asks concise and unambiguous questions and listens closely the interviewee talking (Hyvärinen *et al.*, 2017, chap. 2; Saunder *et al.*, 2019, p. 434). The interview aims at information collecting and is therefore in advance planned goal-oriented activity (Hirsjärvi and Hurme, 2022, para. 4.1.2).

The interviews were semi-structured in which the questions were basically same for everyone, but the answers were not tied to the answer options (Hirsjärvi and Hurme, 2022, para. 4.2.3). With this type of interview, the interviewer wants information about specific things, and do not want to give the interviewees too much freedom. Still, the interviewer wants to clarify and deepen the answers, so there are no ready-made answer options. (Saunders *et al.*, 2019, pp. 437–438) Interviews were transcribed, translated, and anonymized using identification numbers to strengthen the validity of our research. Translated transcriptions were coded in relation to the wanted themes, for example *Competencies, Hybrid operating environment, The amount of remote work, and Systems and technologies*.

4. Results and discussion

4.1. Competence management in hybrid operating environment

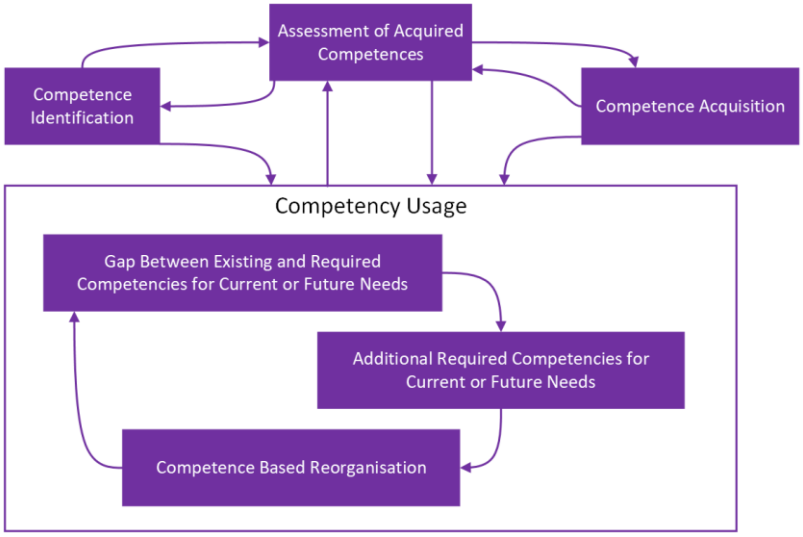
Hybrid operating environment means a wide range of things and practices in which people work. It can mean an IT infrastructure setup that combines on-premise resources with cloud-based services (Dittakavi, 2022, p. 33). It can also mean working in different places and in close collaboration with other operators (Mirbabaie *et al.*, 2021, p. 365). In healthcare, hybrid operating environment can be seen as a use of technologies and digital solutions to implement remote care, as well as different participants working together. Hybrid operating environment needs flexibility from everyone to work properly and it allows organizations to choose the most suitable deployment for each workload or application. (Tysowski and Hasan, 2013, p. 172; Franken *et al.*, 2021, p. 1139) It is quite new thing in healthcare to have flexibility in work or for example where you work. Remote care allows nurses to work from home which is seen as a positive thing. *"This definitely increases work well-being, increases meaningfulness by at least 10% when you can work remotely." (N4)*

Hybrid operating environment reduces the amount of hospital visits from patients. It gives them more freedom to live their lives although being sick. It also brings security for the patients, when they know, they are monitored all the time, and they have a backup in the hospital. As patient education is an important part of nurses' work, hybrid environment can be seen as an advantage with it. In the remote platforms, nurses can send messages to the patients and ensure that patients have written instructions. Also, if patients

have something to ask, they can send a message to nurses via platforms. This saves both time and resources from everyone, when unnecessary calls and hospital visit are reduced.

However, hybrid operating environment set challenges also for competence management. In overall, it shifts the competence requirements towards emphasis on digital technologies and communication skills through digital channels. Competence management is the way in which organizations manage their competencies of individuals and groups. It can be organized through competence management process (Figure 1), which helps organizations to systematically develop competencies (Berio and Harzallah, 2005, pp. 21–22).

Figure 1. Competence management process architecture (modified from Berio and Harzallah 2005).



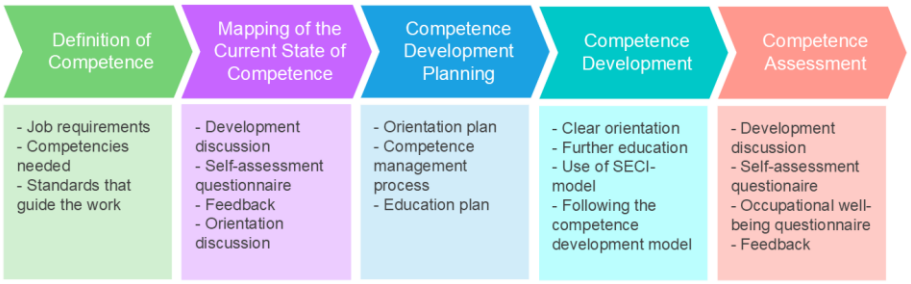
Nurses need many different competencies in remote care carried out in hybrid operation environments. 60% of the interviewed nurses mentioned technical skills and as N2 said: *"You need to know how to use all of the systems smoothly and understand their differences"*. Also, N3 said: *"Using these programs require some kind of IT skills, some kind of general knowledge of how these current systems work".* Other competencies that were mentioned several times, were evaluation of treatment, experience, and pharmaceutical knowledge. As N1 said: *"You have to have an eye to see, if that person fits into the program".* Also, evaluation was seen important, since most of it is made via phone, so a nurse needs to have a competence to do the evaluation just by hearing the patient: *"You have to be able to evaluate what happens when everything isn't quite normal" (N8).* This was also linked to experience by N3: *"Treatment evaluation, and that comes with experience. The experience is one skill."* Experience was seen also as a knowledge from other specialties: *"It's good that you have multidisciplinary experience, i.e., from other than the heart side" (N1*). In the interviews, nurses also pointed out adaptation to changing situations, decision-making capacity, and communication skills. As N5 said in the interview: *"It's always easier to work so that you have a patient face-to-face"*. This emphasizes the importance of good communication skills, when interaction is limited.

4.2. Competence development model for remote care

Based on the literature review and the interviews from the nurses, answer to the research question can be found. The answer consists of two paths: hearing all the remote care participants and making use of the means of knowledge management. Hearing different users gives wider perspective of what is needed when executing safe and efficient remote care. The means of knowledge management consist of systematically executing competence management process and identifying competence needs, and support in making tacit knowledge explicit. These two paths make the base for the developed model (Figure 2).

When the competence gaps have been recognized, it is essential to think, how to answer those needs. One way is to make a clear orientation plan that is systematically followed with every new remote care nurse. It is also important to provide further education for nurses who are already working in remote care. Providing further training will help the nurses to keep their competencies up to date and to evolve their knowledge about remote care practices. The last part is to make clear instructions that are available for everyone. Clear, written instructions ensure the safety of the care, when nurses have a backup, where they can check instructions at any time.

Figure 2. Competence development model.



Systematic implementation of the phases of this proposed competence development model can help the organization to recognize, what competencies are needed, how they can be acquired, and how to develop competencies further.

5. Conclusions

This study contributes to competence management literature by introducing a competence development model for timely context: remote care. With the developed model, a unified way of working can be introduced in hospitals and among them, who do remote care. Based on the interviews, there are no specific ways of developing or evaluating competencies, and sometimes even clear instructions are missing. In the future, the competence development model needs to be further developed to answer real needs of the nurses and to create concrete suggestions of working to develop remote care nurses' competencies.

As future research avenue, the role of knowledge management, especially the potential of application of SECI-model (Nonaka and Takeuchi, 1995) in competence development could be studied in more detail than in this paper. From a competence development perspective, the knowledge management approach consists of the acquisition, transformation, dissemination, and protection of knowledge and expertise (Väyrynen *et al.*, 2015).

References

Ala-Mutka, K. (2011) *Mapping Digital Competence: Towards a Conceptual Understanding.* https://doi.org/10.13140/RG.2.2.18046.00322

Berio, G. & Harzallah, M. (2005). Knowledge Management for Competence Management. *Journal of Universal Knowledge Management, 0*(1), 21-28.

Dittakavi, R. S. S. (2022). Evaluating the Efficiency and Limitations of Configuration Strategies in Hybrid Cloud Environments. *International Journal of Intelligent Automation and Computing, 5*(2), 29-45.

Eurlings, C. G. M. J. *et al.* (2019). Telemedicine in heart failure—more than nice to have?', *Netherlands Heart Journal, 27*(1), 5-15. https://doi.org/10.1007/s12471-018-1202-5

Franken, E. *et al.* (2021). Forced flexibility and remote working: opportunities and challenges in the new normal. *Journal of Management and Organization, 27*(6), 1131-1149. https://doi.org/10.1017/jmo.2021.40

Fukada, M. (2018). Nursing Competency: Definition, Structure and Development. *Yonago Acta Medica, 61*(1), 1-7. https://doi.org/10.33160/yam.2018.03.001

Hirsjärvi, S., & Hurme, H. (2022). *Tutkimushaastattelu: teemahaastattelun teoria ja käytäntö* (2nd Ed.). Helsinki: Gaudeamus. Available at: https://www.ellibslibrary.com/book/9789523458123/tutkimushaastattelu

Hirsjärvi, S., Remes, P., & Sajavaara, P. (2009). *Tutki ja kirjoita*. 15. uud. p. Helsinki: Tammi.

Hyvärinen, M., Nikander, P., & Ruusuvuori, J. (2017) *Tutkimushaastattelun käsikirja*. Tampere: Vastapaino. Available at: https://www.ellibslibrary.com/book/9789517686112/tutkimushaastattelun-kasikirja

Kajander-Unkuri, S. *et al.* (2014). Self-assessed level of competence of graduating nursing students and factors related to it. *Nurse Education Today, 34*(5), 795-801. https://doi.org/10.1016/j.nedt.2013.08.009.

Konttila, J. *et al.* (2019). 'Healthcare professionals' competence in digitalisation: A systematic review - Konttila - 2019. *Journal of Clinical Nursing, 28*(5-6), 745-761. https://doi.org/10.1111/jocn.14710.

Lau, F., Bartle-Clar, J. A., & Bliss, G. (2019) *Improving Usability, Safety and Patient Outcomes with Health Information Technology: From Research to Practice*. Amsterdam, The Netherlands: IOS Press, Incorporated. Available at: http://ebookcentral.proquest.com/lib/tampere/detail.action?docID=5775655

Lindgren, R., Henfridsson, O., & Schultze, U. (2004). Design Principles for Competence Management Systems: A Synthesis of an Action Research Study. *MIS Quarterly*, *28*(3), 435-472. https://doi.org/10.2307/25148646

Medina, R. & Medina, A. (2015). The competence loop: Competence management in knowledge-intensive, project-intensive organizations. *International Journal of Managing Projects in Business*, *8*(2), 279-299. https://doi.org/10.1108/IJMPB-09-2014-0061

Melnyk, B. M. *et al.* (2014). The Establishment of Evidence-Based Practice Competencies for Practicing Registered Nurses and Advanced Practice Nurses in Real-World Clinical Settings: Proficiencies to Improve Healthcare Quality, Reliability, Patient Outcomes, and Costs. *Worldviews on Evidence-Based Nursing*, *11*(1), 5-15. https://doi.org/10.1111/wvn.12021

Mirbabaie, M., Stieglitz, S., & Frick, N. R. J. (2021). Hybrid intelligence in hospitals: towards a research agenda for collaboration. *Electronic Markets*, *31*(2), 365-387. https://doi.org/10.1007/s12525-021-00457-4

Mrayyan, M. T. *et al.* (2023). Original research: Competency in nursing practice: a concept analysis. *BMJ Open*, *13*(6). https://doi.org/10.1136/bmjopen-2022-067352

Nabizadeh-Gharghozar, Z., Alavi, N. M., & Ajorpaz, N. M. (2021), Clinical competence in nursing: A hybrid concept analysis. *Nurse education today*, *97*, 104728-104728. https://doi.org/10.1016/j.nedt.2020.104728

Nonaka, I. & Takeuchi, H. (1995). *The knowledge-creating company: how Japanese compa-nies create the dynamics of innovation*. New York: Oxford University Press.

Oyewunmi, A. E. (2018). Normalizing Difference: Emotional intelligence and diversity management competence in healthcare managers. *Intangible Capital*, *14*(3), 429-444. https://doi.org/10.3926/ic.1050

Paunu, A. & Helander, N. (2023). *Remote monitoring of heart failure patients treatment programme: Customer experience, expectations, barriers and conditions*. SCITEPRESS. https://doi.org/10.5220/0012195800003598

Pilosof, N. P. *et al.* (2023). Designing for flexibility in hybrid care services: lessons learned from a pilot in an internal medicine unit. *Frontiers in medical technology*, *5*, 1223002-1223002. https://doi.org/10.3389/fmedt.2023.1223002

Saunders, M., Lewis, P., & Thornhill, A. (2019) *Research Methods for Business Students*. Harlow, United Kingdom: Pearson Education, Limited. Available at: http://ebookcentral.proquest.com/lib/tampere/detail.action?docID=5774742

Scalvini, S., Comini, L., & Bernocchi, P. (2020). How can multidisciplinary management with remote monitoring improve the outcome of patients with chronic cardiac diseases?. *Expert Review of Medical Devices*, *17*(3), 153-157. https://doi.org/10.1080/17434440.2020.1720510

Smith, J. D. *et al.* (2008). Defining remote medical practice. *Medical Journal of Australia*, *188*(3), 159-161. https://doi.org/10.5694/j.1326-5377.2008.tb01561.x

Tysowski, P. K. & Hasan, M. A. (2013). Hybrid Attribute- and Re-Encryption-Based Key Management for Secure and Scalable Mobile Applications in Clouds. *IEEE transactions on cloud computing*, *1*(2), 172-186.

Väyrynen, H., Helander, N., & Jalonen, H. (2015). Tietämyksenhallinta osana organisaation toimintaa–hallintaa vai hämmennystä?. *Hallinnon tutkimus*, *34*(4).

Vydrová, J. & Bejtkovský, J. (2018). The importance of the individual pillars of social maturity of workers in healthcare organizations in the hierarchy of pillars of competence in management. *Administratie si Management Public*, (31), 21-35. https://doi.org/10.24818/amp/2018.31-02

Walker, R. C. *et al.* (2019). Patient expectations and experiences of remote monitoring for chronic diseases: Systematic review and thematic synthesis of qualitative studies. *International journal of medical informatics (Shannon, Ireland)*, *124*, -78-85.

Wehde, M. (2019). Healthcare 4.0. *IEEE Engineering Management Review*, *47*(3), 24-28. https://doi.org/10.1109/EMR.2019.2930702.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

FACTORIAL VALIDITY AND RELIABILITY OF THE GREEK VERSION OF SCHOOL LIFE QUESTIONNAIRE

Maria Platsidou, Georgia Diamantopoulou, Pagona Leonidou, Lefkothea Kartasidou, Aristi Trokana, & Eleni Kyriakidou
Department of Educational and Social Policy, University of Macedonia (Greece)

Abstract

Schools play a central role in the educational and psychosocial development of students. School experiences - especially during the early years of schooling - can have a significant impact not only on students' daily lives and general well-being, but also on their later academic, social and professional lives. In this context, students' evaluations of their school life are related, but not necessarily identical, to various socio-emotional and enduring purposes of schooling and they have a significant impact on school learning, engagement in learning, and attendance. In the Greek literature, empirical studies on the students' evaluations of the quality of their school life are rather scarce, partly due to the limited number of measures suitable for capturing the multidimensional and complex nature of students' school life quality. To this end, the purpose of the present study was to test the factorial validity and reliability of the School Life Questionnaire-Greek version (SLQ-GR). The sample consisted of 258 students in the fifth and sixth grades of primary school. Students were asked to indicate their level of agreement for each of the 40 questions of the SLQ-GR based on a 4-point Likert scale (from 1=disagree to 4=agree). Results of exploratory and confirmatory analyses revealed that 35 (out of 40 items of the original scale) were organized into seven factors, similar to the structure of the original scale, reflecting two general domains (general satisfaction and negative affect) and five subdomains (teacher-student relations, social integration, opportunities, achievement and adventure) of students' evaluations of quality of school life. Cronbach's alpha for the ~~SLQ-GR~~ subscales ranged from 0.63 to 0.84, while the Cronbach's alpha for the total scale was 0.92, indicating satisfactory reliability for the SLQ-GR. Overall, the results of our study provided initial support for the factorial validity and reliability of the SLQ-GR.

Keywords: *School quality of life, primary education, scale adaptation.*

1. Introduction

Students spend a significant part of their lives at school. Early years of schooling have a strong impact not only on students' daily lives and general well-being, but also on their later academic, social and professional lives. As stated by Epstein and McPartland (1976), the question "Do you like your school?" is such a common question that, although it is discussed daily among children and adults, it has not gained attention and systematic study by social scientists. Based on the work of European Commission (2021, p. 8), *Quality of school life* is defined as "a multidimensional construct reflecting the attitudinal or emotional climate at school in terms of students' perceptions of well-being, determined by school-related factors and their experiences gained through their involvement in school life. Research has long suggested that it plays a vital role in improving students' motivation and effort, engagement with learning and academic achievement".

Students' perceptions of school life quality are shaped by social support, school environment, and personal factors. Studies highlight that support from teachers, peers, and family significantly impacts school satisfaction, though this support tends to decline with age, leading to lower satisfaction (Vidić, 2024). A supportive and safe school environment enhances students' sense of belonging, which is crucial for positive perceptions (Aliyev, & Tunc, 2015). Additionally, students' perceptions can be complex, reflecting both positive and negative aspects of their experiences. Overall, relative research emphasizes the need for schools to foster supportive environments that promote positive student experiences.

To support students' holistic development and help them thrive during their school years, it is crucial to have an accurate understanding of the factors that influence how young students approach and experience schooling. To this end, reliable measures that can capture students' perspectives and feelings about various aspects of their school life are essential. In the Greek literature, empirical studies on the

quality of students' school life are relatively scarce, partly due to the limited availability of tools that can adequately capture the multidimensional and complex nature of students' school experiences.

2. Aim of the present study

To address this gap, our study aimed to translate the School Life Questionnaire (SLQ; Ainley and Bourke, 1992) -one of the most well-known multidimensional tools for evaluating the quality of students' school life - into Greek (SLQ-GR) and test its factorial validity and reliability. We selected the SLQ for our study because it captures the multidimensional nature of school life quality, explores unique aspects of primary students' school life (e.g., social integration), is easy to use and has a relatively short completion time.

3. Method

3.1. Participants

A total of 258 primary school students participated in the study. Specifically, the sample included 106 (41.1%) students from 5th grade and 152 (58.9%) students from 6th grade. Regarding participants' gender, 133 students (51.6%) were boys, 105 students (40.7%) were girls, while 20 students did not provide information about their gender.

3.2. The school life questionnaire

The primary school version of SLQ was created in the early 1990s. It consists of 40 items that capture the multidimensional aspects of primary students' school life. The 40 items of the scale assess different aspects of students' school life and and are organized into seven domains: two general domains related to students' overall school life and five specific domains.

- *General Satisfaction* (also called Positive Affect): It consists of six items that investigate students' general positive feelings about their school (e.g., My school is a place where I really like to go each day).
- *Negative Affect*: This subscale is consisted of five items and refers to students' general negative feelings about their school (e.g., My school is a place where I feel worried). The five specific domains assessed by SLQ are:
- *Achievement* (5 items), which reflects students' confidence in being successful in school (e.g., My school is a place where I am good at schoolwork.);
- *Opportunity* (6 items) explores students' beliefs about the relevance of schooling for their future lives (e.g., My school is a place where what I learn will be useful);
- *Teachers* (also called Teacher-Student Relation, 5 items) focuses on students' perceptions of the quality of interaction with their teacher (e.g., My school is a place where my teacher listens to what I say);
- *Social Integration* assesses students' experiences and gains from getting along with other people at their school (e.g., My school is a place where I get on well with other students in my class);
- *Adventure* (5 items) captures students' sense of self-motivation in learning and their perceptions of learning as an enjoyable process (e.g., My school is a place where I get excited about the work we do.)

Participants were asked to indicate their level of agreement for each of the 40 items of the SLQ-GR based on a four-point Likert scale ranged from 1 (*I disagree*) to 4 (*I agree*). The estimated time for completing the SLQ is approximately 15 minutes.

3.3. Procedure – Ethics

To the best of our knowledge, the SLQ (Ainley & Bourke, 1992) has not been used with a Greek student population before. Therefore, we initially sought formal permission from the Australian Council for Educational Research (ACER), which holds the rights to the SLQ, to translate it into Greek. ACER granted written permission for the translation. Following ACER's approval, we implemented a double-blind translation procedure. The Greek version of the SLQ (SLQ-GR) was subsequently tested through a pilot study with 40 primary school students. After reviewing the results of the pilot study, ACER approved the Greek translation of the SLQ.

With ACER's approval, we proceeded with the main study. Two members of the research team, after coordinating with principals from selected schools, distributed the SLQ-GR in paper-and-pencil format for teachers to administer and collect. Both the pilot and main studies received ethical approval from the Pedagogical Institute of the Ministry of Education of Greece.

4. Results

4.1. Factorial validity of the SLQ-GR

Following the procedure described by Ainley and Bourke (1992), two exploratory factor analyses (EFA) were conducted to examine the factor structure of the SLQ-GR. The first EFA included only items from the Positive and Negative affect domains of the SLQ-GR. The second EFA focused on items reflecting students' perceptions of specific domains of their school experience, including Opportunity, Social integration, Teacher-student relation, Adventure and Achievement.

For the first analysis, the Kaiser-Meyer-Olkin (KMO) test yielded a value of .87, exceeding the recommended threshold of .60 (Kaiser, 1974), while Bartlett's test of sphericity was statistically significant ($\chi^2(45) = 958.502$, $p < .001$). These results confirmed that the data were suitable for conducting an EFA. Subsequently, a principal components analysis with varimax rotation was performed.

The number of factors extracted was determined using the eigenvalue-greater-than-1 criterion (Kaiser, 1960), and a factor loading cut-off of |.40| was applied. The analysis supported a two-factor solution, explaining a cumulative variance of 58.27%. Items loading onto the first factor reflected students' general positive perceptions of their school experience, whereas items in the second factor represented negative perceptions or feelings about school life. Thus, the first factor, consisting of six items, corresponded to the Positive Affect (or General Satisfaction) domain, while the second factor, comprising four items, represented the Negative Affect domain. The detailed results of the EFA for these two general domains of the SLQ-GR are presented in Table 1.

Table 1. Exploratory factor analysis of SLQ-GR items of two general domains.

	Factor I	Factor II
Items	Positive affect	Negative affect
SLQ-GR 8.	.810	
SLQ-GR 33	.809	
SLQ-GR 11	.742	
SLQ-GR 21	.719	
SLQ-GR 1	.697	
SLQ-GR 17	.547	
SLQ-GR 14		.829
SLQ-GR 5		.736
SLQ-GR 28		.726
SLQ-GR 18		.616
Eigenvalue	4.445	1.383
Variance explained (%)	34.058	24.216

Next, a confirmatory factor analysis (CFA) using the maximum likelihood method was conducted with the same items included in the EFA. The statistical indexes of the tested model indicated a good model fit: $\chi^2/df = 1.30$, CFI = 0.97, AGFI = 0.93, RMSEA = 0.06, and SRMR = 0.045, aligning with recommended thresholds (Hu & Bentler, 1999; Kline, 2006). These results provided further support for the two-factor structure of the SLQ-GR, confirming the distinction between the Positive Affect and Negative Affect domains. Subsequently, a second EFA was conducted using the SLQ-GR items related to the specific domains of students' perceptions of school life quality. The Kaiser-Meyer-Olkin (KMO) test yielded a value of .88, exceeding the recommended threshold of .60 (Kaiser, 1974), and Bartlett's test of sphericity was statistically significant ($\chi^2(406) = 2531.615$, $p < .001$), confirming that the data were suitable for EFA. Given these, a principal components analysis with varimax rotation was performed. The number of factors extracted was determined using the eigenvalue-greater-than-1 criterion (Kaiser, 1960), and a factor loading cut-off of |.40| was applied.

The results of the principal components analysis initially supported a six-factor solution. However, the sixth factor contained only a single item (SLQ-GR 36), leading to its removal. The EFA was then repeated with the remaining items, revealing a five-factor solution. During this iteration, three items (SLQ-GR 7, SLQ-GR 24, and SLQ-GR 26) were found to load onto incorrect factors (i.e., they showed a stronger association with a factor different from the one they were originally intended to represent). These items were removed, and the analysis was conducted again. The final EFA results confirmed a five-factor structure, explaining 54.41% of the cumulative variance (Table 2).

Upon reviewing the item loadings, the five factors were identified as follows: the first factor (comprising six items) was identified as the Opportunity subscale. The second factor, also containing six items, represented the Social Integration subscale. The third factor, with five items, was associated with the Teacher-Student Relationship subscale. The fourth factor, consisting of five items, corresponded to the Adventure subscale, while the fifth factor, composed of three items, reflected the Achievement subscale.

Table 2. Exploratory factor analysis SLQ-GR items of specific domains.

	Factor I	Factor II	Factor III	Factor IV	Factor V
Items	Opportunity	Social integration	Teacher-student R	Adventure	Achievement
SLQ-GR12	.707				
SLQ-GR9.	.679				
SLQ-GR15	.678				
SLQ-GR31	.659				
SLQ-GR25	.658				
SLQ-GR39	.632				
SLQ-GR29		.701			
SLQ-GR30		.694			
SLQ-GR20		.675			
SLQ-GR6		.673			
SLQ-GR3	.435	.532			
SLQ-GR35		.531			
SLQ-GR22			.712		
SLQ-GR2			.688		
SLQ-GR38.			.687		
SLQ-GR19			.590		
SLQ-GR34			.586		
SLQ-GR27				.733	
SLQ-GR13				.669	
SLQ-GR32				.648	
SLQ-GR10				.618	
SLQ-GR23				.585	
SLQ-GR4					.765
SLQ-GR16					.692
SLQ-GR40					.519
Eigenvalue	7.099	2.232	1.689	1.335	1.248
Variance explained (%)	28.396	8.927	6.754	5.339	4.992

Although one fit index was below expectations (i.e., the Adjusted Goodness-of-Fit Index (AGFI) fell slightly below the recommended 0.90 threshold), the overall CFA results supported the five-factor solution for the specific domains of the SLQ-GR. The CFA yielded fit indices as follows: $\chi^2/df = 1.56$, CFI = 0.92, AGFI = 0.86, RMSEA = 0.05, and SRMR = 0.05, aligning well with the criteria suggested by Hu and Bentler (1999) and Kline (2006).

4.2. SLQ-GR reliability

The reliability of the SLQ-GR subscales ranged from 0.63 to 0.84, indicating acceptable to high internal consistency. Specifically, the Cronbach's α values for each subscale were as follows: General Satisfaction (6 items, α = 0.85), Negative Affect (4 items, α = 0.75), Opportunity (6 items, α = 0.81), Social Integration (6 items, α = 0.78), Teacher-Student Relation (5 items, α = 0.81), Adventure (5 items, α = 0.72) and Achievement (3 items, α = 0.63). The overall reliability of the SLQ-GR, based on all 35 items, was α = 0.92, demonstrating strong internal consistency.

5. Discussion

The aim of this study was to examine the factorial validity and reliability of the SLQ-GR. Based on the results of exploratory factor analysis and confirmatory factor analysis, the 35 items of the SLQ-GR were found to be structured into seven comprehensible factors. Similar to the original scale, two general factors emerged: General Satisfaction (or Positive Affect) and Negative Affect. Additionally, five specific factors emerged - Opportunity, Social Integration, Teacher-Student Relationship, Adventure, and Achievement - which also aligned with the domains assessed by the SLQ. Overall, the factor structure of the SLQ-GR closely mirrored that of the original scale in both the number and content of factors extracted and the domains represented. However, five items from the original scale were not retained in the SLQ-GR due to poor factor loadings:

SLQ-GR 37 ("My school is a place where I feel restless") failed to load onto the Negative Affect factor. This may be because younger students struggle to grasp the somatic and psychological aspects implied by the term "restless." Research suggests that young children often find it challenging to understand context-dependent vocabulary and abstract meanings (Barsalou, Dutriaux, & Scheepers, 2018). A simplified version, such as "My school is a place where I can't feel calm," might be more appropriate.

SLQ-GR 36 ("My school is a place where other students are very friendly") did not load onto the Social Integration factor. Unlike other items in this factor, which explicitly asked students how others make them feel or how well they are treated (e.g., "My school is a place where I know people think a lot of me"),

this item is worded more generally. It seems to prompt students to evaluate their peers' overall friendliness rather than their own experiences of social integration.

SLQ-GR 7 ("My school is a place where I know how to cope with the work") and SLQ-GR 26 ("My school is a place where I know I can keep up with the work") failed to load onto the Achievement factor. Unlike other Achievement items that directly assess students' perceived success, these items focus more indirectly on their ability to manage schoolwork. Variations in item wording within the same factor can influence how respondents interpret and answer them (Zeng, Jeon, & Wen, 2024).

SLQ-GR 24 ("My school is a place where I am popular with other students") loaded onto the Achievement factor instead of Social Integration. This suggests that students may perceive popularity not just as a social aspect of school life but as something to be earned or achieved. Additionally, in collectivistic cultures like Greece, academic success is often closely linked to popularity, whereas in individualistic cultures the relationship between popularity and academic achievement tends to be neutral or even negative (Zhang, Ren, Li, Liu, & Luo, 2019).

Regarding the reliability of the SLQ-GR, results showed that the reliability values ranged from 0.63 to 0.84 across the different subscales, which is satisfactory, with one exception. The Achievement subscale had lower reliability ($\alpha = 0.63$) and this is likely due to the small number of items (three), as a limited item count is known to reduce Cronbach's α (Iacobucci & Duhachek, 2003). The overall reliability of the SLQ-GR (35 items) was $\alpha = 0.92$, indicating strong internal consistency.

6. Conclusion and implications

Overall, the SLQ-GR demonstrated satisfactory factorial validity and reliability, closely aligning with the structure of the original scale. The findings of the study suggest that the SLQ-GR is an effective tool for assessing students' perceptions of school life quality, capturing both their general emotional experiences (Positive and Negative Affect) and their perceptions of specific school domains (Opportunity, Social Integration, Teacher-Student Relationship, Adventure, and Achievement).

These results have important implications for school psychology and educational practice. The SLQ-GR can help school psychologists, educators, and policymakers identify areas in need of intervention, such as low scores in Social Integration or Teacher-Student Relationship; in turn, these scores may indicate the necessity for peer support programs or teacher training initiatives to foster a more inclusive and supportive school environment. Additionally, the SLQ-GR provides a valuable means of monitoring school climate over time, allowing educators to track changes and evaluate the effectiveness of educational policies aimed at improving student well-being. Furthermore, the Negative Affect subscale may serve as an early indicator of school-related distress, guiding school psychologists in identifying students who may require psychosocial support or mental health interventions.

References

Ainley, J & Bourke, S. (1992). Student views of primary school. *Research Papers in Education, 7*(2), 107-128. https://doi.org/10.1080/0267152920070202

Aliyev, R., & Tunc, E. (2015). The Investigation of Primary School Students' Perception of Quality of School Life and Sense of Belonging by Different Variables. *Revista de Cercetare si Interventie Sociala, 48*, 164-182.

Barsalou, L. W., Dutriaux, L., & Scheepers, C. (2018). Moving beyond the distinction between concrete and abstract concepts. *Philosophical Transactions: Biological Sciences, 373*, pp 1-11.

Epstein, J., & McPartland, J. (1976). The Concept and Measurement of the Quality of School Life. *American Educational Research Journal, 13*(1), 15-30.

European Commission: Directorate-General for Education, Youth, Sport and Culture, Hristova, A. & Tosheva, E. (2021). *Quality of school life and student outcomes in Europe*. Publications Office. Retrieved from https://data.europa.eu/doi/10.2766/268609

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteriaversus new alternatives. *Structural Equation Modeling, 6*, 1-55.

Iacobucci, D., & Duhachek, A. (2003). Advancing alpha: Measuring reliability with confidence. *Journal of Consumer Psychology, 13*, 478-487. https://doi.org/10.1207/S15327663JCP1304_14

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika, 39*, 31-36. https://doi.org/10.1007/BF02291575

Kline, R. B. (2006). *Principles and practices of structural equation modeling* (2nd ed.). Guilford.

Vidić, T. (2024). Primary school students' perceptions of social support, school satisfaction and life satisfaction. *International Journal of Emotional Education, 16*(1), 125-139.

Zeng, B., Jeon, M., & Wen, H. (2024). How does item wording affect participants' responses in Likert scale? Evidence from IRT analysis. *Frontiers in Psychology, 15*. https://doi.org/10.3389/fpsyg.2024.1304870

IMAGINING A FRIEND WITH AN AUTISTIC SPECTRUM DISORDER: INCLUSION STRATEGIES FOR SOCIAL RELATIONS

Veronica Guardabassi
Department of Humanities, University of Macerata (Italy)

Abstract

People with disabilities can be viewed negatively and labelled with negative stereotypes because of their health status (Harder et al., 2022). This condition, known as ableism, also affects people with autistic spectrum disorders (ASD), who may experience discrimination from childhood (Turnock et al., 2022). In order to find possible useful solutions and to address Agenda 2030's goals, this study aims to find inclusion strategies through a writing activity. As imagining a positive relationship with a person from a different group can reduce negative attitudes (see Crisp & Turner, 2009), it was hypothesized that the content of an imagined text about a friendship relationship can provide important insight to promote social inclusion. Specifically, as autistic spectrum disorder is one of the diagnoses with greater deficits in terms of social and relational abilities, the study aimed to identify useful actions to promote friendship with people with this disability. Participants were 26 university students (M = 2; F = 24) in the fourth year of a degree course in primary education (M_{age} = 27.38; SD = 6.80). They enrolled in the workshop "writing and inclusion" and, among the activities, they were also asked to write a text in which they had to imagine that one of their closest friends is a person with an autistic spectrum disorder. Specifically, they were asked to describe how they became friends, what connects them and what they do when they are together. A content analysis was performed. Results from the students' texts showed that school was the most common setting in which friendships had started. Interest in sports, films, painting were the reasons for creating a bond during childhood and being curious, sharing an experience, being informed about ASD, having parents who become friends are elements that can foster this friendship. This relation is seen as an opportunity to develop a new perspective, to appreciate the value of small things and to understand each other beyond words. In adulthood, friends continue to do some activities together (e.g., walking in nature, going to the cinema), although possible problems are also taken into account. To reduce social isolation of people with disabilities, especially people with autistic spectrum disorders, promoting openness as a personality trait and knowledge about the condition (individual level actions), shared experiences (educational interventions), friendships between parents (familiar level actions) can be useful to reduce isolation and promote lasting friendships. Strengths, limits and educational interventions of this study are discussed.

Keywords: *Inclusion, writing activities, autistic spectrum disorder, disability, ableism.*

1. Introduction

Ableism is a new form of discrimination that affect people with disabilities. It based on the assumption that people should have a normal body and each condition that differ from this assumption is considered a defect rather than a difference (Campbell, 2001; Goodley, 2014). This condition led to define people with disabilities with negative stereotypes and to behave in a biased way toward people with disabilities leading to several difficulties from a health and social relation prospective (Mannor et al. 2024).

People with autism spectrum disorder (ASD) may also be subject to negative evaluations and experience discrimination from childhood (Turnock et al., 2022). The resulting social isolation can be particularly challenging for people with ASD, as they have impaired social abilities due to their medical condition (APA, 2013), and therefore find it difficult to overcome. Consistently, the WHO (2023) emphasised that social stigmatisation is one of the main factors that compromises quality of life.

Thus, identifying effective strategies to encourage socialisation from an early age can help to foster positive relationships and constructive friendships with people with disabilities, especially with ASD, thereby promoting inclusion, which is one of the aims of Agenda 2030.

It is already known from the literature that inclusive settings, i.e., "schools for all", have a positive impact on the social interaction and participation of people with disabilities (Dell'Anna et al., 2022), as well as on shared experiences between people with and without disabilities (e.g., Paluck et al., 2021). According to Allport's (1954) contact theory, shared activities can reduce the distance between different groups and an extension of this theory, the imagined contact theory (Crisp & Turner, 2009), suggests that imagining positive interactions can also be useful for this purpose.

Based on this assumption, the present study — which is part of a larger investigation into writing activities and inclusion — aims to identify effective inclusion strategies in the text resulting from an imaging activity. Indeed, as writing about a potential friendship with someone with ASD can trigger the imagined contact effect, it was expected that the content would provide valuable insights into strategies for reducing social isolation and promoting the inclusion of people with autistic spectrum disorder.

2. Method

2.1. Participants and procedure

The participants were fourth-year university students on a primary education degree course. They were attending the "Educational Psychology" course, which includes a 10-hour laboratory activity. The course tutor provided students with the opportunity to choose from a range of different workshops, one of which was "Writing and Inclusion". Students were informed that this workshop was part of a research project, and that they would be asked to complete a questionnaire and carry out some writing activities as participants. Participants provided consent for their participation and for the treatment of their data.

2.2. Measures

A questionnaire was used to collect descriptive information about the participants, such as their year of birth and gender. Other questions were about their experiences of disability, such as working or volunteering experience (from 1 = *never*, to 4 = *always*), and whether they have relatives with disabilities (*yes* or *no*). Further questions concerned autistic spectrum disorder: How would you rate your knowledge of autistic spectrum disorder on a scale from 0 to 10? Have you ever studied autistic spectrum disorder in your studies?

Information about a possible friendship with a person with autistic spectrum disorder was investigated through an individual writing activity. Participants were given the following assignment: "*Imagine you have had a long friendship with someone with autistic spectrum disorder since childhood. Describe how you became friends, what bonds you together, what you do together, and what you plan to do next weekend. Write a text of at least 500 words and send it using the link*".

2.3. Analysis

Descriptive analyses were conducted to examine the composition of the sample. A content analysis of produced texts was also performed.

3. Results

3.1. Sample description

The participants were 26 university students (M = 2; F = 24) in the fourth year of a degree course in primary education (M_{age} = 27.38; SD = 6.80). Their involvement with disabled people was valued at 2.52 (SD = 1.16) in a work setting and 1.40 (SD = .82) in a volunteering context. Despite 84.6% of participants declaring that they had studied autistic spectrum disorder in their academic course, they evaluated their knowledge of the disorder at 5.19 (SD = 1.82). Among the participants, 88.5% did not have a relative with a disability, whereas 11.5% declared that they did.

3.2. A friendship with a person with autistic spectrum disorder

The school was the most commonly indicated setting for the first meeting, where friendships had started. Indeed, 17 participants said that it was at school, 3 talked about a sporting setting, 3 about a friendship formed through family, while 1 person indicated the church and another a volunteer centre.

When describing what creates a bond, participants talked about having a common interest in games or films (N = 2), being able to practise a sport together (N = 4), or being involved in creative activities such as painting or playing the piano (N = 8). They also mentioned having similar habits, such as being tidy (N = 2).

Among the strategies for supporting friendships, participants emphasised the importance of spending time together (N = 8), as well as talking to each other (N = 9). They highlighted the significance of acquiring knowledge about diseases (N = 2), as well as being curious about their friends' special abilities or characteristics (N = 6). The significance of a friendship between parents of children with ASD and without disabilities was also emphasised by 3 participants.

Friendships with people with ASD were described as deep bonds (N = 4), leading to a new perspective (N = 9), i.e., learning something new and appreciating the value of small things, as well as the importance of silence and slowness.

Being friends can be difficult during adulthood (N = 2), but numerous shared activities were also reported, such as spending time in nature (N = 14), enjoying culture (e.g. movies, art, music and museums; N = 11) and spending time together (e.g. cooking, eating ice cream and shopping; N = 10).

4. Discussion

The present study was conducted to identify effective strategies for fostering friendships with people with ASD. Social impairment is indeed one of the main characteristics of people with ASD (APA, 2013), and reducing its impact on everyday life is important for promoting their inclusion in society.

Participants' answers suggest that schools are an important place to encourage friendships between students with and without disabilities. This supports the idea of favouring this kind of organisation in an educational setting and promoting the “school for all”, as emphasised in the Convention on the Rights of Persons with Disabilities (United Nations, 2006). However, schools and social or religious centres can also play an important role by continuing to promote shared activities, which have already been shown to be effective in reducing distance (Allport, 1954). Indeed, participants wrote that the opportunity to do activities together (from sports to culture) during childhood and adulthood creates a bond. However, sharing activities is not sufficient: participants emphasised the importance of making an effort to befriend someone and being curious about their differences, which they also identified as an added value of this kind of friendship. This suggests the need to develop a specific mindset that requires deep cultural and educational intervention towards values of tolerance, democracy and equality between people. In addition, participants emphasise the importance of having knowledge and awareness of ASD, which is useful for at least two reasons. Firstly, receiving information about another social group is a strategy that can improve individuals' attitudes (Paluck et al., 2021). Secondly, offering knowledge and real answers to something difficult to understand, i.e., ASD, represents a problem-solving strategy rather than an avoidance strategy. This kind of approach promotes positive growth for children and adolescents and fosters people's well-being in the long term (Richardson et al., 2021). The results also highlighted the importance of parents, showing that a friendship between parents provides an opportunity to establish a friendship with a child with ASD while also consolidating that relationship. This highlights the importance of fostering a robust social network for children with ASD and their families. It also provides further confirmation of contact theory. In fact, one condition for efficient intergroup contact is the support of those in authority, a role played by parents in children's friendships (Allport, 1954).

4.1. Strengths, limits and future directions

This study explored a new topic based on the imagined contact theory (Crisp & Turner, 2009), adding new content to this area of literature, particularly with regard to exploring and analysing imagined content. Focusing on disability, particularly ASD, this study also led to an examination of ableism and strategies for inclusion, which are among the main goals of Agenda 2030. However, this study also has some limits. The sample size is small, so the results cannot be generalised. Additionally, the imbalance between male and female participants must be acknowledged. Furthermore, no attitudes towards people with disabilities were measured after this activity, so it is only possible to hypothesise the activation of the imagined contact effect. Nevertheless, all the content showed positive considerations about people with ASD, emphasising a possible positive outcome in this respect. Future studies should consider developing this line of research further, by using writing activities to identify new strategies for improving perspective-taking and social inclusion.

Policymakers should take these results into consideration. Clinical and educational institutions that work with children and adolescents with ASD and aim to promote inclusion need to foster social relations among their parents, too. In other words, they should take a more holistic approach to the whole family. Schools and other social contexts should encourage cooperative activities to promote positive interactions between children. All educational stakeholders, from families to communities, should promote values such as tolerance, persistence, and an openness to difference as the basis for social relationships.

4.2. Conclusions

This study underlined the importance of find new strategies to promote social inclusion and, at the same time, suggest some possible directions. At the individual level, it is important promoting personal openness and tolerance, as well as knowledge and an appreciation of the effort involved in building relationships. At the family level, participants' texts seem to emphasise the importance of networking within the family to create and promote lasting friendships. At the educational level, shared experiences emphasise the importance of using cooperative learning approaches and other group activities to reduce social isolation. Political and institutional stakeholder should consider these possible lines of actions to support people with autistic spectrum disorder as well as people with other disabilities.

Acknowledgments

This work has been funded by the European Union - NextGenerationEU under the Italian Ministry of University and Research (MUR) National Innovation Ecosystem grant ECS00000041 - VITALITY - CUP D83C22000710005.

References

Allport G. (1954). *The nature of prejudice*. Cambridge, Mass.: Addison-Wesley Pub. Co.

APA (2013). *DSM-5. Manuale diagnostico e statistico dei disturbi mentali*. Milano: Raffaello Cortina.

Campbell, F. (2001). Inciting legal fictions: 'Disability's' date with ontology and the ableist body of the law. *Griffith Law Review*, *10*, 42-62.

Crisp, R. J., & Turner, R. N. (2009). Can imagined interactions produce positive perceptions?: Reducing prejudice through simulated social contact. *American psychologist*, *64*(4), 231-240.

Dell'Anna, S., Pellegrini, M., Ianes, D., & Vivanet, G. (2022). Learning, social, and psychological outcomes of students with moderate, severe, and complex disabilities in inclusive education: A systematic review. *International Journal of Disability, Development and Education*, *69*, 2025-2041.

Goodley, D. (2014) *Dis/ability studies: theorising disablism and ableism*. Routledge, New York.

Mannor, K. M., & Needham, B. L. (2024). The study of ableism in population health: A critical review. *Frontiers in Public Health*, *12*, 1383150.

Paluck, E. L., Porat, R., Clark, C. S., & Green, D. P. (2021). Prejudice reduction: Progress and challenges. *Annual review of psychology*, *72*, 533-560.

Richardson, C. E., Magson, N. R., Fardouly, J., Oar, E. L., Forbes, M. K., Johnco, C. J., & Rapee, R. M. (2021). Longitudinal associations between coping strategies and psychopathology in pre-adolescence. *Journal of Youth and Adolescence*, *50*, 1189-1204.

Turnock, A., Langley, K., & Jones, C. R. (2022). Understanding stigma in autism: A narrative review and theoretical model. *Autism in Adulthood*, *4*, 76-91.

WHO (2023, November 15). *Autism*. Retrieved April 28, 2025, from https://www.who.int/news-room/fact-sheets/detail/autism-spectrum-disorders

EXAMINING THE EXPERIENCES OF PARAPROFESSIONAL OF COLOR IN AN ONLINE GROW YOUR OWN TEACHER EDUCATION PROGRAM

Joy Myers, Bryan Zugelder, Oris Griffin, & Leonard Richards
James Madison University (United States of America)

Abstract

A major shift over the past twenty years has been how teachers are prepared and credentialed given the teacher shortage. This qualitative study provides a detailed analysis of how five paraprofessionals of Color perceptions evolved during their first year in an online Grow Your Own (GYO) teacher education program. By examining the experiences, victories, and challenges of these non-traditional students we hoped to gain insights into the realities of participating in a GYO program and can then better support future students in this program. Findings suggest that given the need for teachers, particularly teachers of Color, teacher education programs must be in tune with the needs of these non-traditional students to support them best. This work may be a partial answer to addressing teacher shortage.

Keywords: *Paraprofessionals, online learning, grow your own programs.*

1. Introduction

Grow Your Own (GYO) initiatives provide school divisions with quality teachers who are familiar with the demographics of the communities and the specific needs of their students. By utilizing local talent, these programs can lead to an increased positive school climate and build meaningful relationships with families resulting in higher student achievement (Espinoza et al., 2018). However, becoming a teacher is not cheap. A price tag of $25,000, or more, for a degree and licensure is extremely prohibitive for paraprofessionals who are paid very little. Also, many potential teachers are unaware of the various pathways and resources available to adults interested in becoming teachers.

At a large public research university in the Southeast, where this study took place, we believe in the concept of "growth" specific to teacher candidates (TCs), rather than "producing" or "training." In that spirit, and with the help of 4.2 million dollars in state funding, we were able to offset the tuition cost of traditional students, on campus, and paraprofessionals, who took courses online, to complete their degree and become an early childhood, inclusive early childhood, elementary, or special education teacher. In return, the participants agreed to teach in their school division for two years once they graduated. In this paper, we focus on the experiences of the paraprofessionals in a GYO program, specifically Paraprofessionals of Color (PoCs).

Examining the experiences of PoCs is essential; Gist et al. (2019) advocate that GYO programs should be committed to increasing racial, ethnic, and linguistic congruence between teachers and student populations as well as dismantling structural barriers related to the recruitment, preparation, and retention of Black, Indigenous, and People of Color. The purpose of this study was to answer the following question: What are the experiences of Paraprofessionals of Color (PoCs) in an online GYO teacher degree and licensure program?

2. Literature review

Teachers of Color, regardless of teaching area, are sorely underrepresented in today's schools despite the evidence of the benefits of having a teacher of the same race and ethnicity as the student (Egalite et al., 2015; Gershenson et al., 2016). Dee (2004) noted that teachers who are the same race as their minority students were more likely to improve reading and math scores. Therefore, these teachers are essential to closing the longstanding achievement gap between students of racial/ethnic groups and their counterparts, particularly the disparity between Black and White students (James et al., 2020). However, the benefits are not just academic. According to Lindsay and Hart (2017), Black students taught exclusively by Black teachers were 2 to 3 percentage points less likely to be removed from their typical learning environment,

due to suspension or expulsion, than if they encountered only non-Black teachers. One particularly promising approach to creating a more diverse teaching workforce is to create new pathways for paraprofessionals to become licensed teachers (Delgato et al., 2021).

Teacher candidates, and particularly candidates of Color, need access to more financial resources and guaranteed job placement upon degree completion (James et al., 2020). Passage of licensure exams has also been identified as a barrier to entering the teacher workforce for non-traditional students (Madkins, 2011). Standardized testing requirements are racially, culturally, and linguistically biased (Suzuki & Valencia, 1997). Furthermore, some future teachers of Color report feelings of isolation from a majority of White professors who instruct them on teaching diverse student populations (Ladson-Billings, 2006; Picower, 2009). Others have shared that the academic climate of EPPs is not always hospitable to future teachers of Color (Bristol & Goings, 2019). These barriers are why many minority candidates are more likely to not pursue teacher licensure (James et al., 2020).

3. Methods

We chose a case study approach to gain an understanding of the paraprofessionals of Color (PoCs) perceptions related to their participation in an online GYO program. Before engaging in the study, it was approved by the university's Office of Research Integrity (Legacy-24-4314). A case study approach allowed us to take into consideration the lived realities and nuances experienced by the PoCs in a way that would not be possible through a quantitative approach (Glesne, 2006). Through data triangulation, we identified themes that helped explain factors that affected the PoCs during their time in the GYO program.

A diverse cohort of 15 paraprofessionals joined the first funded online GYO cohort in the fall of 2022. Our goal was to support these future early childhood, inclusive early childhood, elementary, and special education educators financially so that they would (a) successfully obtain their degree and (b) return to their home district to teach. We held online information sessions to provide the paraprofessionals with information about the GYO program. After the sessions, school division leaders were essential in identifying which paraprofessionals should participate in the GYO program since they know their student populations, as well as their employees, and were best able to target individuals who would make excellent future teachers.

4. Participants

The five participants were selected for the study through a criterion-based nomination process. The criteria were (a) being a paraprofessional in the GYO program; (b) pursuing a degree to become an elementary education, special education, early childhood, or inclusive early childhood education teacher; and (c) being a future teacher of Color. All agreed on two one-on-one semi-structured Zoom interviews which were conducted by a university researcher. The university researcher assured participants that all identifiable information from the interview transcripts would be removed. For this paper, a pseudonym has been assigned to each PoC.

5. Data sources and analysis

Creswell and Plano Clark (2011) describe the interview process as effective in providing the best source of gathering information when a researcher does not have direct access to participants and when the need exists to engage an individual in sharing their ideas. Interviews can allow the researcher to control the line of questioning and explore deeper issues that arise. Like Gist (2022), our interviews consisted of semi-structured open-response questions to capture the perceptions of the participants' experiences within the GYO program.

Interviews were conducted using Zoom and each researcher interviewed at least one participant. Among the questions asked were: "Why did you decide to participate in the GYO program?" and "What types of support do you think will help you be the most successful this year?" Additional questions explored advice and insights the PoCs might offer to future POCs as well as advice for colleges and universities hoping to recruit PoCs into the teaching profession.

Zoom technology generated automated transcripts of the interview questions and responses. Instead of relying solely on the transcription of responses, analyzing the recorded video allowed for observation of body language, voice tone, and emotion as the participants responded to questions. To analyze the data, the researchers met as a team to discuss the data using grounded theory (Charmaz, 2014). Each participant was labeled as a case. Combined with the interpretation of the emotional responses from each participant and the transcription of data, the research team identified specific themes for each case.

After establishing themes for each case, the researchers compared the themes across the cases to determine overlap and outliers.

6. Results

Each case presents the individual context of the paraprofessional interviewed; it is critical to understand the background, beliefs, and experiences of each paraprofessional who was interviewed. Following the presentation of each case is a synthesis of the findings that demonstrate unique and overlapping themes across the cases.

Kathy

Kathy, a paraprofessional, works in the school library at an elementary school in a large urban school district. She identifies as Hispanic and has vast experience helping students conduct and complete research for projects. In her role, she also assists students using multiple resources and technologies to complete the projects. When asked what the program could do better to support her, Kathy expressed that the online format of the program was manageable; however, it was often a heavy lift in terms of all of the content that was loaded into a condensed semester. Since she works in the library, she does not know as much about the instructional aspects of supporting students with disabilities as perhaps a paraprofessional who works in a special education classroom. Kathy expressed strong feelings about the acceleration of the first core course in the GYO program, Foundations in Exceptional Education which contained an enormous load of terminology related to special education and legal aspects for students with disabilities.

Kelly

Kelly is a paraprofessional who works in an elementary school and is pursuing a degree in Elementary Education. She already earned an associate's degree, is a working mother, and identifies as African American. Kelly is very enthusiastic about the GYO program because it helps her meet her future goal, which is to be an elementary school teacher in the school district where she lives.

During the interview, Kelly was asked what was working well for her in the online education program. She noted that she benefits from learning about child development and behavior management, as the coursework helps her not only in the classroom setting but also as a mother of young children. The courses she took during her associate's degree made her feel more than adequately prepared to handle the demands of the online program in Elementary Education to complete her bachelor's degree. Kelly feels the workload of the program is manageable, for the most part, as a working mother. She is extremely appreciative of the financial support the program offers her, so she does not have to worry about the money for tuition. She said, "Obviously, not only financially, but also just being able to have the opportunity to go back to my home district and teach there [is a plus of this program]." Kelly described the financial support as a "life changer" for her.

Joan

Joan is a paraprofessional who works in a special education classroom within an early childhood setting. She supports students using one-on-one instruction. Joan is pursuing a degree and licensure in Special Education. She has many years of experience working in childcare settings, feels very comfortable working with young children, and has a passion for special education advocacy which is what motivates her pursuit of the teaching license. Joan identifies as Black and at the time of the interview she was working to fulfill the General Education requirements for the degree, including science and mathematics courses. When Joan was asked what works well for her in the GYO program, she focused on the benefits from the friendships she has made in her education classes. She has built a bond with her classmates, especially those who work in the same school district where she works. Joan appreciates the flexibility and accessibility of the online classes. She is very comfortable with Zoom meetings and likes that she can attend them from home or work. Joan feels that the condensed semesters of seven-week courses are very demanding and that she often does not have the opportunity to delve deeply into what she is learning. The demands of work-life balance continue to worry her.

April

April is a first-generation college student and a current paraprofessional in the Early Childhood licensure area of the GYO program. April has fond memories of teachers since childhood and always dreamed of becoming a teacher. Limited financial and personal support prevented her from becoming a teacher. April has an associate's degree, and substitute teaching experience, and has worked in an after-school program. What is working well for April about the GYO program is the financial support that comes from being a participant. April receives academic accommodations within university courses because she presents with temporary mental health concerns. Her first fall semester she described as "a little rough," but she felt supported. April felt she needed better communication from the GYO program

staff specifically to answering her questions. April also commented on how, with her mental health concerns, she would like for program faculty to better understand her personal needs. She felt that her success so far was a result of the support she received from her family. She stated,

Sue

Sue, a current paraprofessional, recently moved back home to Virginia after having a baby, knowing that she needed family support to help care for the newborn. Sue identifies as Black, and she is thankful that her family helps with the baby while she is at work and when taking classes online. As a single parent, Sue is grateful to have the support of her family. Sue has had 10 years of experience as a paraprofessional and shared she has great time management skills. When asked what is working well for her in the GYO program, Sue directly noted the excellent advice from program staff and the faculty who teach the courses. She considers herself to be resilient and feels very comfortable managing stress and the demands of work and school. Sue is in the Special Education degree and licensure track of the GYO program and especially enjoys the connections she has made with others.

7. Cross Case Analysis

Examining the data across cases for the PoCs in this study, one noteworthy theme is that all participants felt they had made growth as future teachers specifically due to the networking opportunities. The paraprofessionals valued that they had courses together and communicated with each other within and outside of their online classes. The importance of relationships with GYO program staff was also particularly salient across the cases. Another common pattern was an appreciation of the flexibility of the program in terms of delivery mode. Online classes provided the participants with access to college coursework without the demands of driving to a campus and sitting in a classroom for in-person learning. Furthermore, the online environment provided them with the flexibility to juggle work and home life.

8. Discussion and implications

The findings of this study contribute to the field by providing insights for colleges and universities seeking to diversify their student body while at the same time positively impacting the teaching force by inducting more teachers of Color. However, the findings should be interpreted with some caution, as the study included a limited number of participants over one year. Despite the limitations of this study, the insights gained provide perspective into the experiences of Paraprofessionals of Color in an online GYO program. We believe that these lessons are relevant to EPPs across the country. The themes explored in the cross-case analysis revealed that the support we put in place (i.e., cohort model, success coaches, etc.) helped build a collegial professional community that the PoCs could turn to while in the program and hopefully will continue to rely on as they begin their new career.

There has been a growing understanding of the importance and magnitude of teacher turnover and retention. Like Van Overschelde and Wiggins (2020), we want the high-quality diverse teachers we are recruiting and supporting, to remain teaching. However, to do this, we must acknowledge that the transition from a paraprofessional to a lead teacher can be complicated. Chopra et al., (2004) argue that it can be particularly challenging for Paraprofessionals of Color who are entering a predominantly White teacher workforce. Since the GYO program was created in 2022, we continue to gain insights into how to best support paraprofessionals in the program specifically PoCs. This has led to changes and refinements in the academic, financial, and logistical support we provide students to complete the education program, gain licensure, and transition to lead teacher roles. Some changes include regional networking opportunities and one-on-one non-evaluative mentoring. However, the impact of our work extends beyond the walls of our university and has potential implications for schools, colleges/universities, and public policy.

References

Abbate-Vaugh, J, & Paugh P. (2009). The paraprofessional-to-teacher pipeline: barriers and accomplishments. *Journal of Developmental Education, 33*(1) 16-29.

Bakhtin, M. M. (1986). *Speech genres and other late essays* (V.W. McGee, Trans.; C. Emerson & M. Holquist, Eds.). University of Texas Press.

Bissett, J. (2023, January). *W Virginia Department eases teacher requirement*. The Dominion Post. Retrieved from https://www.dominionpost.com/2023/01/19/w-va-department-of-education-eases-teacher-requirement/

Bristol, T. J., & Goings, R. B. (2019). Exploring the boundary-heightening experiences of Black male teachers: Lessons for teacher education programs. *Journal of Teacher Education*, *70*(1), 51-64.

Calarco, J. (2014). Coached for the classroom: Parents' cultural transmission and children's reproduction of educational inequalities. *American Sociological Review, 79*(5), 1015-1037.

Carver-Thomas, D. & Darling-Hammond, L. (2017). *Addressing California's growing teacher shortage: 2017 update.* Palo Alto, CA: Learning Policy Institute.

Castro, A., Quinn, D. J., Fuller, E., & Barnes, M. (2018, January). *Policy Brief 2018-1: Addressing the importance and scale of the U.S. teacher shortage.* http://www.ucea.org/wp content/uploads/2018/01/Addressing-the-Importance-and-Scale-of-the-US-Teacher Shortage.pdf

Charmaz, K. (2014). *Constructing grounded theory* (2nd ed.). Sage.

Chopra, R. V., Sandoval-Lucero, E., Aragon, L., Bernal, C., De Balderas, H. B., & Carroll, D. (2004). The paraprofessional role of connector. *Remedial and Special Education, 25*(4), 219-231.

Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research*. Sage publications.

Dee, T. S. (2004). The race connection: Are teachers more effective with students who share their ethnicity? *Education Next*, *4*(2), 52-60.

Delgado, L., Baese, K., & Hauptman, A. (202). A pathway to teaching for paraprofessionals of color. *Phi Delta Kapan, 103*(3), 17-21.

Dunn, R. & Lizama, G. D. (Spring, 2022). Advancing equity: Mentoring to develop and retain bilingual teachers of color. *PDS Partners: Bridging Research to Practice*, *17*(1), 3-5.

Egalite, A. J., Kisida, B., & Winters, M. A. (2015) Representation in the classroom: The effect of own- race/ethnicity teacher assignment on student achievement. *Economics of Education Review, 45*, 44-52.

Fermanich, M., & Finster, M., (2023). *Improving the pipeline strategies for recruiting teacher residency candidates.* Region 5 Comprehensive Center. Retrieved from: https://region5compcenter.org

García, E., & Weiss, E. (2019). (Rep.). *Challenging working environments ('school climates'), especially in high-poverty schools, play a role in the teacher shortage* (4th ed., Ser. The Perfect Storm in the Teacher Labor Market). Washington, DC: Economic Policy Institute. www. epi.org/16291

Gershenson, S., Holt, S. B., & Papageorge, N. W. (2016). Who believes in me? The effect of student-teacher demographic match on teacher expectations. *Economics of Education Review*, *52*, 209-224.

Gist, C. D. (2022). Ensuring Equity in Grow-Your-Own Programs. *State Education Standard*, *22*(3), 39-43.

Gist, C. D., Bianco, M., & Lynn, M. (2019). Examining grow your own programs across the teacher development continuum: Mining research on teachers of color and nontraditional educator pipelines. *Journal of Teacher Education*, *70*(1), 13-25.

Glesne, C. (2006). *Becoming qualitative researchers* (3rd ed.). Pearson Allyn & Bacon.

James, W., Scott, L., & Temple, P. (2020). Strategies used by historically Black colleges and universities to recruit minority Teacher Education Candidates. *Teacher Educators' Journal*, *13*, 76-104.

Ladson-Billings, G. (2006). From the achievement gap to the education debt: Understanding achievement in US schools. *Educational Researcher 35*(7), 3-12.

Lindsay, C. A., & Hart, C. M. (2017). Exposure to same-race teachers and student disciplinary outcomes for black students in North Carolina. *Educational Evaluation and Policy Analysis, 39*(3), 485-510.

Madkins, T. C. (2011). The Black teacher shortage: A literature review of historical and contemporary trends. *The Journal of Negro Education, 80*(3), 417-427. Retrieved from: https://www.jstor.org/stable/41341143

Picower, B. (2009). The unexamined whiteness of teaching: How white teachers maintain and enact dominant racial ideologies. *Race Ethnicity and Education*, *12*(2), 197-215.

Suzuki, L. A., & Valencia, R. R. (1997). Race–ethnicity and measured intelligence: Educational implications. *American Psychologist*, *52*(10), 1103.

Van Overschelde, J. P., & López, M. M. (2019). Raising the bar or locking the door? The effects of increasing GPA admission requirements on teacher preparation. *Equity & Excellence in Education, 51*(3-4), 223–241. doi:10.1080/ 10665684.2018.1539355

Van Overschelde, J. P., & Wiggins, A. Y. (2020). Teacher preparation pathways: Differences in program selection and teacher retention. *Action in Teacher Education*, *42*(4), 311-327.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

"QUI VAL DI FIASTRA": A TERRITORY EDUCATION PROJECT WITH CHILDREN AND ADOLESCENTS

Alessandro Maranesi, & Paola Nicolini
Department of Humanities - Macerata University (Italy)

Abstract

In accordance with the national trend, Le Marche region is facing a depopulation of the so-called "inland areas" that are characterised by lack of services, poor job and education offer, and other difficulties caused by earthquakes hitting the region regularly. Thanks to the bustle already in place in the last few years, a project called "Qui Val di Fiastra" is being implemented with the long-term aim to reverse the tendency towards the abandonment of small villages. The project concerns the activation of processes of shared participation between local communities to raise awareness regarding sustainability issues. Moreover, the project involves the organisation of local administrations and educational institutions in the four municipalities included. The present study encompasses an exploratory investigation that aims to apprehend if and how the territory's understanding can be improved from both a quantitative and qualitative point of view, through the experiential comprehension of the material and non-material environment. All students attending a lower secondary school and of the third and fifth grades of a primary school were involved and invited to answer to a questionnaire at the beginning and at the end of the project, after 6 months. They responded to a questionnaire of 6 open-ended questions in which they were asked to indicate three places that deserve to be visited for the built heritage, the natural heritage, the knowledge heritage and traditions. They were also asked to indicate the best aspect of the landscape surrounding their city and what to do or to say to convince someone to visit it. Content analysis was performed for each question. Results show a fairly significant increase in the number of answers to the questions. Regarding the built heritage, there was an increase from 70.28% to 76.80%; the natural heritage went from 35.43% to 55.80%; the knowledge heritage and traditions rose from 44.57% to 57.46% and finally, the one related to the panorama ascended from 42.86% to 67.96%. Before and after every activity in the area, in addition to questionnaires, other surveys were carried out using various tools to give the opportunity to acquire further details adopting different kinds of languages. The data collected improved the responses, mainly from a qualitative point of view as revealed during the class discussions, the greater details showed in the drawings and descriptions, the acquisition of technical and new terms. A clear consolidation of knowledge is appreciable.

Keywords: *Inland areas, environmental education, territory education project, adolescents, children.*

1. Introduction

In recent years, in Italy, political and academic debate has returned to the so-called "inland areas" that, due to an acceleration of depopulation and impoverishment of local businesses, due to long-term dynamics intertwined with more recent phenomena, find themselves in a situation of abandonment and marginality (Paternariato, 2014; Dezio, et al, 2021; Giacomelli & Calcagni, 2022). For this reason, the National Strategy for Inner Areas (SNAI) was promoted in 2012 in order to identify the areas that are characterised by a strong long-term demographic decline and by their physical distance from the main "Poles" or "Intermunicipal Poles", which are those areas or groups of areas that possess within them at least one high school and at least one among technical and professional institutes, at least one hospital providing comprehensive patient care and at least one railway station with direct connections and long-distance routes (Paternariato, 2014; Istat 2020).

In line with the national trend, depopulation of the "inland areas" is also occurring in Le Marche region: those who live in these areas, in addition to having fewer opportunities in terms of education, work and health services, have to deal with the difficulties caused by the seismic events that periodically strike the region. These areas therefore suffer a significant gap compared to the "Poles", which Le Marche are mostly concentrated in the coast (Istat 2020), In order to reduce this gap and fight against the widespread uprooting that globalisation has brought and to give back centrality to the places of the inland areas, in the municipalities of the upper Macerata in 2020, Borgofuturo+ (Giacomelli & Calcagni, 2022), a participatory

process aimed at territorial valorisation through socio-cultural regeneration, will be launched in the provincial territory belonging to the "Val Di Fiastra" area. Inspired by the concepts and guidelines of the European Landscape Convention (2000) and the Faro Convention (2005), Borgofuturo+ relies on the involvement of communities in the co-creation of a strategic imaginary, which is then translated into a local project of territorial and socio-ecological inspiration. Borgofuturo+, through territorial tables characterised by a multidisciplinary and multi-sectoral approach initiated a process of shared participation among the area's communities and raising awareness on sustainability and quality of life issues in a participatory manner.

From the ferment arose by Borgofuturo+, the “Qui Val di Fiastra” social and cultural regeneration project was taking shape. Its long-term objective is to counter the dynamics of abandonment of historical centres, increase social and cultural participation, while activating the socio-economic fabric of the valley.

2. Design

The ‘Qui Val di Fiastra’ project has the municipalities of Colmurano, Loro Piceno and Ripe San Ginesio as implementing bodies, with Ripe San Ginesio as lead partner, and is coordinated by ‘Inabita, Laboratorio territoriale’, together with the Department of Humanistic Studies of the University of Macerata, as scientific-cultural partner, the Istituti comprensivi and ‘Legambiente Marche’. The municipality of Urbisaglia, on the border of the area of interest, is also involved in some of the activities.

In order to counter the widespread sense of uprooting that also seems to characterise the inhabitants of the Val di Fiastra, territorial education paths have been created, dedicated to the youngest generations, which take into account the resources of the place in which they are to be developed and aim at active community participation, the recovery of traditions, values and knowledge, and the collective recognition of material and immaterial heritage (Giorda & Puttilli, 2011). The youngest inhabitants of the area are at the centre of the project. For this reason, all schools of all levels in the municipalities of Colmurano, Loro Piceno, Ripe San Ginesio and Urbisaglia have been involved: from the last year of kindergarten to the third grade of secondary school.

Bearing in mind that outdoor education has positive effects on children's moods, enhances their concentration (Crudeli, 2021) and allows one to take care of children's quality of life without being overwhelmed by the learnification that manifests itself in the habit of referring to students, pupils, children, and adults as “learners” (Biesta, 2020), leading to the marginalisation of the educational aspects of teaching. (Di Pietro, 2022), a project was developed as follows**.** In these outings, villages, rivers and parks, businesses, workshops and everything related to the culture and tradition of the area have been transformed into open-air classrooms in which to create pre-texts to foster the acquisition of new skills and knowledge related to the territory, understood both as a spatial order and as a dimension of meaning, a network of symbols and values. For each school year, a theme was identified as the leitmotif of the field trips. Water has been the theme for the 2023/2024 school year, so the focus of the organised visits have been the places that have something to do with this element: the Ripe San Ginesio springs, the Colmurano springs, the Urbisaglia purification plant, the former watermill at Passo San Ginesio and the Fiastra river that runs through the valley. In order to develop a shared path of coexistence, growth, and valorisation of human and environmental resources, all members of the educating community were involved in the organisation of each outing: teachers, managers, administrators, experts, and people from the valley who made their time and skills available (Del Bene & al., 2021). They also made their contribution during the outdoor experiences.

3. Objectives

The aim of this study is to understand whether and how knowledge of the territory can be improved both quantitatively and qualitatively through an experiential understanding of the material and immaterial environment in which they live. A long term objective is to create a link with their everyday contexts and developing an attitude of care towards the living space made up of nature and relational, cultural, value and physical artefacts.

4. Method

Thanks to constant consultation between all the parties involved in the 2023/2024 school years, four outings lasting one and a half hours were organised for nursery, kindergarten and primary school children. Two hours visits were organized for secondary school pupils. In each of the visits, workshops and outdoor lessons were organised by experts and those from the valley community who made themselves available to tell the story and traditions of the area. In order to design the most suitable teaching and training

intervention and to foster learning processes, it is important to start from what students already know. To this end, activities have been planned to understand what knowledge is already available. This step is necessary in order to deal with new topics, to adapt them and gradually transform them into knowledge shared by the community and scientifically validated (Nicolini, 2012).

Each proposal was accompanied by a collection of data aimed both at monitoring the process of knowledge development and at understanding how this relates to the learner's body of knowledge.

The theoretical assumptions on which the planned activities are based are:

- the recognition of the more or less organised wealth of information prior to each event
- the use of tools for the detection of naive theories
- the use of scientific methodology
- group discussion for the co-construction of knowledge

For the detection of the knowledge already possessed by the pupils, keeping in mind H. Gardner's theory of multiple intelligences (1983), various tools were used to enable different languages to be adopted: drawings, concept maps, storytelling, sense-motor games, questionnaires, group discussions, dramatisation, musical performances. The method of ecological observation was also used, with situational data collection and the proposal of real situations, following a learning by doing approach (Dewey, 1938).

4.1. Measures and analyses

The data collected in the third and fifth classes of the primary school of Colmurano, Loro Piceno and Ripe San Ginesio, and the first, second and third classes of the secondary school of Loro Piceno and Urbisaglia will be presented. An open-ended questionnaire was proposed and administered to the children to find out what they knew about their place of origin. They were asked to indicate three places that are worth visiting regarding the built heritage, the natural heritage, and the heritage of knowledge and traditions. They were also asked to name three elements of the landscape around their city that strike them the most and what they would do or say to convince a person to visit it. The first questionnaire (t0) was administered at the beginning of the school year, before any activities were carried out. The second questionnaire (t1) was administered at the end of the project, after the last activity had been completed. The aim was to find out if and how all the activities carried out were helpful in promoting knowledge about the place where the children live. Further data collection was carried out before and after the third field visit with all participating pupils. In addition, before and after the fourth field visit, children in grades three, four and five of primary school and all classes of secondary school were involved in the data collection.

5. The activities

The first outing was in October to the springs of Ripe San Ginesio. It consists in a tour guided by Legambiente Marche experts and some local inhabitants. Stopping at the most significant places, their characteristics were described and their story told, enriched by anecdotes and legends. The route to the springs, immersed in nature, provided an opportunity to have a sensory experience and talk about the typical fauna and flora of the area.

The second tour in November consists of a walk from the village to the Colmurano springs. In addition to the guided tour of the village, there was a workshop on the red apple, a typical local product, organised by the ‘Le Paccucce’ association. At the ‘Allungo spring’, some of the locals, after having shown the ‘Madonna della Fonte’, recounted their experiences of going to the spring to fetch water and showed how they washed their clothes. Following this, artist Mario Migliorelli held a landscape painting workshop.

In March the tour was to the Giansanti mill in Passo San Ginesio for the children from nursery to fourth grade of primary school, and Urbisaglia purification plant for the fifth grade of primary school and the first grade of secondary school. At the mill, after a brief moment of guided meditation with the sound of flowing river water in the background and playful-theatre activities preparatory to the visit, held by an expert, the owners demonstrated the operation of the mill. At the purification plant, the visit was guided by the manager who described and showed what steps the water has to go through to be purified. Afterwards, experts from Legambiente held a workshop on the topic of conscious consumption and water pollution.

The fourth outing was in to the Fiastra river. The children, from nursery to second primary class, took a sensorial walk into the river, guided by experts from ‘La Meridiana’ association and a workshop held by the photographer Marco Gatta. The students, from the third primary class to the third secondary class, cleaned up the river: with the support of Legambiente experts, they separated and catalogued the waste, then handed it over to COSMARI, the waste management service of the province of Macerata.

At the end of the activities, before returning to school, there were moments of discussions and reflection where students, teachers and experts could share thoughts and emotions: a very important step in order to have the opportunity to gather information to reshape the experience and improve the knowledge.

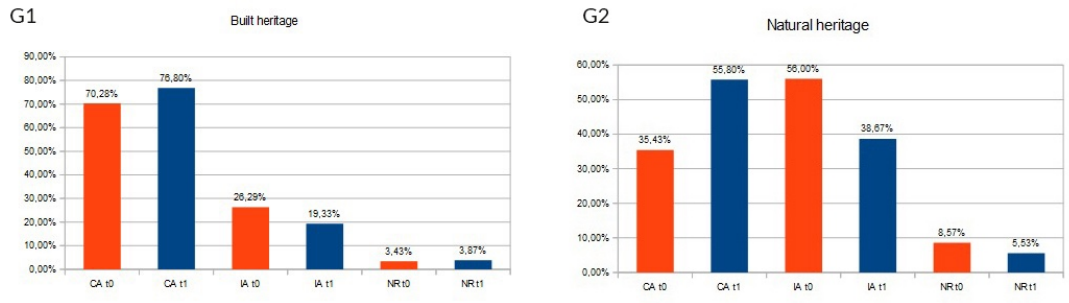
6. Results

The questionnaires were administered in class during the school time, which is why the numbers of children between t0 and t1 are different, as there were absentees in both sessions. The intended sample size was 200 students of which 69 were primary school students and 131 secondary school students. The t0 questionnaire was completed by 175 students (m: 85, f: 90) 64 of which from the primary schools and 111 from the secondary school. Questionnaire t1 was completed by 181 students (m: 90, f: 91) of whom 63 from the primary schools and 118 from the secondary school. To enable a comparison between t0 and t1, the numbers were considered in percentages.

In a first analysis, the change in the number of complete responses (CA), incomplete responses (IC) and no responses (NR) between the first and second questionnaire was counted. The answer is complete when three places/elements have been indicated, as required; the answer is incomplete when only one or two have been indicated. No place/element indicated is considered a non-response. Adopting a descriptive statistical analysis, there was an increase in the number of answers. As is evident in the following graphs, there was a 6.52% increase in complete answers in the question on built heritage (G1): from 70.28% to 76.80%. Consequently, incomplete answers decreased by 6.96%, from 26.29% to 19.33%. Non-response had a very slight increase of 0.44%: from 3.43% to 3.87%.

Compared to the question on natural heritage (G2), complete answers had an even greater increase: 20.37%, from 35.43% to 55.80%. Both incomplete responses and non-responses decreased by 17.33%, from 56% to 38.67%, and 3.04%, from 8.57% to 5.53%, respectively.

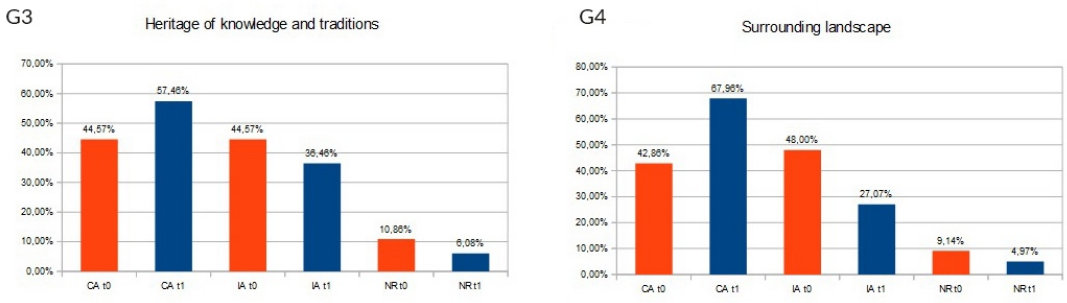
Figure 1.



In the question on the heritage of culture and traditions (G3), there was a 12.89% increase in complete answers: from 44.57% to 57.46%. Incomplete answers went from 44.57% to 36.46%, showing a decrease of 8.11%, while non-answers decreased by 4.78% from 10.86% to 6.08%.

Finally, in the answers to the question asking which elements of the surrounding landscape (G4) strike one most, there was a 25.1% increase in complete answers: from 42.86% to 67.96%. Incomplete answers went from 48% to 27.07%, a decrease of 20.93%. Non-responses went from 9.14% to 4.97%: a decrease of 4.17%.

Figure 2.



7. Discussions

From this data, it seems to emerge how effective outdoor lessons are for learning and how important it is to experience the area in order to get to know it. This is also confirmed by the interviews conducted with the children and adolescents during the field visits and in the classroom meetings. Learning about the history and functions of the Leonina Tower of Ripe San Ginesio inside the tower itself, from an expert, made the experience meaningful and favoured learning. The same thing happened at the “Fonti Allungo” in Colmurano, where members of the town's community made themselves available to tell the story of how the place was once used for washing clothes. The story and, above all, the representation of how soap was made, how one arrived at the springs with a basket on one's head full of clothes and what the stages of washing were probably moved those present to the point of making the experience unforgettable.

A few months later, when asked to recall what had remained most impressed from that outing, most recalled this very moment. The pre and post surveys show change both quantitatively and qualitatively with a progression in knowledge construction. Indeed, the experts' intervention enabled the students to better define their knowledge and learn a number of specific, technical and new terms. For example, before the third outing, the children of the first three primary classes were asked to draw a mill, imagining it, since hardly anyone had ever seen it. After the visit, the same request was made. From the analysis of the drawings, it was interesting to see how the children were able to use this tool to rethink and re-elaborate the experience: most of the drawings made before the visit simply showed a house with a wheel, located near a river; in the second drawing, the interior of the mill is shown, with machinery, grain and flour. The wheel disappeared, and this outcome is because the children learned that the mill no longer runs on water but on electricity.

8. Conclusion

Analyses of the data collected show how the activities carried out outside school were effective in improving knowledge of the area. But that's not all, the classroom interviews, carried out after the outings, also showed how a change in the children's and adolescents' outlook towards the places they belonged to is taking place: the experience at the river, in particular, first shocked them, no one imagined there could be so much waste. Then it aroused in them the desire to take care of it, creating the conditions to foster attachment. Very important was the involvement of the entire educating community, from associations to local residents, from teachers to the members of the municipal administrations involved, both in the planning phase and in the field: thanks to their expertise and enthusiasm, they were able to give valuable indications for the planning and, above all, they were able to enthuse children and adolescents, encouraging learning. In conclusion, it can be said that, although the project is still in its initial stages, it seems that all the interventions implemented so far with the involvement of the entire educating community are creating good conditions for improving a knowledge of the area that is also functional in fostering attachment to it and the desire to remain there, taking care of it.

Acknowledgement

The research was financed by the project ‘QUI Val di Fiastra’, assignee of the PNRR M1C3 Intervention 2.1 ‘Attractiveness of Historical Villages’, line B, the contents of the research activity are connected to intervention 14 ‘Educating to heritage and territory’.

References

Biesta G. (2022). *Riscoprire l'insegnamento*. Milano: Raffaello Cortina.

Crudeli F. (Ed). (2021). *L'outdoor education. Per la costruzione di una comunità educante.* Parma: Edizioni Junior.

Del Bene, G., Rossi, A. L., & Viaconzi, R. (2021). *La comunità educante. I patti educativi per una scuola aperta al futuro.* Novate Milanese: Fabbrica dei sogni editore.

d'Europa. C. (2000, October). Convenzione europea del paesaggio. In *Congresso dei poteri locali e regionali del Consiglio d’Europa, Firenze* (Vol. 20). https://www.premiopaesaggio.beniculturali.it/wp-content/uploads/2021/04/convenzioneeuropea.pdf

d'Europa. C. (2005). Value of cultural heritage for society. *Council of Europe Framework-Convenzione quadro del Consiglio d’Europa (CETS no. 199)*, Faro. 18, 03-08. https://www.coe.int/en/web/culture-and-heritage/faro-convention

Dewey, J. (1938). *Experience and education*. United Kingdom: Macmillan.

Dezio, C., D'Armento, S., Kercuku, A., Moscarelli, R., Pessina, G., Silva, B., & Vendemmia, B. (Eds.). (2021). *Le Aree Interne Italiane. Un banco di prova per interpretare e progettare i territori marginali| Inner Areas in Italy. A testbed for interpreting and designing marginal territories.* Listlab.

di Partenariato, A. (2014). *Strategia nazionale per le Aree interne: definizione, obiettivi, strumenti e governance*.

Di Pietro A. (2022). *Facciamo scuola all'aperto. Esperienze interdisciplinari di didattica ludica alla primaria*. Trento: Erickson.

Gardner, H. (1983). *Formae mentis. Saggio sulla pluralità delle inetlligenze*. Trad. it., Milano: Feltrinelli.

Giacomelli, M., & Calcagni, F. (Eds). (2022). *Borgofuturo+: un progetto locale per le aree interne.* Roma: Quodlibet.

Giorda C., Puttilli M. (Eds). (2011). *Educare al territorio, educare il territorio. Geografia per la formazione.* Roma: Carocci.

Istat. (2020). *Ambiente e Territorio.* Istat Roma.

Nicolini P., Pandolfi S. (Eds). (2012). *Comprendere l'ambiente: riflessioni teoriche e buone pratiche in ecosistemi apogei.* Parma: Edizioni Junior.

THE IMPACT OF EXTENDED CURRICULUM PROGRAMMES: GRADUATION TRENDS AND STUDENT NARRATIVES

Jeanine Mwambakana-Mutombo
Foundation Programmes, University of Pretoria (South Africa)

Abstract

This study investigates the efficacy of Extended Curriculum Programmes (ECPs) in Science and Commerce at the University of Pretoria, specifically designed to mitigate the enduring effects of educational inequality in South Africa. By providing an alternative pathway for students who do not meet standard admission criteria, *Extended curriculum programmes (ECPs), Graduation rate, Educational inequality, Cohort analysis and Student experience* - these ECPs offer access to four streams: commerce, physical sciences, mathematical sciences and biological sciences, with the goal of enabling students to graduate within the minimum time plus one year (n+1). A cohort analysis, conducted from 2017 to 2020, reveals a modest but positive trend in student graduation rates within the (n+1) timeframe, increasing from 17% to 19.5%. However, the study also highlights significant challenges, with approximately 33% of students discontinuing their studies by the fourth year. Furthermore, a substantial portion of the remaining students require longer than the stipulated timeframe to complete their degrees. To gain a deeper understanding of these quantitative findings, the research incorporates a qualitative dimension through interviews with ten randomly selected students who commenced their studies in the foundational ECP year. These interviews explore the students' lived experiences, identifying factors that facilitated or hindered their academic progress. The insights gleaned from these interviews offer a nuanced perspective on the ECPs' effectiveness, highlighting both successful strategies and areas necessitating improvement. Student generated recommendations provide valuable, practical suggestions for enhancing the ECPs and fostering greater student success. These recommendations offer actionable insights that can inform program adjustments and contribute to improved student outcomes. Ultimately, this study aims to provide a comprehensive analysis of the ECPs' performance, combining quantitative data with qualitative perspectives to inform strategies for enhancing student success and addressing the enduring challenges of educational inequality in South African higher education.

Keywords: *Extended Curriculum Programmes (ECPs), graduation rate, educational inequality, cohort analysis and student experience.*

1. Introduction

The Study University offers four streams of Extended Curriculum Programmes (ECPs, on a dedicated Campus, and three of which are Bachelor of Science (BSc) Programmes and one a Bachelor of Commerce (BCom) Programme. The BSc Stream is comprised of a) BSc Extended Physical Sciences, b) BSc Extended Mathematical Sciences and c) BSc Extended Biological and Agricultural Sciences. The BSc extended curriculum programme, formerly known as the BSc Four-year programme was implemented in 2008 whereas the BCom extended curriculum programme formerly known as BCom four-year programme was implemented in 2012.

The ECPs were designed for students who are not academically prepared but who have the potential to succeed and obtain their degree. While these students, however, have achieved from their matric results a bachelor's degree endorsement they have not meet the minimum requirement for enrolment in the mainstream modules. The programmes include an additional year of study which aims to enhance students' basic knowledge and skills before they progress to more specialist studies in later years. Thus, the students admitted in the first cohort of this study, class of 2017, should complete their first degree in December 2020 (n+1) and their graduation take place in the subsequent year. Students who embarked on these programmes have much greater opportunity to succeed as students who need assistance to bridge the gap between school and higher education are provided with dedicated support (Engelbrecht *et al.*, 2014; Pearce, *et.al.*, 2015). In this paper, students who commenced their journey in the ECPs, will be refered to as 'ECPs students'.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

2. Design

With over a decade of implementation, this research seeks to evaluate the impact of Extended Curriculum Programmes (ECPs) on its students population. Thus, the aims of the study were to: a) determine the degree to which ECPs have significantly influenced students' trajectories and achievements. b) explore the experiences of ten randomly selected group of ECPs graduating students, providing qualitative insights into the perceived effects of these programmes. c) analyse the movement of ECPs students across different qualifications and faculties to identify preferred pathways and destinations associated with graduation.

3. Objectives

The main objective of this research is to provide a comprehensive analysis of the impact and experiences related to the (ECPs). Specifically, it seeks to quantify the effect of ECPs on graduation trends, illuminate the lived experiences of participating students, and map the academic trajectories of these students through various qualifications and faculties leading to graduation. This understanding will contribute valuable insights into the future of ECPs at the University.

4. Methods

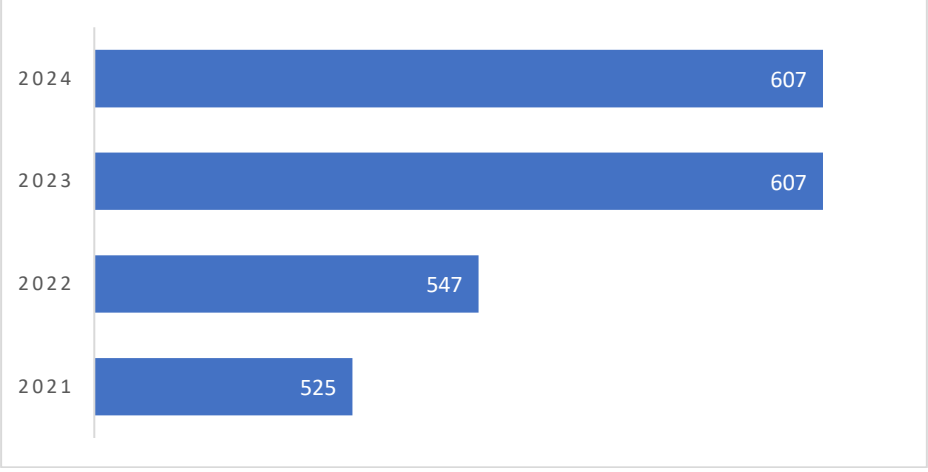
Mixed method was used in this research. The tracking of ECPs students' pathways and gaining insights from the responses to the open-ended questions of the ten randomly selected students.

5. Discussions

By embracing the Extended Curriculum Programmes (ECPs), we have opened doors to a significant number of aspiring students who might otherwise have been denied access to higher education. A rising number of ECPs graduates are successfully completing their degrees and embarking on fulfilling careers. This is a testament to the transformative power of education and the dedication of our students, faculties and staff. By providing a supportive teaching and learning environment and tailored academic support, we have empowered these individuals to overcome challenges and achieve their dreams.

Of the cohort that started in 2017, only 17% completed their studies in December 2020 and their graduation takes place in the following year. This percentage demonstrated a steady increase, reaching 19.5% in 2024. The bar graph presented in Figure 1, utilising data from University Graduation Ceremonies between 2021 and 2024, reveals a noteworthy pattern of consistent and substantial growth in the annual number of graduates. Although the data is cumulative, including students who take more than n+1 years to graduate, this upward trend is clearly evident. This achievement underscores the transformative impact of the ECPs and the dedication of our students and faculties. However, the cohort analysis also highlights significant challenges; approximately 33% of ECPs students discontinuing their studies by the fourth year.

Figure 1.



The Study University offers a wide array of academic programs across various faculties, providing students with numerous pathways to success. A total of 2286 ECPs students who started at the Study University received their degrees from the 2021 to 2024 graduation ceremonies, as undergraduates or postgraduates students. The table below showcases the movement of ECPs students across different faculties with Natural and Agricultural Sciences and Economic and Management Sciences being in the lead with more than two third of students (68%) graduating from various degrees within these two faculties.

Table 1. Number of Graduates who started their academic journey from 2017 to 2020 receiving their degrees from 2021 to 2024.

Faculties	2021	2022	2023	2024	**Total number of graduates: 2286**
Natural & Agricultural Sciences	220	204	220	208	**37.3%**
Economic and Management Sciences	107	156	219	219	**30.7%**
Engineering, Built, Environment and Information Technology	88	77	64	66	**12.9%**
Health Sciences	76	61	64	72	**11,9%**
Education	18	12	12	12	**0.24%**
Humanities	8	7	13	12	**0.17%**
Law	6	13	7	8	**0.15%**
Veterinary Science	1	15	8	9	**0.14%**
Theology and Religion	1	1			**0.01%**
GIBS Business School		1		1	**0.01%**

Students were asked to share their lived experiences, identifying factors that facilitated or hindered their academic progress and areas necessitating improvement.

In general, all the students appreciated the slower pace, smaller classes, and the opportunity for reflection and adjustment to university life. Student 1 stated: "*It provided a crucial foundation that facilitated my later success in mainstream programmes*". Students 2 and 3 initially felt some disappointment about being in the Extended Curriculum Programmes but later they recognised its value in preparing them for their chosen fields. All students recalled the shift to online learning during the pandemic (COVID-19) leading to a feeling of isolation. The pandemic presented significant challenges with online assessments. They had to increase self-discipline.

All students emphasised the necessity of hard work, dedication, and perseverance to succeed in their studies. They acknowledged that the university journey can be challenging and requires consistent effort. They also valued the support systems available to them: family, lecturers (faculty members) and tutors, friends and peers played a crucial role in supporting them through difficult times, especially during the pandemic and when facing academic challenges.

Student 4 and 5 mentioned the importance of taking breaks, pursuing extracurricular activities, and making meaningful connections to enhance their overall university experience.

The following were the advice and suggestions made by the students: a) Have different tutors for maths and physics tutorials who can offer alternative explanations to the lecturer, b) improve the facilities with faster computers and more diverse seating areas in the library, c) do not discontinue the programmes due to their positive impact on students' journeys, d) expand the range of events, clubs, and sports on the study campus to foster a stronger sense of community, and e) implement a programme to help students navigate the increased workload and pace when transitioning to a different campus and faculty.

The current students were encouraged to be curious, seek for help, persevere, enjoy the journey, and to maintain a clear sense of purpose.

6. Conclusions

The analysis clearly shows that ECPs do give access to students who could not have been admitted to science and commerce fields due to their matric results not meeting the minimum criteria for mainstream degrees. These 2286 students would not have graduated if they did not start at study Campus. Moreover, in the paper by Ogude *et al* (2019), previous and successful students attest that during their time at this Campus, they received the necessary support, which enabled them to successfully complete their degrees.

More than a decade after its inception, the study University's ECPs continue to give students access to higher education and to lay a solid foundation by equipping them with the knowledge and skills necessary for success in mainstream higher education. Although the number of successful students is below 20%, this success could not have been possible if the access was not denied to them. ECPs put into practice the shift of policy emphasis from "access to success" (Lubben *et al.*, 2010; Slabbert & Friedrich-Nel, 2015), which is the main drive of the university in South African context.

Providing a supportive teaching and learning environment, along with tailored academic support, we have empowered individuals to overcome challenges and achieve their dreams. However, with approximately 80% of ECPs students taking longer than n+1 timeframe to successfully complete their studies and with about 33% of students dropping out the programmes by their fourth year of studies and students migrating to other Faculties (and 112 various qualifications) at the university rather than graduating from the opted programmes for which they originally opted, the management of the University reviewed the ECPs offerings. Based on the graduation trends and students' narratives, the University has introduced, in 2025, 11 new programmes; ten in the Faculty of Natural and Agricultural Sciences and one in the faculty of Economic and Management Sciences.

Acknowledgments

My Ccolleagues from the Department of Enrolment and Student Administration (DESA) used a service indicator to backtrack the cohorts that started at the Study Campus from 2017. The data of ECPs graduates in table 1 above were pulled from the University-Graduation Ceremonies from 2021 to the 2024.

References

Engelbrecht, J., Harding, A., & Potgieter, M. (2014). Evaluating the Success of a Science Academic Development Programme at a Research-intensive University. *African Journal of Research in Mathematics, Science and Technology Education, 18*(3), 287-298. DOI: 10.1080/10288457.2014.962726

Lubben, F., Davidowitz, B., Buffler, A., Allie, S., & Scott, I. (2010). International Journal of Educational Development Factors influencing access students' persistence in an undergraduate science programme: A South African case study. *International Journal of Educational Development (on-line), 30*, 351-358. http://dx.doi.org/10.1016/j.ijedudev.2009.11.009

Pearce, H., Campbell, A., Craig, T. S., leRoux, P., Nathoo, K., & Vicatos, E. (2015). The articulation between the mainstream and extended degree programmes in engineering at the university of cape town: reflections and possibilities. *South African Journal of Higher Education, 29*(1), 150-162.

Slabbert, R., & Friedrich-Nel, H. (2015). Extended curriculum programme evolution: a road map to academic success? *South African Journal of Higher Education, 29*(1), 45-59.

Ogude, N. A., Meyer, I. J., Mwambakana, J., & Mthethwa, N. E. (2019). Can extended curriculum programmes be improved through engagement with students using appreciative inquiry? *South African Journal of Higher Education, 33*(4), 219-236.

POSTERS

Designed by Freepik

THE USE OF 3D PRINTING AS A DIDACTIC TOOL IN TECHNICAL DRAWING EDUCATION WITH AN EMPHASIS ON ECODESIGN

Tetjana Tomášková, Jan Krotký, & Jarmila Honzíková
Department of Mathematics, Physics and Technology, Faculty of Education, University of West Bohemia (Czech Republic)

Abstract

This article explores the use of 3D printing as a didactic tool in the teaching of technical drawing, with an emphasis on ecodesign. 3D printing offers an innovative approach to education, allowing students to better understand complex geometric shapes and constructions through interactive and tangible models. This approach not only increases the interactivity of teaching but also provides students with practical experiences that can significantly improve their spatial imagination and technical skills. The article further focuses on aspects of ecodesign and sustainability, which are crucial in modern education. The use of ecological materials for 3D printing, such as biodegradable plastics, contributes to environmental protection and supports sustainable practices. The efficient use of resources enabled by 3D printing can also reduce waste and material consumption compared to traditional production methods. Practical applications of 3D printing are illustrated with specific project examples where 3D printed models have been successfully integrated into the teaching of technical drawing. These examples include feedback from students and teachers who have utilized this technology, demonstrating how 3D printing can enrich the educational process and increase students' interest in technical fields. Technological aspects include an overview of the necessary software and hardware for 3D printing and a discussion of the challenges and solutions in its implementation in teaching. This article provides a comprehensive view of the potential of 3D printing as a tool for modern and sustainable technical drawing education, highlighting its importance for the future of technical education.

Keywords: *3D printing, didactic tool, technical drawing, ecodesign, sustainable education.*

1. Introduction

In recent years, 3D printing has become an important tool in education, especially in the field of technical drawing (Song, 2018; Pearson & Dubé, 2022; Abu Khurma, Ali & Swe Khine, 2023; Anđić, Ulbrich, Dana-Picard et al., 2023). This article focuses on the use of 3D printing as a didactic tool with an emphasis on ecodesign (Bravo-Díaz & Gutiérrez-Yurrita, 2015; Neto, 2019; Bedmar, Artigas-Arnaudas, Vázquez-López, Cifuentes, Calderón-Villajos & Muñoz, 2024; Tomášková, Duda, Krotký & Honzíková, 2024; Morales Méndez, del Cerro Pérez & del Cerro Velázquez, 2024; Favi & Marconi, 2025). 3D printing brings an innovative approach that allows students to better understand complex geometric shapes and structures through interactive and tangible models.

2. Didactic aids printed on a 3D printer in technical drawing education

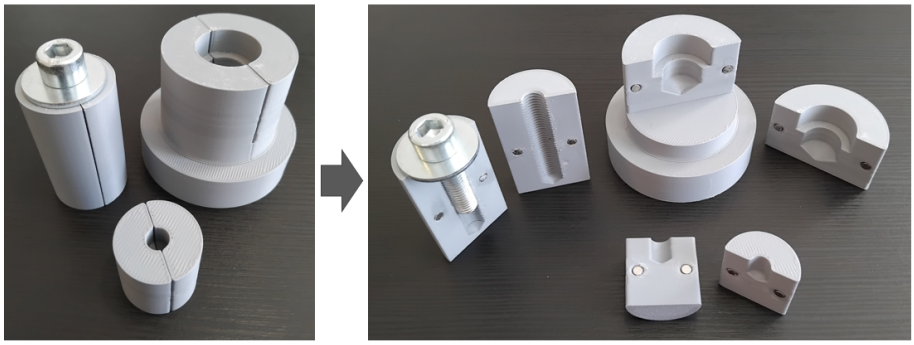
3D printing offers an innovative approach to teaching technical drawing, allowing students to better understand complex geometric shapes and structures through interactive and tangible models. This approach not only increases the interactivity of the teaching, but also provides students with hands-on experience that can significantly improve their spatial imagination and technical skills.

2.1. Benefits of 3D printing in technical drawing teaching

3D printed models allow students to physically manipulate objects, which increases their engagement and interest in technical drawing, for example, models of machine components can be easily created and used in teaching, see Figure 1.

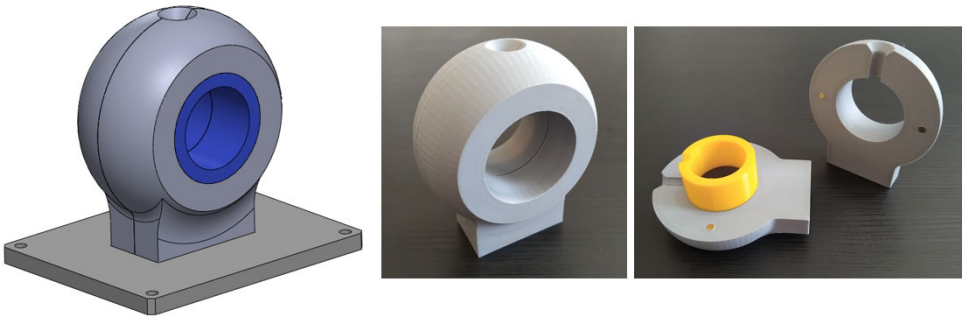
p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

Figure 1. Didactic aids printed on a 3D printer in technical drawing education.



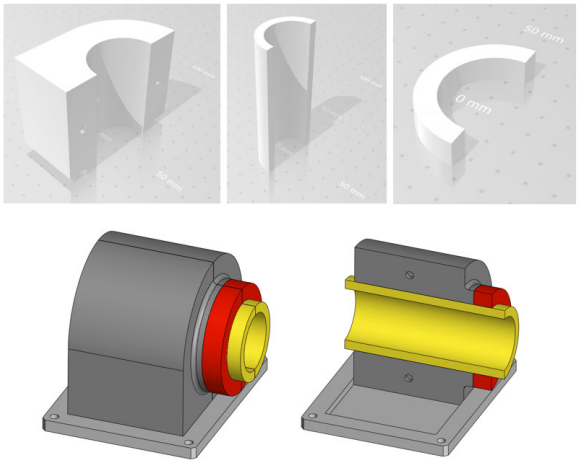
3D printing allows for the use of a variety of materials, including environmentally friendly and recyclable materials. This not only reduces costs but also promotes environmental sustainability. Students can learn about different types of materials and their properties, which is important for technical drawing and engineering. Students can gain valuable hands-on experience designing and manufacturing their own models, which they then print on a 3D printer, and this process supports creativity and technical skills that are important for future careers in engineering and technology, see Figure 2.

Figure 2. Didactic aids printed on a 3D printer (modelling in SOLIDWORKS).



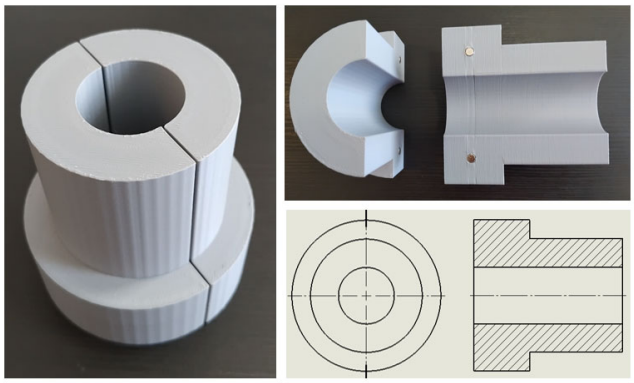
3D printed models of geometric shapes and structures can help students better understand abstract concepts and relationships between different shapes, see Figure 3.

Figure 3. Model of didactic aids (modelling in SOLIDWORKS).



Models of various machine components can be used to teach technical drawing and engineering, allowing students to study and understand their design and function in detail. Students can design and print their own technical drawings and models, providing them with hands-on experience in technical drawing and engineering processes, see Figure 4.

Figure 4. Model of didactic aid and technical drawing.



3. Conclusion

Based on simple studies and practical experience, we can conclude that without didactic aids, students achieved an average improvement in understanding and application of technical drawing of around 15%. When didactic aids printed on a 3D printer were used, students achieved an improvement in understanding and application of technical drawing by up to 35% due to the interactive and practical approach. If didactic aids are effectively integrated into the teaching and students have enough opportunities to use them, 3D printed models can significantly increase student engagement, their spatial imagination and technical skills, which leads to better learning outcomes.

References

Abu Khurma, O., Ali, N., & Swe Khine, M. (2023). Exploring the impact of 3D printing integration on STEM attitudes in elementary schools. *Contemporary Educational Technology, 15*(4), ep458. https://doi.org/10.30935/cedtech/13568

Anđić, B., Ulbrich, E., Dana-Picard, T., et al. (2023). A Phenomenography Study of STEM Teachers' Conceptions of Using Three-Dimensional Modeling and Printing (3DMP) in Teaching. *Journal of Science Education and Technology, 32*, 45-60. https://doi.org/10.1007/s10956-022-10005-0

Bedmar, J., Artigas-Arnaudas, J., Vázquez-López, A., Cifuentes, S.C., Calderón-Villajos, R., & Muñoz, M. (2024). Using Technological Tools to Teach Arts and Design Students About Materials Science and Manufacturing. *EDULEARN24 Proceedings*, 4130-4135. DOI: 10.21125/edulearn.2024.1040

Bravo-Díaz, B. & Gutiérrez-Yurrita, P. J. (2015). Eco-design as a tool to implement the new approach of the education model by competencies in engineering courses. *ICERI2015 Proceedings*, 6578-6587. ISBN: 978-84-608-2657-6. ISSN: 2340-1095.

Favi, C. & Marconi, M. (2025). Product Eco-Design in the Era of the Circular Economy. *Sustainability*, *17*(1), 213. https://doi.org/10.3390/su17010213

Morales Méndez, G., del Cerro Pérez, A., & del Cerro Velázquez, F. (2024). Prototype Pultrusion of Recycled Polyethylene Terephthalate Plastic Bottles into Filament for 3D Eco-Printing: Education for a Sustainable Development Project. *Sustainability*, *16*(19), 8347. https://doi.org/10.3390/su16198347

Neto, V. (2019). Eco-design and Eco-efficiency Competencies Development in Engineering and Design Students. *Education Sciences, 9*(2), 126. https://doi.org/10.3390/educsci9020126

Pearson, H. A. & Dubé, A. K. (2022). 3D printing as an educational technology: theoretical perspectives, learning outcomes, and recommendations for practice. *Education and Information Technologies*, *27*, 3037-3064. https://doi.org/10.1007/s10639-021-10733-7

Song, M. J. (2018). Learning to teach 3D printing in schools: how do teachers in Korea prepare to integrate 3D printing technology into classrooms? *Educational Media International, 55*(3), 183-198. https://doi.org/10.1080/09523987.2018.1512448

Tomášková, T., Duda, D., Krotký, J., & Honzíková, J. (2024). Ecodesign as a new possibility in teaching technical subjects in secondary schools. In *Education and New Developments*. Lisbon, Portugal: inScience Press, 199-203. ISBN 978-989-35-7280-1, ISSN 2184-044X.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

EMPOWERING INNOVATION: THE ROLE OF GENERATIVE AI IN TRANSFORMING PROJECTS FOR UNIVERSITY STUDENTS

Karen McGivern
Business Department, St Mary's University College (Northern Ireland)

Abstract

This study explores the transformative role of Generative AI (GAI) in university students' academic projects, focusing on its potential to enhance creativity, idea generation, and research processes. The rapid evolution of AI technologies necessitates a thorough understanding of their benefits and challenges in educational contexts. The research investigates how GAI tools like ChatGPT and AI-driven design platforms can facilitate creative problem-solving and streamline research practices. It addresses key questions about GAI's influence on student creativity, its perceived benefits and challenges, and effective integration strategies for educators. Drawing on recent literature (Zawacki-Richter et al., 2024; Luckin et al., 2022), the study reveals that GAI enhances students' creativity, streamlines research processes, and offers personalized learning experiences. However, it also raises ethical concerns and challenges related to academic integrity. The author emphasises the urgent need for comprehensive lecturer training on GAI to enable effective integration into classroom instruction and assessment practices. This approach is crucial for developing students' AI literacy and mitigating potential over-reliance on technology. The study recommends a balanced curriculum that leverages AI's creative potential while addressing its limitations, ultimately encouraging responsible and innovative use of these emerging technologies in higher education.

Keywords: *AI, innovation, integrity, training, technologies.*

1. Introduction

The emergence of Generative AI (GAI) in higher education presents transformative opportunities alongside significant challenges. Building on foundational studies like Luckin and Holmes (2016), research highlights GAI's potential to support personalised learning and enhance students' academic skills. For instance, Donlon and Tiernan (2023) demonstrate its ability to streamline research and improve academic writing processes. However, the integration of GAI is not without concerns. Institutions are exploring strategies such as licensing to ensure fair access, while the Quality Assurance Agency for Higher Education (QAA, 2023) calls for rethinking assessment methods to focus on critical thinking and creativity rather than memorization. To maximise its benefits, a balanced approach is essential. GAI's integration into curricula also raises questions about its impact on creativity and pedagogy. Luckin et al. (2022) present the concept of AI Readiness, emphasising the need for a contextualised approach to help people understand AI, particularly in the education and training sector. This framework recognises the diverse impact of AI across professions and workplaces, highlighting a significant shift in how educators are prepared for the integration of AI in educational settings. However, this transformation requires deliberate efforts to adopt both information literacy and AI literacy, as emphasised by Tiernan et al. (2023). This includes fostering AI literacy among students and educators while addressing risks such as over-reliance and academic integrity. Comprehensive strategies for responsible integration can enable higher education to leverage GAI effectively, enhancing learning and innovation in academic practices.

This paper explores the multifaceted role of GAI in academic projects, addressing its influence on student creativity, the challenges it presents, and strategies for its responsible integration. By drawing on existing literature, this study emphasizes the need for educator training and balanced curricula to harness GAI's potential while mitigating its limitations.

2. Literature review

Generative AI (GAI) has emerged as a transformative force in higher education, particularly in supporting creativity and enhancing academic processes. Zawacki-Richter et al. (2024) highlight GAI's ability to stimulate innovative thinking, providing students with diverse perspectives and enabling the generation of novel ideas. This aligns with Tiernan et al. (2023), who emphasize GAI's potential to foster creative problem-solving, empowering students to tackle challenges through unconventional approaches.

These findings demonstrate the growing role of GAI in reshaping academic practices and fostering deeper engagement. Despite its promise, GAI integration raises critical concerns. Bobula (2024) warns against over-reliance on AI-generated content, which may hinder students' ability to develop original ideas and critical thinking skills. Donlon and Tiernan (2023) also address ethical challenges, particularly those surrounding academic integrity, as students increasingly incorporate AI into their work. Gupta (2024) further critiques disparities in access to GAI tools, advocating for equitable strategies to ensure that their benefits are universally available. Addressing these challenges requires a concerted effort to train educators in AI literacy and develop balanced curricula. Luckin and Holmes (2016) argue that such measures are essential for leveraging GAI's potential while safeguarding against its limitations, paving the way for responsible and innovative use in education.

3. Methods

Using a mixed-methods approach the study captures both the nuanced experiences of students and educators engaging with GAI tools and the measurable outcomes of creative academic projects. This comprehensive methodology provides empirical insights into GAI's transformative potential while addressing the complex opportunities and challenges it presents in education. The research methodology employed a comprehensive, multi-phase approach to examining Generative AI's role in academic contexts. Initially, an anonymous baseline survey was administered to 84 students to establish their pre-existing perceptions, knowledge, and attitudes towards AI in educational settings. Following this, students participated in a targeted training session designed to provide foundational knowledge and practical skills related to Generative AI tools. After the intervention, a post-training anonymous survey was conducted to assess shifts in their understanding, perceptions, and intended usage of AI technologies. To complement the student-focused quantitative data, semi-structured interviews were conducted with a purposive sample of five lecturers drawn from various degree programs. These interviews explored participants' levels of confidence and attitudes towards using Generative AI in their teaching practices, as well as perceived challenges and limitations of integrating these tools into academic projects. Data analysis combined quantitative and qualitative approaches. Survey data underwent descriptive statistical analysis to identify trends in student responses. Interview data was subjected to thematic analysis to identify key themes. This mixed-methods design allowed for data triangulation, enhancing the validity of findings. By combining survey data with qualitative insights from interviews, the study aimed to provide a comprehensive understanding of Generative AI's impact in higher education.

4. Findings

The pre-survey data was completed by 60 students, a response rate of 70%. This data reveals key insights into university students' use of Generative AI (GAI) tools for academic purposes. Around 85% of respondents reported using GAI tools, with ChatGPT being the most popular, followed by tools like Canva, Microsoft Copilot, and Snapchat MyAI. Usage varied, with about 30% using GAI weekly, 25% monthly, and 25% less than once a month. Around 5% never used GAI despite knowing about it. The primary academic uses included idea generation (70%), brainstorming (60%), assignment writing and editing (40%), research summarization (35%), and visual content creation (20%). About 15% used GAI for productivity enhancement. The perceived benefits were substantial: 65% cited improved work quality, 60% for creative ideas, 50% for time-saving, and 45% for simplifying complex tasks. Most students rated the benefit highly (7-10 on a scale of 1 to 10). Concerns included information accuracy (70%), ethical issues like plagiarism and bias (60%), over-reliance on technology (40%), and potential impacts on creativity (35%). Additionally, 75% of students expressed interest in receiving more training to better utilize GAI tools in their academic work. The post-survey data revealed a significant increase in GAI tool usage among students. The response rate remained consistent at 70% (60 students). Notably, the percentage of students using GAI tools rose from 85% to 93%, with a marked increase in frequency of use. Weekly usage jumped from 30% to 45%, while monthly usage increased from 25% to 32%. The proportion of students who never used GAI despite knowing about it decreased from 5% to just 2%. There was also a diversification in the types of GAI tools used, with more students reporting the use of specialised academic AI tools. The academic applications expanded, with a notable increase in using GAI for research analysis (from 35% to 50%) and collaborative projects (new category at 30%). These findings suggest a growing integration of GAI tools into students' academic routines and a broadening of their applications in various aspects of university work. The interview data, analysed through inductive thematic analysis, revealed several key themes regarding the use of generative AI in higher education. Most respondents demonstrated a limited understanding and usage of generative AI, with some having only engaged with basic tools like transcription software or virtual assistants, and others not using it at all. Despite this, there was recognition of its potential benefits, including enhancing accessibility for students with diverse backgrounds or learning

difficulties, streamlining research processes, and assisting in course preparation and content creation. However, concerns were raised about over-reliance on AI, which could deskill students, and about the accuracy and reliability of AI-generated information, along with the risk of academic misconduct and plagiarism. Respondents also emphasised the need for comprehensive training for staff, development of guidelines for responsible AI use in academic settings, and teaching students how to use AI tools effectively and ethically. Some lecturers had already begun adapting their teaching and assessment methods, modifying assignment formats to reduce AI misuse, implementing stepped assignments to track progress, and exploring creative alternatives to traditional assessments. Comfort levels with using generative AI varied, with some respondents hesitant and others actively incorporating it into their teaching and research.

5. Conclusion

This study has demonstrated the transformative potential of generative AI tools in enhancing university students' academic projects. The findings highlight that successful integration of AI requires a multi-faceted approach involving the development of critical thinking skills, responsible AI use, and collaborative learning environments. Students must be equipped to critically assess AI-generated content, recognise biases, and synthesise diverse sources to avoid over-reliance on AI outputs. Additionally, establishing clear guidelines and policies is essential to address issues related to plagiarism, academic integrity, and the ethical use of AI. Collaborative learning activities that incorporate AI can further promote teamwork, knowledge sharing, and problem-solving skills. The research also emphasises the importance of lecturer preparedness and institutional support in realising the benefits of AI in education. Comprehensive training for educators on AI's pedagogical applications and ethical considerations is crucial for guiding responsible use among students. Furthermore, investing in infrastructure, such as appropriate technology and professional development opportunities, supports the effective integration of AI into learning environments. Continued research is needed to understand the long-term impact of generative AI on student outcomes and to establish best practices. These insights contribute to the broader conversation on AI in education, informing future policies and ensuring that AI's potential is harnessed responsibly and effectively.

References

Bobula, M. (2024). Generative artificial intelligence (AI) in higher education: A comprehensive review of challenges, opportunities, and implications. *Journal of Learning Development in Higher Education, 30*. https://doi.org/10.47408/jldhe.vi30.1137

Braun, V., & Clarke, V. (2012). Thematic Analysis. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA Handbook of Research Methods in Psychology, Vol 2: Research Designs: Quantitative, Qualitative, Neuropsychological, and Biological* (pp. 57-71). American Psychological Association. https://doi.org/10.1037/13620-004

Donlon, E., & Tiernan, P. (2023). Chatbots and Citations: An Experiment in Academic Writing with Generative AI. *Irish Journal of Technology Enhanced Learning, 7*(2), 75-87. https://doi.org/10.22554/ijtel.v7i2.125

Gupta, A. (2024) Generative Artificial Intelligence and higher education: A double-edged sword, BERA. Retrieved November 12, 2024, from: https://www.bera.ac.uk/blog/generative-artificial-intelligence-and-higher-education-a-double-edged-sword

Luckin, R., Cukurova, M., Kent, C., & du Boulay, B. (2022). Empowering educators to be AI-ready. *Computers and Education: Artificial Intelligence, 3*, 100076. https://doi.org/10.1016/j.caeai.2022.100076

Luckin, R., & Holmes, W. (2016). *Intelligence unleashed: An argument for AI in education*. UCL Knowledge Lab. Retrieved November 12, 2024, from: https://www.researchgate.net/publication/299561597_Intelligence_Unleashed_An_argument_for_AI_in_Education

Tiernan, P., Costello, E., Donlon, E., Parysz, M., & Scriney, M. (2023). Information and Media Literacy in the Age of AI: Options for the Future. *Education Sciences, 13*(9), 906. https://doi.org/10.3390/educsci13090906

The Quality Assurance Agency for Higher Education. (2023). *Reconsidering assessment for the ChatGPT era: QAA advice on developing sustainable assessment strategies*. Retrieved December 2, 2024, from: https://www.qaa.ac.uk/docs/qaa/members/reconsidering-assessment-for-the-chat-gpt-era.pdf

Zawacki-Richter, O., Bai, J. Y. H., Lee, K., Marín, V. I., Bond, M., & Bedenlier, S. (2024). New advances in artificial intelligence applications in higher education? *International Journal of Educational Technology in Higher Education, 21*(1), 32. https://doi.org/10.1186/s41239-024-00464-3

CREATIVE THINKING: LEARNING FROM A NEW PERSPECTIVE

Rui Braz[1], & Ana Lúcia Luís[2]
[1]IPAM – Instituto Português de Administração de Marketing - Lisboa (Portugal)
[2]ISG –Business & Economics School (Portugal)

Abstract

Creative thinking is one of the most fundamental human skills. It is an essential requirement in a globalized and ever-changing world. The new technological era will present challenges that did not exist previously and require us to be focused on finding new answers through creative thinking and disruptive and innovative lines of thought. Creative thinking is a mental process that involves generating new and original ideas, concepts, and solutions. It is the ability to see beyond the obvious and explore innovative possibilities. It spans all areas of life, from solving everyday problems to pushing science and technology forward. The selection of creativity as one of the skills assessed in PISA 2022 is significant. It indicates that creative thinking is of growing importance and value in the education of young people. The motivation for this paper emerged with the results of PISA 2022, where Portugal was among the 12 countries above the OECD average in creative thinking. This work aims to analyze and reflect on the importance of this performance. The necessary debate is not so much about the importance of creativity but how education can adapt to new forms of learning to stimulate students with creative skills. By comparing the results of various countries and analyzing current Portuguese educational policies, we concluded that, despite the encouraging results for Portugal, there is still a lot to be done to enhance creative thinking in the school context. From teacher training to curriculum changes, new approaches are required.

Keywords: *Creative thinking, education, PISA, skills.*

1. Introduction

PISA 2022 (Programme for International Student Assessment) evaluated creative thinking for the first time, recognizing it as a vital competence necessary for young individuals and adults to navigate and adjust to the complexities of contemporary society and the labor market of the 21st century. Since 2012, PISA has focused on assessing key competencies relevant to this century, alongside the traditional three core subjects: Mathematics, Reading, and Science. In 2012, it included problem-solving, followed by collaborative problem-solving in 2015, global competencies in 2018, and now, in the 2022 assessment, it has examined the creative thinking abilities of 15-year-olds across 64 countries and economies worldwide.

Creativity can manifest in numerous ways, but the literature usually distinguishes between *big-C* and *little-C* (Csikszentmihalyi, 2013, Simonton, 2013). The little-c type of creativity represents the ability to solve small everyday problems that result from our capacity for change. On the other hand, big-c creativity is something quite different and rarer, which occurs when someone creates something that has a significant impact on people's lives. The PISA 2022 framework defines creative thinking as the ability to actively participate in generating, assessing, and refining ideas, which can lead to innovative and effective solutions, the creation of new knowledge, and significant expressions of creativity (OECD, 2024). This interpretation of creative thinking corresponds to the concept of *little-C*, which reflects the capabilities of 15-year-old students about everyday contexts, distinguishing it from creative thinking specific to particular fields, such as the arts.

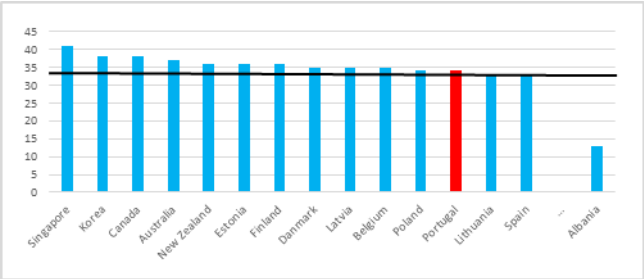
2. Key results for Portugal

Portuguese students' results were above the OECD average (33 points), achieving a performance of 34 points on a scale of 0 to 60 points. In the total sample of 64 countries, the highest score belongs to

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

Singapore with 41 points, a significantly higher score than all the others, and the lowest to Albania, with just 13 points (Figure 1).

Figure 1. Performance in Creative Thinking.



Three large groups of countries can be observed: 12 countries with a statistically significant score above the OECD average, including Portugal, 8 countries whose score is not statistically different from the average, and 44 countries that are statistically below average. The 12 countries performing above the OECD average are, in descending order: Singapore, Korea, Canada, Australia, New Zealand, Estonia, Finland, Denmark, Latvia, Belgium, Poland, and Portugal.

It was expected that countries with the best results in the core subjects (OECD, 2023a) would also have better results in creative thinking. Portugal was the exception, showing a lower correlation between core subjects and creative thinking than the average for OECD countries (Table 1). Of the 12 countries that perform significantly above the OECD average in creative thinking, Portugal is the only country not above the OECD average in any of the other core domains assessed.

Table 1. Correlation in performance among creative thinking, mathematics, reading and science OECD average.

Correlation between:			
Mathematics	Reading	Science	**…and…**
0.67	0.66	0.66	Creative thinking
	0.80	0.87	Mathematics
		0.80	Reading

Source: OECD (2024).

According to the PISA report, 83 percent of Portuguese students reach the basic level of creative thinking (78 percent in the OECD) and 29 percent reach a high level of proficiency (27 percent in the OECD), demonstrating the ability to create, evaluate and improve original and diverse ideas for a range of different tasks set in more complex and abstract contexts. Nine out of ten Portuguese students believe that it is possible to be creative in any field and that creative thinking is not exclusive to the arts. In OECD countries, on average, this number is around seven out of ten students. A high percentage of Portuguese students have a very positive attitude towards teaching practices in the classroom: 71 percent believe that teachers give them enough time to develop creative solutions to tasks, 76 percent that they encourage them to give original answers, and 80 percent that they value the creativity shown in the classroom.

The differences in gender and socio-economic status follow the pattern of the OECD averages (OECD, 2023b). Girls always perform better than boys in creative thinking (2 points higher in Portugal and 3 in the OECD) and students from favored socio-economic backgrounds perform better than students from disadvantaged backgrounds (a difference of 9 points in Portugal and 9.5 in the OECD). As in the core domains, Mathematics, Reading and Science, socio-economic status is always a strong indicator of performance in creative thinking.

Despite their good performance, Portuguese students show much lower participation in creative activities at school when compared to the OECD average. Less than 15 percent of students participate at least once in art classes, creative writing or debate clubs. Only 10% of students participate at least once a month in theatre clubs, music-related activities, science clubs, school newspapers, etc. Despite the low level of participation in creative activities at school, creative thinking is one of the transversal competencies included in the *Students´ Profile by the End of Compulsory Schooling* (Martins et al., 2017). This document seeks to establish a unified framework for all schools and educational programs in Portugal, within the realm of compulsory education, particularly concerning curriculum development, planning, execution, and both internal and external evaluations of teaching and learning processes. The mention of a profile is not intended to promote uniformity; instead, it serves as a reference point.

3. Public policy for education

In Portugal, educational policies to encourage creativity are practically non-existent. Two major shortcomings have been identified. Firstly, there is limited space for creative teaching in the curriculum. This can be fostered by taking advantage of opportunities arising from the formative work promoted in existing subjects such as Maths, Philosophy, Biology, Literature, etc. There is no benefit in adding new subjects to existing ones, so as not to further overload already heavy school time schedules. Secondly, to bring creativity into the classroom, teachers need specific training. With the right training, they may be able to change their classroom strategy to include humor, games, teamwork, creative reading, etc. systematically. By teaching more literature or more mathematics in a prescriptive and repetitive way, reducing free time and reinforcing the content of young people's workload, we are not better preparing young people for the skills required in the 21st century. With the rise of artificial intelligence (AI), any machine can carry out these tasks quickly and easily, relieving students of the time-consuming tasks associated with repetition and routines. AI is programmed to process data, find patterns, and optimize results according to algorithms and logic but lacks creativity, which is an intrinsically human characteristic. Creativity is a complex process, involving the ability to achieve divergent thinking, and originality. It involves breaking patterns in thinking and taking risks. This is why encouraging creativity in a school context gives us a glimpse of what the future will be like in this third millennium. The existing school education policy in Portugal overestimates school rankings and the final results of the so-called noble subjects obtained in national exams, which are by definition uniform and standardized. When certificated assessment becomes the objective by which training work in schools is defined, creativity is excluded.

4. Conclusions

In Portugal, creative thinking is not explicitly included in the curriculum or teacher training, even though it is an area of competence in the Students´ Profile by the End of Compulsory Schooling. Public education policies in Portugal need to change to promote the development of creativity in the school environment. Despite the encouraging results in the context of creative thinking, there is still a long way to go. Learning from a new perspective will be imperative to navigate the complexities of the 21st century.

The selection of creativity as one of the skills assessed in PISA 2022 is significant. It indicates that creative thinking is of growing importance and value in the education of young people. Creativity is expected to be among the most valued skills by employers and is projected to experience a notable rise in demand in the upcoming five years (Di Battista, 2023). A new paradigm is therefore needed in which education adapts to new forms of learning. AI lacks the human emotions necessary for creativity. To program AI, capable of freeing us from routine and standardized tasks, and leaving room to use time in a more creative and meaningful way, human creativity is essential.

References

Csikszentmihalyi, M. (2013). *Flow: The psychology of happiness*. Random House.

Di Battista, A, Grayling, S, Hasselaar, E, Leopold, T, Li, R, Rayner, M & Zahidi, S. (2023). *Future of Jobs Report*. World Economic Forum, Geneva. https://www.weforum.org/publications/the-future-of-jobs-report-2023/

Martins, G., Gomes, C., Brocardo, J., Pedroso, J., Carillo, J., Silva, L., Encarnação, M., Horta, M., Calçada, M., Nery, R., & Rodrigues, S. (2017). *Students´ Profile by the End of Compulsory Schooling*. Ministério da Educação – DGE. https://www.dge.mec.pt/perfil-dos-alunos

OECD (2023a), *PISA 2022 Results (Volume I): The State of Learning and Equity in Education*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/53f23881-en

OECD (2023b). New PISA results on Creative Thinking: can students think outside the box? *PISA in Focus*, 125.

OECD (2024), *PISA 2022 Results (Volume III): Creative Minds, Creative Schools*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/765ee8c2-en

Simonton, D. K. (2013). What is a creative idea? Little-c versus Big-C creativity. In *Handbook of research on creativity* (pp. 69-83). Edward Elgar Publishing.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

INNOVATIVE TUTOR TRAINING: THE DEVELOPMENT OF A GAMIFIED DIGITAL ESCAPE ROOM FOR ENHANCING TEACHING COMPETENCIES

Michelle Pippig, & Sabrina Hänsel
Center for Open Digital Innovation and Participation, Dresden University of Technology (Germany)

Abstract

This paper presents the ongoing development process of an innovative digital escape room for student tutors at the Dresden University of Technology, which aims to enhance teaching skills and streamline seminar preparation through immersive, game-based learning. Traditional training methods are often inflexible, time-consuming and offer limited opportunities for tutors to develop relevant competences. They also have limitations in meeting the needs of modern education systems. By further developing existing qualification formats into a digital escape room format, game-based learning technologies will be integrated to create an immersive and customisable learning experience that encourages critical thinking and collaboration by simulating university learn-teach scenarios. The interactive and hands-on learning environment provides a flexible, secure platform where student tutors can test teaching strategies and build knowledge through active problem solving. The approach combines digital education with problem-based and collaborative methods and contributes to the digital transformation of higher education. Future evaluations will assess the escape room's effectiveness compared to traditional formats, aiming to refine the approach and set new standards for tutor training at the Dresden University of Technology.

Keywords: *Digital-simulation-learning, game-based learning, student tutor training, higher education didactics.*

1. Introduction

The digital transformation process poses challenges for universities, but also offers opportunities for the innovative design of teaching and learning processes. As part of the university innovation strategy, Saxon universities are also increasingly focusing on the implementation of digital teaching methods in order to sustainably improve the teaching and learning culture and to promote knowledge and technology transfer (SMWK, 2024), with the use of game-based learning in particular proving to be an effective approach to increasing learning motivation and problem-solving skills (Pais et al., 2023). In addition to subject knowledge, such methods also promote cross-curricular skills such as solution-oriented thinking, creativity, use of digital tools and virtual communication. Tutors as student teachers play a central role in this changing landscape. At the Dresden University of Technology (TUD), around 600 student tutors lead tutorials, exercises or internships each semester, which corresponds to around 40 per cent of the teaching staff (TUD, 2022). They are of central importance, especially in the critical introductory phase of studies, as they provide orientation, ensure continuity and guarantee the quality of teaching (Netzwerk Tutorienarbeit, 2018; Zitzelsberger, 2015). However, traditional methods of tutor training are often time-consuming and do not adequately prepare for hybrid teaching environments, technical challenges or the diverse needs of students. This article presents the ongoing development of a digital escape room for student tutor training. It provides an overview of previous training formats, highlights theoretical and methodological principles, and looks forward to the technological innovations used.

2. From traditional methods to digital solutions: Challenges and needs in tutor training

Student tutors face a number of challenges in preparing and delivering their tutorials, including room organisation, implementing inclusive and accessible teaching methods, and the routine use of technical equipment. In addition, the heavy student workload makes it difficult for student tutors to acquire new skills and knowledge through further trainings. Traditional training methods, with their limited flexibility and interactivity, fall short in addressing these challenges. To bridge this gap, innovative solutions like a digital escape room offer a promising way to provide flexible, realistic, and engaging learning environments for modern student tutor training. An innovative approach to meeting these

challenges is the development of a digital escape room that provides a motivating and interactive learning environment through game-based learning. This escape room is based on the *Room of Horrors* training programme from medical simulation training, which uses an interactive training environment to make participants aware of the sources of error and risks in this environment (Zimmermann & Schwappach, 2019). This concept was adapted for the training of student tutors at TUD to simulate typical challenges of hybrid teaching-learning scenarios.

In order to gain insights into the challenges and professional development needs of tutors, a survey was conducted at TUD in June 2024 (TUD, in print). The results showed that 68% of the respondents expressed a need for further training, especially for key qualifications such as moderation, dealing with difficulties, course organisation, didactic design and personal development/soft skills. Given the dual role of tutors as both students and teachers, flexible training formats are preferred. Responding to the demand for flexible learning formats, the original "Room of Horrors" was reimagined as a mobile-friendly, interactive 360-degree environment. This immersive technology enables asynchronous participation and allows tutors to identify sources of error in a simulated classroom, such as locked laptops, misplaced cables or documents containing sensitive data. While the 360-degree application reduces the effort required for classroom training and increases accessibility, it does not offer direct collaboration with other participants and only limited simulation of error detection.

To bridge this gap, a digital escape room is being developed as a playful and adaptive learning format. Combining problem-based and collaborative learning (Deterding et al., 2011; Gee, 2003), it fosters teamwork, critical thinking, and practical problem solving through engaging puzzles embedded in a virtual narrative. Multimodal tasks – integrating text, audio and video – increase accessibility for different learning styles (Mayer, 2001) and create immersive flow experiences (Csikszentmihalyi, 1990). In addition, visual anonymity encourages creative and unconventional behaviour and reduces fear of judgement (Zimbardo, 1969; Joinson, 2001). Together, these elements create a motivating, flexible training environment tailored to the needs of modern student tutors.

3. Design, development and technological implementation of the digital escape room

The digital escape room is being developed to improve the flexibility and accessibility of student tutor training. By integrating playful and interactive elements, it aims to motivate tutors to pursue voluntary qualifications. Embedded in a fictional storyline, players solve practical tasks within a given timeframe, such as room and material preparation, technical equipment and increasing inclusion and accessibility. The interactive and narrative structure makes the learning process practical and motivating. There are also plans to integrate a chatbot that will act as an additional character in the game, providing a personalized and collaborative learning experience with real-time feedback. In order to reach an international audience, multilingual options will also be implemented. Extensive usability tests, including "*thinking aloud*" methods, are conducted iteratively to refine the user experience and identify potential design improvements.

Several factors are crucial for evaluating the usability of virtual games in educational contexts, particularly when aiming to foster engagement and learning outcomes. One key consideration is the design of an intuitive user interface, which allows users to navigate and interact with the environment seamlessly, enabling them to focus on the educational content without unnecessary distractions. Additionally, balancing cognitive load is vital; tasks should be challenging enough to stimulate learning without overwhelming the user, supporting an optimal learning process. Immersion plays a significant role in maintaining user motivation, as the extent to which learners feel immersed in virtual environments enhances their engagement and overall experience. Kavanagh et al. (2017) highlight that well-designed virtual learning environments can effectively combine these elements, creating an engaging and interactive space for learners. Technical stability is essential to ensure a smooth user experience and avoid frustration, while accessibility considerations accommodate diverse learners, including those with disabilities. By integrating these principles, the digital escape room creates a robust, inclusive learning environment tailored to the needs of modern student tutors. Combining technical innovations, practice-oriented design, and thorough usability tests, it serves as a motivating tool that supports tutor qualification and fosters interdisciplinary skills, collaboration, and creativity in an inclusive educational context.

4. Conclusion and outlook

The ongoing development of the digital escape room is specifically aimed at addressing existing gaps in tutor training, such as the need for greater accessibility, flexible learning opportunities and the development of interpersonal and technical skills. A detailed concept for the escape room has been developed, including learning objectives, narrative structures and task designs that are tailored to real-life

teaching scenarios. The escape room is intended to provide an initial qualification for the preparation of accessible seminar rooms to enable teachers to effectively support inclusive teaching environments.

The current focus is on developing a prototype and conducting beta testing with a small group of tutors. Feedback will help refine the platform's features and ensure an optimal user experience. Future iterations will focus on integrating advanced AI features, such as real-time adaptive feedback and dynamic problem-solving scenarios, to further enhance the escape room's interactivity and pedagogical value. In addition, scalability remains a key objective in order to adapt the escape room for wider use in higher education institutions.

The digital escape room combines gamification elements and mobile learning technologies to create a flexible and effective solution for tutor training, offering great potential for preparing tutors for the demands of modern higher education and digital change.

References

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. Harper & Row.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining "gamification". In *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments* (pp. 9–15). https://doi.org/10.1145/2181037.2181040 (28.09.2024).

Gee, J. P. (2003). *What Video Games Have to Teach Us About Learning and Literacy*. Palgrave Macmillan. https://doi.org/10.1145/950566.950595 (28.09.2024)

Johnson, D. W., & Johnson, R. T. (1999). *Learning together and alone: Cooperative, competitive, and individualistic learning*. Allyn and Bacon.

Joinson, A. N. (2001). Self-disclosure in computer-mediated communication: The role of self-awareness and visual anonymity. *European Journal of Social Psychology, 31*(2), 177-192. https://doi.org/10.1002/ejsp.36 (26.09.2024).

Kavanagh, S., Luxton-Reilly, A., Wuensche, B., & Plimmer, B. (2017). A systematic review of Virtual Reality in education. *Themes in Science and Technology Education, 10*(2), 85-119. https://files.eric.ed.gov/fulltext/EJ1165633.pdf (10.01.2025).

Mayer, R. E. (2001). *Multimedia learning*. Cambridge University Press. Online: https://doi.org/10.1017/CBO9780511811678 (25.09.2024).

Netzwerk Tutorienarbeit an Hochschulen, 2018. *Zukunft der Tutorienarbeit an Hochschulen*. Positionspapier.

Pais, S., Sousa, A. E., & Pires, A. (2023). Using an escape room activity to enhance the motivation of undergraduate life science students in mathematics classes - A case study. *17th European Conference on Game-Based Learning (ECGBL)*. https://doi.org/10.34190/ecgbl.17.1.1431 (18.07.2024).

Savery, J. R., & Duffy, T. M. (1995). Problem-based learning: An instructional model and its constructivist framework. *Educational Technology, 35*(5), 31-38.

Sächsisches Staatsministerium für Wissenschaft, Kultur und Tourismus – SMWK (2024). *Hochschulinnovationsstrategie zur Förderung des Technologietransfers in Sachsen*. https://www.studieren.sachsen.de/download/BroschuereHIS.pdf (10.01.2025).

Technische Universität Dresden. (2022). *Statistischer Jahresbericht 2022. Zentrale Universitätsverwaltung (Hrsg.)*. https://tu-dresden.de/tu-dresden/profil/ressourcen/dateien/statjb/StatJB2022.pdf?lang=de (10.01.2025).

Technische Universität Dresden. (in print). *TUTORING@TUD 2024: Herausforderungen und Chancen in Arbeits- und Weiterbildungsstrukturen für studentische Lehrende*.

Zimbardo, P. G. (1969). The human choice: Individuation, reason, and order versus deindividuation, impulse, and chaos. In W. J. Arnold & D. Levine (Eds.), *Nebraska symposium on motivation* (Vol. 17, pp. 237-307). University of Nebraska Press. https://stacks.stanford.edu/file/gk002bt7757/gk002bt7757.pdf (09.01.2025)

Zimmermann, C. & Schwappach D. (2019). *Interaktives Lernen im Room of Horrors. Manual für Spitäler*. Stiftung für Patientensicherheit Schweiz. Zürich. https://patientensicherheit.ch/wp/wp-content/uploads/2023/03/Room_of_Horrors_Manual_Spit_ler_D_V2.pdf (10.01.2025)

Zitzelsberger, Olga (Hrsg.), 2015. *Neue Wege in der tutoriellen Lehre in der Studieneingangsphase. Dokumentation der gleichnamigen Tagung im März 2014 an der TU Darmstadt*. Schriften zur allgemeinen Hochschuldidaktik, Münster, Germany, WTM.

ENHANCING CROSS-CULTURAL IN ENGLISH LANGUAGE TEACHING: DIGITAL INNOVATIONS AND ITS REACTION ON COMMUNICATION SYSTEMS AND CULTURAL LEARNING

Sugandika Sewwandi Alles*
Institute of foreign languages, Peoples' friendship university of Moscow (Russia)

Abstract

As globalization advances, English has emerged as the global lingua franca. This research explores the way digital innovations and modern learning tools have impacted and transformed English language teaching into a cross-cultural learning platform beyond linguistic capability enhancement. The research concepts are built upon several theoretical frameworks; sociocultural theory, TPACK, and SAMR. The research findings are anticipated to provide insights on the role of technology and English language in enhancing cross-cultural interactions.

Keywords: *Globalization, English, digital tools, cross-cultural interactions.*

1. Introduction

As technologies advances, the world is becoming more and more a smaller interconnected unit with diminishing boundaries. English language serves as a lingua franca that facilitates operations of such interconnected world across diversities. As of 2023, an estimated 1.5 billion people worldwide speak English either as the native or second language. This accounted for 18% of the global population (Statista, 2024). As English has attained this new role as the language that interconnects world, its form, shape, and language rules have also changed with contributions coming from various cultures and communities worldwide.

With the rapid globalization, the role of English educators has shifted beyond teaching linguistic skills to a more sophisticated sociocultural and global communication competency development. The teaching of English language plays a pivotal role in fostering cross-cultural communication (Ilahude, Inawati, & Pratolo, 2023). The advancement of technology is an important element that supports English educators to embrace this new role with more ease and competence. For example, innovations such as virtual reality (VR), augmented reality (AR), and artificial intelligence (AI) have enhanced both the teaching and learning processes. These digital tools not only support educators to enhance linguistic skills in learners but also to enhance their cultural competencies by creating an immersive and personalized learning environment that bridges cultural divides.

Some advantages associated with these modern learning tools are their ability to create a real-life social environment within the digital world, helping learners to use their inherent communication skills in navigating these tech-created contexts, and the ability to tailor and personalize learning experiences according to the learner's background. Despite these benefits, there are some disadvantages of these modern learning tools. Some of these disadvantages are hindering the development of critical thinking skills with extreme dependence on technology, the impact of unequal access to technology, and the creation of digital divide within society.

2. Objectives

The current study aims to understand the impact of digital innovations on the enhancement of cross-cultural communication competencies of learners while teaching the language. It explores the way English language education redefined by modern tools such as VR, AR, and AI. The specific objectives under this aim are as follows.

- To examine the role of VR, AR, AI and similar interactive platforms in learning engagement and motivation within English language teaching.

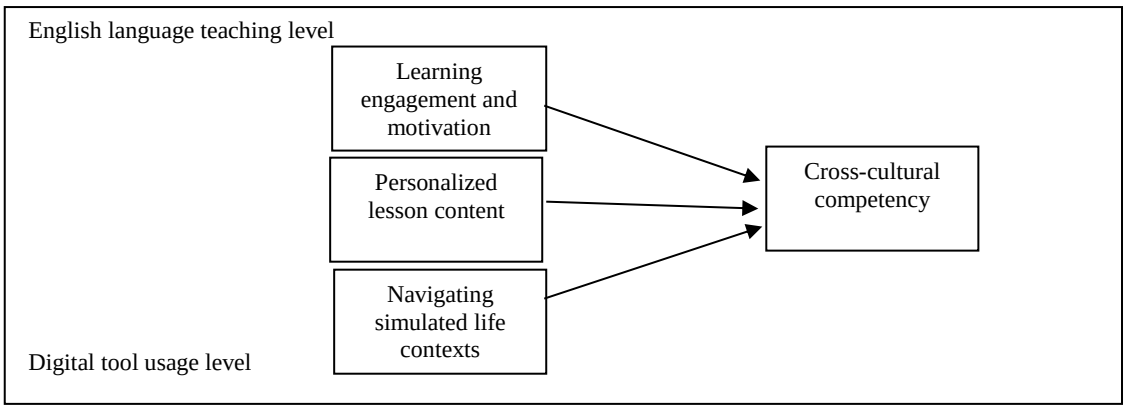
* PhD in theory and methodology of teaching and upbringing (by fields and levels of education).
ORCID ID: https://orcid.org/0000-0003-0806-4298 / sewwandialles@gmail.com

- To assess the influence of VR, AR, AI and similar interactive platforms on developing personalized lesson content within English language teaching.
- To assess the influence of VR, AR, AI and similar interactive platforms on offering opportunities to navigate simulated life contexts.
- To examine the influence of VR, AR, AI and similar interactive platforms on enhancing the cross-cultural competency within English language teaching.

3. Conceptual framework

The conceptual framework of the research is built upon two theoretical models: sociocultural theory of learning and technological, pedagogical, content knowledge (TPACK) model. Sociocultural theory emphasizes that learning is a social process stimulated by interactions, dialogue, and cultural factors (Poehner & Lu, 2023). TPACK describes the importance of aligning technology with lesson content and teaching strategies for an effective learning outcome (Poehner & Lu, 2023). The Common European Framework of Reference for Languages (CEFR) will be used in assessing the language teaching level and approach while substitution, augmentation, modification, and redefinition (SAMR) will be used in understanding digital tool usage.

Figure 1. Conceptual framework of the research.



4. Methods

4.1. Research onion framework

Research design describes the fundamentals associated with the research build up. One of the common frameworks associated with building the research design is research onion model. It includes six different layers; research philosophy, research approach, research strategy, choice of method, time horizon, and data collection and analysis techniques (Saunders, Lewis & Thornhill, 2019). Research philosophy describes the underlying philosophy of research about truth. Current research adopts a positive research philosophy, which believes the truth is objective. It describes the underlying philosophy of the research about truth. The approach of this research is deductive as it uses existing theories in understanding the research context. Research strategy discusses the overall implementation plan of the research. There are several types of research strategies. Some of them are surveys, case studies, experiments, ethnographic studies, action reviews, and systematic reviews. The current research adopts a survey-based approach. The common methodological choices are qualitative, quantitative, and mixed methods. Quantitative method uses numerical data while qualitative methods use all types of non-numerical data. Mixed method uses a combination of both these approaches. This research adopts a quantitative approach. Research can be conducted at a single point of time or across several time points. The ones conducted in a single time point are called cross-sectional research and those that involve several time points are called longitudinal research. This research adopts a cross-sectional approach.

4.2. Study population

The study population consists of English language educators worldwide. They play a critical role in shaping the linguistic and cross-cultural competencies of learners. However, this population is broad and scattered globally. Therefore, the population was characterized by several features, for the purpose of this study. Table 1 elaborates these characteristics.

Table 1. Characteristics of the study population.

Characteristic	Description
1. Professional background	Educators need to attain accepted certification to teach English as a second language (ESL) or English as a foreign language (EFL)
2. Technological experience	Educators need to be exposed to the integration of digital tools into their teaching process for a minimum of one year or more. They have familiarity with using at least one or more tools out of AI, AR, VR, and similar interactive platforms.
3. Geographic and cultural diversity	Educators from multiple regions provide a broad spectrum of insights about the integration of digital tools and cultural contexts in teaching English language. Therefore, no regional differentiations were made in determining the study population.
4. Teaching levels	Educators teach English language to students at various competency levels ranging from beginner, intermediate, to competent. At the beginner and intermediate levels more focus is given on language rules and technicalities rather than emphasizing the cross-cultural contexts. The individuals at competent level focus more on cultural context compared to the other two levels. Therefore, the study population involved English language educators who are teaching the language at competent level.

In addition to the characteristics elaborated in Table 1, the educators included in the study population must currently teach English language. They also need to work with learners from diverse cultural and linguistic backgrounds to ensure that they are familiar with the cross-cultural communication competencies. Educators teaching subjects other than English or those who are not using any type of modern digital tools are excluded from the population.

4.3. Sampling framework

The study population size is difficult to estimate. Therefore, a random sample size of 150 educators was selected as the sample size. Previous research has justified that a 150-sample size is sufficient in educational research to achieve a balance between statistical validity and feasibility [Besekar, Jogdand & Naqvi, 2024). Since no official sampling framework is available, a non-probability sampling approach, specifically convenience sampling is adopted. Social media platforms and prominent public/private/online teaching institutes will be used to identify suitable educators to be included in the sample.

4.4. Data collection and analysis

A questionnaire is developed as a data collection instrument which addresses both quantitative and qualitative insights on English language teaching, digital tools, and cross-cultural communication. The questionnaire will be divided into seven main sections; demographic description of the respondent, English language teaching approach, digital tools used, learning engagement and motivation, personalized lesson content, navigating simulated life contexts, and cross-cultural competency. This will be shared with the sample in the form of a Google questionnaire survey.

The data analysis process will start with a descriptive evaluation of the respondents' demographic details. Then it will assess different types of English language teaching and the extent to which digital tools are used in the process. Several Likert scales will be used to assess the relationship between variables illustrated in Figure 1. This relationship would be assessed under different levels of English language teaching and digital tool usage. A MANOVA is used for the analysis purpose.

References

Besekar, S., Jogdand, S., & Naqvi, W. (2024). *Exploring Sample Size Determination in Educational Research: A Comprehensive Review*. F1000Research. DOI: 10.12688/f1000research.141173.3

Ilahude, F. F., Inawati, I., & Pratolo, B. W. (2023). Teachers' TPACK development in English language teaching: a systematic review. *Premise Journal of English Education, 12*(3), pp. 935-956. doi: 10.24127/pj.v12i3.7429

Poehner, M. E., & Lu, X. (2023). Sociocultural Theory and Corpus-Based English Language Teaching. *Tesol Quarterly, 58*(3), pp. 1256-1263. https://doi.org/10.1002/tesq.3282, 2023.

Saunders, M., Lewis, P., & Thornhill, A. (2019). *Research Methods for Business Students* (8th ed.). New York: Pearson.

Statista. (2024, July 4). *The most spoken languages worldwide in 2023* [Online]. Retrieved from: https://www.statista.com/statistics/266808/the-most-spoken-languages-worldwide/

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

DEVELOPING A PHYSICAL THERAPY PROGRAM WITH EMPHASIS ON INCREASING ACCESSIBILITY FOR RURAL AND UNDERSERVED COMMUNITIES

Peggy R. Trueblood, & Jennifer Fleckenstein
School of Physical Therapy, Pacific Northwest University of Health Sciences (USA)

Abstract

The lack of physical therapists (PTs) in rural areas is a significant concern facing the profession and the public. As rural populations experience higher rates of chronic disease, physical limitations, and injury, the need for physical therapy (PT) services has become critical. Although there is an expansion of Doctor of Physical Therapy (DPT) programs across the nation, few are focused on enhancing the supply of PTs in rural and underserved areas, where they are needed most. This has led to regional disparities with urban regions experiencing oversupply while rural areas continue to suffer from a shortage of PTs and other healthcare professionals. Most DPT programs focus on urban settings, making clinicians less prepared to practice in rural areas. The purpose of this paper is to describe the critical components of a DPT program developed at Pacific Northwest University of Health Sciences (PNWU) that intentionally focuses on educating future PTs to work in rural and underserved communities throughout the Northwest using a recruit-educate-return model. PNWU's founding belief was that students selected with an interest in rural and underserved care are likely to stay in the area where they are educated once they reach independent professional status. Students complete one of three full-time clinicals in a rural or medically underserved area. PT clinics located at two different federally qualified healthcare centers were also established for hands-on exposure. In addition, students participate in a community-based student-run pro-bono clinic established on campus to provide needed services for under or uninsured clients with neurological impairments.

Keywords: *Rural, medically underserved, doctor of physical therapy (DPT) programs.*

1. Introduction

Physical therapists (PTs) play a critical role in fall and injury prevention, management of injury and disease, and rehabilitation. People living in rural and medically underserved areas (MUAs) experience disproportionately poor health outcomes, including higher rates of chronic conditions, disability, obesity, musculoskeletal disorders, and fall rates (Rural Health Information Hub [RHIH], 2024; Tuttle, 2020; Weeks, 2023). Access to healthcare services, including physical therapy is limited by access to safe and affordable transportation, socioeconomic disparities, and workforce shortages (Graves, 2022). According to the Health Resources and Services Administration (HRSA, 2024), MUAs often lack sufficient primary and specialized care providers, with a provider-to-population ratio far below recommended levels (HRSA, 2024).

Therefore, the development of a Doctor of Physical Therapy (DPT) program to prepare students to work in rural and medically underserved communities was established at Pacific Northwest University of Health Sciences (PNWU) in Yakima County (a HRSA designated rural MUA). The mission at PNWU is to "train health care professionals emphasizing service among rural and medically underserved communities throughout the Northwest." PNWU was established to address a shortage of primary care providers (Bellamy, 2011) through a Doctor of Osteopathic Medicine program. People who live in rural areas and MUAs are thought to be more likely to return to those areas once they graduate. PNWU, therefore utilizes a recruit, educate, and return model to address shortages in these areas.

Three key challenges facing rural communities and physical therapy need, according to Felter (2022), are 1) the ability to recruit and retain rural physical therapy staff, 2) insufficient didactic education addressing cultural humility and cultural awareness, and 3) overlooking the rural practice challenges in contemporary PT education programs.

PNWU's DPT program seeks to address these challenges by recruiting students from rural and underserved backgrounds, educating them with a curriculum focused on cultural humility, social determinants of health, and rural health challenges as well as supporting their education to return to serve these communities upon graduation.

2. Key components of PNWU's DPT program

2.1. Curriculum development

The DPT program is a three-year (8 semester), 112 credit hour, year-round program admitting up to 50 students every fall semester. Didactic coursework in the School of Physical Therapy (SOPT) seeks to teach students about the social determinants of health and health disparities. Students engage in implicit bias training, principles and importance of therapeutic alliance, motivational interviewing, ethics of physical therapy access, advocacy, cultural humility, trauma-informed care, rural health considerations, telehealth, and the role of nutrition and reality of food insecurity.

Telehealth is one solution to improve access of physical therapy services to people in rural communities. The DPT students learn to do virtual assessments, online patient education, and create remote rehabilitation programs. Another key element unique to PNWU, is an emphasis on interdisciplinary training. PNWU created an interprofessional practice and education consortium called Northwest Interprofessional Health Collaborative (NIHC) partnering with nearby institutions. Physical therapy students engage in interprofessional healthcare education sessions with other health professions students including occupational therapy, osteopathic medicine, physician assistant, nursing, pharmacy, and dietetics. These sessions include error disclosure, learning about roles and responsibilities of the interprofessional team, and engaging in opioid reduction strategies.

Additionally, in clinical courses students role model how to talk to patients about pain, imaging and test results, the importance of physical activity, and educate on the role of nutrition and wellness to populations of socioeconomic and culturally diverse populations. Movement Science and clinical courses thread justice, diversity, equity, and inclusion including activities in which students role play, interact with community members, and access educational opportunities through standardized patients in the PNWU Simulation Center.

2.2. Rural-focused clinical education

The clinical education component of the DPT program emphasizes students working in rural and underserved settings. During 3 of the 8 semesters, students are off campus enrolled in full-time clinical experiences throughout the region. Students are required to complete at least one rural/MUA full-time clinic within three years. Developing these partnerships is critical in providing the type of patients and sites for students. In addition, all students participate in our rural integrated clinical experience that was developed at a local homeless shelter with a free medical clinic including physical therapy services. In addition, the program developed a physical therapy clinic at a federally qualified health center, where students provide physical therapy to a unique population that represents our mission of serving underserved patients. These rural clinics are specifically designed to expose students to the unique challenges of rural healthcare practice. They were intentionally structured to help students develop skills in managing diverse caseloads, working with limited resources, and providing care in geographically isolated areas.

Just as important to developing rural sites for students that provide services to the medically underserved populations is hiring faculty with experience working in rural and underserved areas. They serve as mentors and role models, demonstrating how to navigate the complexities of rural healthcare practice. Furthermore, these faculty members are valuable in developing curriculum and training materials that reflect the realities of rural practice.

2.3. Community service emphasis

Incorporating community engagement into the program can help students better understand the social determinants of health that affect rural populations. Examples of community engagement include community health fairs and outreach. These events provide free screenings, education, and preventive services to rural populations. Incorporated into the curriculum is a community wellness project, whereby students work in groups to design and implement a community-based wellness/prevention program that explores health and wellness across the lifespan in various community agencies in the Yakima Valley.

2.4. Student recruitment and support

To support students and create a sense of belonging, it is important to know who is in your program (Magee, 2024). As part of recruitment, we target applicants from rural and medically underserved communities in our region. Our students come from socioeconomically, culturally, ethnically, and gender diverse backgrounds. For many of our students, English is not their first language and for others, they have grown up speaking another language in their household. With an understanding of the individuals in each of the student cohorts we can better ensure inclusivity and equity for the layers of diversity and meet the needs of our students. PNWU offers a food pantry to address students experiencing food insecurity. The SOPT organizes a Big doc/Little doc program to provide mentoring from second-year students to first-year students. Orientation integrates students from multiple program years, faculty, and university resources to provide support and integration from day one. Workshops on learning, life skills, and how to be a graduate student serve to support students in their journey to becoming a PT. Our program is continuing to explore and make progress in offering recitation opportunities for challenging courses, closed captioning and universal design to ensure access for students of all different learning styles, and provide equity with accommodations according to the American Disabilities Act.

3. Conclusion

Starting a DPT program with an emphasis on rural and underserved practice is an innovative approach to addressing the healthcare disparities faced by these communities. By designing a curriculum that emphasizes rural health issues, creating clinical placements in underserved areas, building strong community partnerships, and offering support systems for graduates, DPT programs can play a key role in expanding access to physical therapy services in rural and underserved regions.

References

Bellamy, G. R., Bolin, J. N., & Gamm, L. D. (2011). Rural Healthy People 2010, 2020, and beyond: the need goes on. *Fam Community Health, 34*(2), 182-188.

Felter, C. E., Zalewski, K., Jermann, R., Palmer, P., Baier, A., & Falvey, J. (2022). Rural Health: The Dirt Road Less Traveled. *Physical Therapy*, *102*(11). https://doi.org/10.1093/ptj/pzac112

Graves, J. M., Abshire, D. A., & Alejandro, A. G. (2022). System- and Individual-Level Barriers to Accessing Medical Care Services Across the Rural-Urban Spectrum, Washington State. *Health Services Insights, 15*. doi:10.1177/11786329221104667

Health Resources and Services Administration. (2024). *Health Workforce Shortage Areas*. Retrieved January 25, 2025, from: https://data.hrsa.gov/topics/health-workforce/shortage-areas

Magee, J., Brown, D., Woods, L., & Portee, C. (2024). A Roadmap to Cultivating a Culture of Belonging for Learners in Physical Therapy Education. *Journal of Physical Therapy Education, 38*(2). doi: 10.1097/JTE.0000000000000354

Rural Health Information Hub. (2024). *Need for Addressing Chronic Disease in Rural Areas*. Retrieved January 25, 2025, from: https://www.ruralhealthinfo.org/toolkits/chronic-disease/1/rural-need

Rural Health Information Hub. (2024). *Social Determinants of Health for Rural People*. Retrieved January 25, 2025, from: https://www.ruralhealthinfo.org/topics/social-determinants-of-health

Tuttle, C., Tanem, J., Lahr, M., Schroeder, J., Tuttle, M., & Henning-Smith, C. (2020). *Rural-Urban Differences Among Older Adults*. University of Minnesota Rural Health Research Center. Chartbook: Rural-Urban Differences among Older Adults, 2020.

Weeks, W. B., Chang, J. E., Pagán, J. A., et al. (2023). Rural-urban disparities in health outcomes, clinical care, health behaviors, and social determinants of health and an action-oriented, dynamic tool for visualizing them. *PLOS Glob Public Health, 3*(10). doi: 10.1371/journal.pgph.0002420.

THE REVOLUTION OF ARTIFICIAL INTELLIGENCE IN THE CLASSROOM: AN EXPERIENCE IN ENGINEERING

Jorge Ventura[1], Fernando Martínez-Gil[1], & María Dolores Gil[2]
[1]Department of Engineering, University of Almería, Ciaimbital (Spain)
[2]Department of Informatics, University of Almería (Spain)

Abstract

This study explores the educational revolution driven by the integration of generative Artificial Intelligence (AI) in the classroom, highlighting its vast didactic potential. Specifically, it describes the development and implementation of "TutorAI," an innovative AI-powered tool designed to transform the learning experience in the Electrical Engineering course. TutorAI has been integrated into the virtual classroom and operates as an intelligent virtual assistant, leveraging Chipp technology to interact with students and provide personalized learning support. TutorAI has been meticulously trained using comprehensive course materials, enabling it to address students' specific needs effectively. This AI assistant not only delivers clear and concise explanations of theoretical concepts but also provides practical examples and step-by-step problem-solving guidance, facilitating a deeper understanding and application of complex knowledge. The implementation of TutorAI has proven to be a valuable resource, particularly in the practical components of the course. Its availability 24/7 allows students to access support and guidance at any time and from any location. Additionally, its ability to adapt to each student's individual learning pace ensures a personalized and effective educational experience. Preliminary results indicate a positive impact on students' academic performance and motivation. By providing immediate and personalized feedback, TutorAI helps students identify areas for improvement and reinforces their understanding of key concepts. This study underscores the potential of AI-driven tools to enhance engineering education and optimize student learning outcomes.

Keywords: *Artificial intelligence (AI), virtual learning assistants, engineering education, personalized learning, educational technology.*

1. Introduction

The integration of generative AI is rapidly transforming traditional teaching and learning. This study focuses on the development and implementation of "TutorAI," an AI-powered tool to enhance learning in Electrical Engineering. The complexity of engineering disciplines necessitates personalized support, which intelligent virtual assistants can provide through on-demand assistance and adaptive learning. This paper presents the design, objectives, implementation, and outcomes of integrating TutorAI into the curriculum, exploring AI's broader impact on STEM education (Liu et al., 2025).

2. Design

TutorAI is an intelligent virtual assistant using generative AI and natural language processing. It was designed for the specific needs of an Electrical Engineering course, using Chipp technology for interaction within the Virtual Classroom (Moodle). The design of TutorAI draws upon principles of effective chatbot interaction, emphasizing clarity, responsiveness, and pedagogical soundness (Følstad & Brandtzæg, 2017). The development process involved meticulous training of TutorAI using comprehensive course materials, including lecture notes, textbooks, problem sets, and supplementary resources. This extensive training dataset allows TutorAI to address a wide range of student queries effectively. Key design features include:

- Contextual Understanding: TutorAI is engineered to understand the specific context of student questions, drawing upon the relevant course material to provide accurate and targeted responses.
- Explanatory Capabilities: Beyond simply providing answers, TutorAI offers clear and concise explanations of theoretical concepts, breaking down complex ideas into digestible segments.

- Practical Application Support: Recognizing the importance of practical application in engineering, TutorAI provides practical examples and step-by-step guidance for problem-solving, bridging the gap between theory and practice.
- 24/7 Availability: A crucial design element is TutorAI's continuous availability, offering students support and guidance at any time and from any location, overcoming the limitations of traditional office hours and enhancing accessibility.
- Personalized Learning: TutorAI is designed to adapt to each student's individual learning pace, identifying areas of difficulty and providing tailored support to ensure a more effective and personalized educational experience. This aligns with the growing interest in leveraging AI for personalized learning pathways in higher education (Popenici & Kerr, 2017).

3. Objectives

The primary objectives of this study were:

1. Develop and implement an AI-powered virtual learning assistant (TutorAI) for an Electrical Engineering course.
2. Evaluate the impact of TutorAI on students' academic performance in the course, including a detailed analysis of assessment metrics.
3. Assess the influence of TutorAI on student motivation and engagement with the learning material through surveys and interaction data.
4. Investigate the effectiveness of TutorAI in providing personalized learning support and addressing individual student needs, analyzing how students utilized the tool for different learning challenges.
5. Explore the potential of AI-driven tools to enhance engineering education and optimize overall student learning outcomes, while also considering potential limitations and challenges, as discussed in broader literature on AI in higher education (Zawacki-Richter et al., 2019).

4. Methods

This study used a mixed-methods approach, combining quantitative and qualitative data to assess TutorAI's impact.

4.1. Participants

A total of 60 Electrical Engineering students were divided into two groups (n=30 each):

- Control Group: Received standard course instruction.
- TutorAI Group: Received standard instruction plus access to TutorAI.

4.2. Implementation

TutorAI was integrated into the virtual learning environment, allowing the TutorAI group to:

- Ask course-related questions.
- Seek clarifications.
- Receive problem-solving guidance.

4.3. Data collection

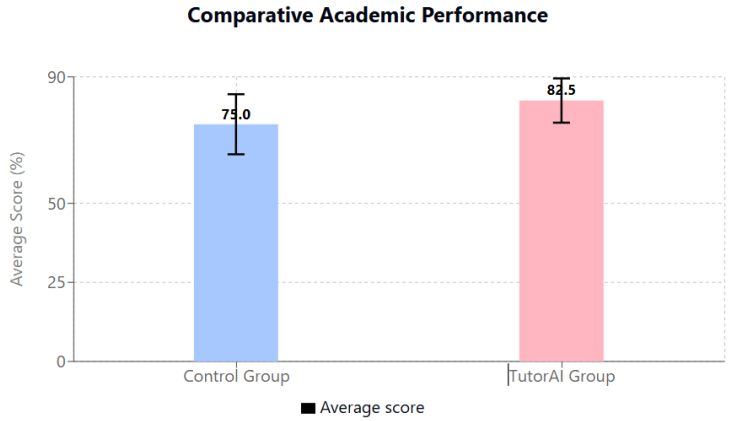
- Quantitative: Grades from assignments, quizzes, and exams were analyzed. Mean scores, standard deviations, and statistical significance (p-value from t-tests) were compared.
- Qualitative: Surveys and questionnaires gathered student feedback on learning experience, engagement, and perceived support.

5. Results and discussion

The quantitative analysis revealed that the TutorAI group had a significantly higher mean score (82.5%) compared to the control group (75.0%) ($p < 0.01$), as shown in Figure 1. The TutorAI group also demonstrated a lower standard deviation (7.0%) compared to the control group (9.5%), indicating more consistent performance. These results align with research on intelligent tutoring systems, suggesting that TutorAI effectively enhanced student learning outcomes.

Qualitative data from surveys indicated higher satisfaction, engagement, and perceived personalized learning in the TutorAI group. Intelligent virtual assistants hold significant potential in addressing these challenges by offering on-demand assistance, adaptive learning pathways, and immediate feedback (Okonkwo & Ade-Ibijola, 2021).

Figure 1. TutorAI Group Outperforms Control Group in Academic Performance ($p < 0.01$).



While these results are promising, it's important to acknowledge limitations. This study represents an initial investigation, and further research with larger samples and in-depth interaction analysis is needed to generalize these findings and fully understand TutorAI's benefits.

6. Conclusions

This study demonstrates the significant potential of generative AI-driven virtual learning assistants like TutorAI to revolutionize engineering education. The integration of TutorAI led to notable improvements in Electrical Engineering students' academic performance, evidenced by higher mean scores and reduced performance variability. This suggests that generative AI can effectively enhance learning outcomes and promote greater consistency among students. Furthermore, student feedback highlighted increased satisfaction and engagement, indicating that TutorAI fosters a more positive and personalized learning environment. The 24/7 availability and adaptive support of AI tools can cater to diverse learning needs and schedules, ultimately empowering students in their learning journey. These findings contribute to the growing body of evidence supporting the transformative power of generative AI in higher education. However, further research is needed to explore the long-term impact, scalability, and ethical implications of generative AI integration in educational settings.

Acknowledgments

This work was supported by the PPIT-UAL, Junta de Andalucía-ERDF 2021-2027. Objective RSO1.1. Programme 54.A and MentorIA Project of the University of Almería.

References

Følstad, A. & Brandtzæg, P. B. (2017). Chatbots and the new world of HCI. *Interactions*, *24*(4), 38-42. https://doi.org/10.1145/308555

Liu, C. G., Wang, C., & Wang, H. F. (2025). The Application of Artificial Intelligence in Engineering Education: A Systematic Review. *IEEE Access*, *13*, 17895-17910. doi: 10.1109/ACCESS.2025.3532595

Okonkwo, C. W., & Ade-Ibijola, A. O. (2021). Chatbots applications in education. *International Journal of Educational Technology*, *8*(2), 159-179. https://doi.org/10.1016/j.caeai.2021.100033

Popenici, S. A. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning, 12*, 22. https://doi.org/10.1186/s41039-017-0062-8

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence in higher education. *International Journal of Educational Technology in Higher Education*, *16*, 39. https://doi.org/10.1186/s41239-019-0171-0

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

A SYSTEMATIC LITERATURE REVIEW OF INTERVENTIONS PROMOTING THE SOCIAL INCLUSION OF ELEMENTARY SCHOOL CHILDREN WITH ETHNIC MINORITY AND IMMIGRANT BACKGROUND

Lili Madár[1], Réka Kassai[2], Anikó Fehérvári[2], & Anna Kende[3]
[1]*Doctoral School of Psychology, ELTE Eötvös Loránd University, Budapest (Hungary)*
[2]*Institute of Education, ELTE Eötvös Loránd University, Budapest (Hungary)*
[3]*Institute of Psychology, ELTE Eötvös Loránd University, Budapest (Hungary)*

Abstract

The literature shows that children from an ethnic minority or immigrant background often face social exclusion in partner countries of the European Union. Educational settings play an important role in forming the intergroup orientations of children and can potentially promote pro-social behaviour, thus supporting peers to be inclusive towards each other and overcome ethnic and cultural differences. The purpose of the study was to identify interventions that promote social inclusion of ethnic minority and immigrant children in formal and non-formal educational settings by shaping the intergroup relations and orientations of children as well as their social skills. A systematic search was conducted in three databases (Scopus, Web of Science, ProQuest). After excluding duplications, 2565 studies were assessed for eligibility. We included studies written in English, with participants between the age of 5 and 12, examining both majority and minority samples. We found 12 eligible studies. Data was synthetized regarding the content and common elements of interventions, methodological characteristics, and contextual factors of feasibility. Six studies used qualitative methods, other five used quantitative methods, while one used a mixed approach for measuring the effect of the interventions. Our results show that most interventions for inclusion are implemented in a formal educational setting, mainly focusing on children aged between 5-10. Three studies involved parents in the intervention. The studies focused on the following inclusive approaches: multiculturality, positive peer-interactions, prejudice reduction, social and communicational skills, interactivity, cooperation.

Keywords: *Social inclusion, education, ethnic minority, systematic literature review.*

1. Introduction

The European Union Social Cohesion policy (European Commission, 2021) clearly states that social inclusion in European education is a priority, yet children from an ethnic minority or immigrant background often face social exclusion in partner countries of the European Union (Madanipour & Weck, 2015). In an environment where social inclusion is not promoted, peer victimization, peer-rejection and friendlessness emerge more easily (Juvonen et al., 2019). In addition, social exclusion and perceived prejudice not only have a negative impact on psychological well-being but can also affect academic achievement and progress in the school environment (Hood et al., 2017). Educational settings play an important role in forming the intergroup orientations of children (Cooper & Slavin, 2001) and can potentially promote pro-social behaviour (Alan, 2021), thus supporting peers to be inclusive towards each other and overcome ethnic and cultural differences. Training of social skills can also be beneficial for children at risk of social exclusion as the promotion of these skills can result in higher levels of social interactions (Denham et al., 2007).

1.1. Objectives

We hypothesize that the intervention programs aiming to support the inclusion of children from ethnic minority or immigrant background are procedurally and methodologically diverse. The purpose of the study is to identify interventions that promote social inclusion of ethnic minority and immigrant children in formal and non-formal educational settings by shaping their intergroup relations and orientations of children as well as their social skills. Based on the data, our aim is to collect all the reported interventions and best practices that are available in the current literature, furthermore we would like to identify the main characteristics of these interventions.

2. Methods

A systematic search was conducted in Scopus (n=667), Web of Science (n=1050) and ProQuest (n=898). After excluding duplications, 2565 studies were screened based on title and abstract. 54 papers were assessed for eligibility. We found 12 eligible studies. We included published and unpublished studies, written in English. Our inclusion criteria were: 1. The study had to assess an intervention promoting positive peer interaction and cooperation between immigrant/ethnic minority children and/or promoting social acceptance and belonging of minority groups to support the inclusion of the children with immigrant/ethnic minority background, 2. We included studies examining participants between the age of 5 and 12, from both majority and minority samples, 3. We included both qualitative and quantitative data. Data was synthetized regarding the content and common elements of interventions, methodological characteristics, and contextual factors of feasibility and then analyzed with a thematical approach.

2.1. Method table

Table 1. Method Table.

First author,date	Location	Age	Minority status	Name of program	Outcome
Auh 2021	Gyeonggi, Korea	n.d.	Participants from China, Vietnam, Thailand, USA, Philippines, Cambodia, Myanmar	Global Cultural Citizenship Education (GCCE)	**Qualitative methods** Surveys, formative and summative evaluations, interviews
Boucher 2021	Turkey, Europe	n.d.	Refugee children from Syria	Preschool Summer Camp Program	**Quantitative methods** Friendship network (1 measure) Prosocial behaviour (1 measure)
Canabate 2021	Spain, Europe	4-8	Immigrant children	Cooperative Learning Techniques	**Qualitative methods** Analysis of reflective narratives
Gabrielli 2020	Italy, Europe	10-12	Italian children	Yesterday-Today-Tomorrow program (YTT)	**Quantitative methods** Implicit prejudice (1 measure)
Isaac 2022	Los Angeles, USA	*M* = 7	Latino children from immigrant background	Bridging Cultures Project	**Qualitative methods** Ethnographic Observations Reporting of videotapes Hypothetical Scenarios Teacher Interviews
Khalfoui 2023	Spain, Europe	7-9	Romani, African, Asian	Succesful Educational Actions (SEAs)	**Qualitative methods** Observation Discussion groups
Lopez&Kirk 2021	Spain, Europe	9-11	Romani, African, Latin-American, Caucasion, Sub-Saharan	Sport Education	**Qualitative methods** Focus group
O'Donell 2014	California USA	5-12	Latino	YMCA Family Involvment Project	**Quanitative methods** Family involvment (1 measure)
Pirchio 2017	Italy Europe	7-9	Caucasian, Asiatic, other ethnicities	School and Family together for the integration of immigrant children (SOFT)	**Quantitative methods** Immigrant rejection (1 measure)

Spyropoulou 2020	Greece Europe	9-12	Greek, Albanian, Italian, other ethnicities	Friendship Project – Greek version (FP-GR)	**Quantitative methods** Attitudes Towards Refugees (1 measure)
Weidinger 2015	Romania Europe	4-12	Romani	Families and Children in Education (FACE)	**Quantitative methods** Self-concept (1 measure) **Qualitative methods** Learning material adaptation
Zake 2010	Latvia Europe	5-7	Romani	Step by step program	**Qualitative methods** Questionnaires Interviews Observations

3. Results

Six of the identified studies used qualitative methods for measuring the effect of the interventions, while other five used quantitative approach. One study used mixed methods for the measurements. Our literature review shows that most interventions for inclusion are implemented in a formal educational setting, focusing on children aged between 5-12. Three identified studies involved parents in the interventions. The studies included in the research focused on the following inclusive approaches: multicultural values, empathy for others, positive peer-interactions, prejudice reduction, social and communicational skills, interactivity, cooperation.

4. Conclusions

Children from ethnic minority and immigrant background often face various challenges in EU countries. The research aims to offer relevant insights for policy makers and educators in Europe, by overviewing literature on educational and social inclusion.

Acknowledgements

The European Union (Agreement number: KA220-YOU-DF044676)
"Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them."

References

Alan, S., Baysan, C., Gumren, M., & Kubilay, E. (2021). Building social cohesion in ethnically mixed schools: An intervention on perspective taking. *The Quarterly Journal of Economics, 136*(4), 2147-2194. https://doi.org/10.1093/qje/qjab009

Cooper, R., & Slavin, R. E. (2001). Cooperative learning programs and multicultural education: improving intergroup relations. In *Multicultural education: Issues, policies, and practices* (pp. 16-19). Essay, Information Age Pub.

Denham, A., Hatfield, S., Smethurst, N., Tan, E., & Tribe, C. (2006). The effect of social skills interventions in the primary school. *Educational Psychology in Practice, 22*(1), 33-51. https://doi.org/10.1080/02667360500512411

European Commission. (2021). Priorities for 2021-2027. *Inforegio - Priorities for 2021-2027*. https://ec.europa.eu/regional_policy/policy/how/priorities_en

Hood, W., Bradley, G. L., & Ferguson, S. (2016). Mediated effects of perceived discrimination on adolescent academic achievement: A test of four models. *Journal of Adolescence, 54*(1), 82-93. https://doi.org/10.1016/j.adolescence.2016.11.011

Juvonen, J., Lessard, L. M., Rastogi, R., Schacter, H. L., & Smith, D. S. (2019). Promoting social inclusion in educational settings: Challenges and opportunities. *Educational Psychologist, 54*(4), 250-270. https://doi.org/10.1080/00461520.2019.1655645

ANALYSIS OF THE IMPACT OF VIRTUAL REALITY ON THE LEARNING OF ABSTRACT CONCEPTS IN ENGINEERING

Jorge Ventura[1], Fernando Martínez-Gil[1], & María Dolores Gil[2]
[1]Department of Engineering, University of Almería, Ciaimbital (Spain)
[2]Department of Informatics, University of Almería (Spain)

Abstract

This article examines the impact of Virtual Reality (VR) on the learning of abstract concepts among engineering students, with a particular focus on Geometric Algebra applied to Electrical Engineering. This field requires an understanding of complex spatial relationships, which has traditionally been challenging due to the difficulty of visualizing three-dimensional representations using conventional tools. To address this issue, a VR-based learning experience was implemented, allowing students to interact with 3D geometric models within a virtual environment. By using VR headsets, participants were able to manipulate these objects and directly observe geometric transformations in a three-dimensional space, significantly enhancing their comprehension of dimensions and spatial relationships. The results showed a notable improvement in students' learning outcomes, as demonstrated by their increased motivation, engagement with the subject, and enhanced problem-solving skills. Students highly valued the immersive and multisensory nature of the experience, which enabled them to actively interact with abstract concepts and build knowledge through experiential learning. Furthermore, assessments and surveys indicated that students who used VR performed better in spatial reasoning tasks compared to those who relied solely on traditional learning methods. The technology also reduced cognitive overload by providing a more intuitive and interactive way to grasp complex ideas. This study highlights the transformative potential of VR as an effective pedagogical tool, promoting a deeper and more meaningful understanding of abstract concepts. The findings suggest that integrating VR into engineering education could lead to more effective learning experiences, ultimately improving students' conceptual mastery and academic performance in highly complex subjects.

Keywords: *Virtual reality (VR), geometric algebra, engineering education, spatial visualization, immersive learning.*

1. Introduction

The teaching of abstract concepts such as Geometric Algebra presents challenges due to the difficulty of visualizing complex spatial relationships with traditional methods (Shepard & Metzler, 1971). Virtual Reality (VR) emerges as a promising solution by creating immersive and interactive learning environments (Bailenson, 2005), facilitating the intuitive understanding of abstract theories. This study investigates the impact of a VR-based learning module on the comprehension of Geometric Algebra in Master's students in Industrial Engineering, with the hypothesis that VR will improve spatial reasoning, engagement, and learning outcomes compared to traditional teaching. The VR software used, Neotrie VR, was developed by the company Virtual Dor and the University of Almería, within the framework of the pilot project "Neotrie VR, New Geometry in Virtual Reality" of the European educational platform Scientix.

2. Design and objectives

A quasi-experimental design was employed with a total of 24 Master's students in Industrial Engineering, divided into two groups of 12 students each. The experimental group used the Neotrie VR software to learn concepts of Geometric Algebra, interacting with 3D models. The control group received the same instruction through traditional methods. The objectives were to evaluate the effect of VR on learning outcomes (spatial reasoning and conceptual understanding), the impact on motivation and engagement, and the potential to reduce cognitive load (Mayer & Moreno, 2003).

3. Methods

- Participants: A total of 24 Master's students in Industrial Engineering participated, distributed heterogeneously into two groups of 12 students each.
- Learning Materials and Procedure: Both groups covered the same concepts of Geometric Algebra. The experimental group used the Neotrie VR software, developed by Virtual Dor and the University of Almería, which offered interactive 3D visualizations and object manipulation tools (Dorst et al., 2007). The control group received traditional instruction. The duration and content were equivalent for both groups.
- Data Collection Instruments: Pre- and post-tests were used to evaluate spatial reasoning (based on existing tools) and conceptual understanding. Post-intervention questionnaires were administered to measure motivation, engagement, and cognitive load (Paas et al., 2003). Observational data on the interaction with Neotrie VR was optionally collected.
- Data Analysis: Statistical tests were applied to compare quantitative results between and within groups. Qualitative data was analyzed through thematic analysis.

4. Results and discussion

The results of this study reveal a positive and notable impact of Virtual Reality (VR) on the learning of Geometric Algebra by Master's students in Industrial Engineering. Table 1 presents the means of the scores obtained in the pre- and post-intervention tests for both groups, as well as the mean improvement observed.

Table 1. Approximate Results of the Pre and Post Tests for the VR and Control Groups.

Variable	Group	Mean (Pre-Test)	Mean (Post-Test)	Mean Improvement
Spatial Reasoning	VR	6.5	8.8	+2.3
	Control	6.2	7.1	+0.9
Conceptual Understanding	VR	5.8	9.1	+3.3
	Control	5.5	6.8	+1.3

Note: Scores are on a hypothetical scale of 0 to 10. "Mean Improvement" is the difference between the Post-Test Mean and the Pre-Test Mean.

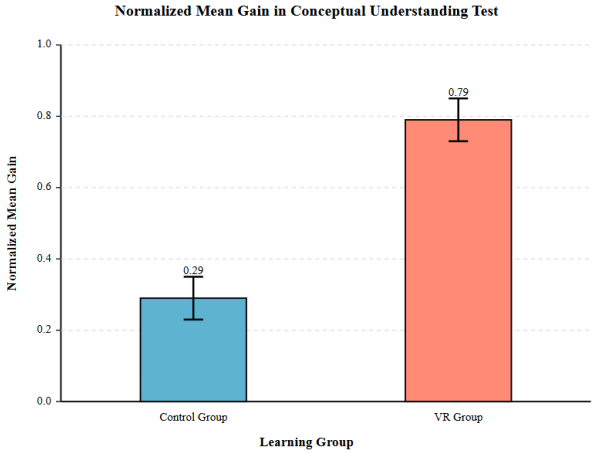
Regarding Spatial Reasoning, the experimental group (VR) demonstrated a mean improvement of 2.3 points in their performance, increasing from a pre-test mean of 6.5 to a post-test mean of 8.8. In contrast, the control group experienced a much smaller improvement of only 0.9 points (from 6.2 to 7.1). This difference suggests that the immersion and the capacity for three-dimensional manipulation offered by VR significantly facilitated the understanding and development of spatial reasoning skills related to the abstract concepts of Geometric Algebra (Shepard & Metzler, 1971). Similarly, in Conceptual Understanding, the disparity between the two groups was even more pronounced. The VR group achieved a substantial mean improvement of 3.3 points (from 5.8 to 9.1), while the control group improved by only 1.3 points (from 5.5 to 6.8). This result supports the hypothesis that active interaction with geometric models in a virtual environment allows students to build a deeper and more lasting understanding of abstract concepts, overcoming the limitations of traditional two-dimensional representations (Bailenson, 2005).

Figure 1, which illustrates the normalized mean gain, reinforces these findings by showing a significantly higher proportion of relative improvement in both assessed aspects for the VR group compared to the control group. The greater normalized gain in conceptual understanding suggests that VR was particularly effective in facilitating the internalization of the theoretical principles of Geometric Algebra.

Beyond cognitive improvements, anecdotal observations and qualitative data collected through post-intervention questionnaires indicated a higher level of motivation and engagement among students who used Neotrie VR. The interactive and multisensory nature of VR appears to have increased interest and active participation in the learning process.

Finally, the perception of cognitive load also differed between the groups. Although specific numerical data is not presented in the table, reports from students in the VR group suggested a lower intrinsic cognitive load when approaching complex concepts, possibly due to the more intuitive and direct representation offered by VR (Mayer & Moreno, 2003; Sweller, 1988).

Figure 1. Comparison of Normalized Mean Gain in Conceptual Understanding.



5. Conclusions

Virtual Reality has proven to be a promising and effective pedagogical tool for teaching abstract concepts such as Geometric Algebra to Master's students in Industrial Engineering. The results of this study indicate significant improvements in spatial reasoning and conceptual understanding in the group that utilized VR, compared to the control group that received traditional instruction. Beyond cognitive gains, VR appears to have fostered a higher level of motivation and engagement among students, possibly due to the immersive and interactive nature of the learning experience. The perception of a lower cognitive load when tackling complex concepts also suggests that VR can facilitate the assimilation of abstract ideas by providing more intuitive and direct representations. Collectively, these findings highlight the potential of VR to transform engineering education, offering new avenues to overcome the challenges associated with teaching inherently complex and visually demanding subjects. The exploration and adoption of immersive technologies like VR could, therefore, lead to more effective learning experiences and a deeper understanding of engineering fundamentals by students. Future research should continue to explore the diverse applications of VR in different areas of engineering and with diverse student populations, as well as investigate strategies to optimize its implementation and assess its long-term impact on learning and knowledge retention.

Acknowledgments

This work was supported by the PPIT-UAL, Junta de Andalucía-ERDF 2021-2027. Objective RSO1.1. Programme 54.A and MentorIA Project of the University of Almería.

References

Bailenson, J. N., & Yee, N. (2005). Digital Chameleons: Automatic Assimilation of Nonverbal Gestures in Immersive Virtual Environments. *Psychological Science*, *16*(10), 814-819. https://doi.org/10.1111/j.1467-9280.2005.01619.x

Dorst, L., Fontijne, D., & Mann, S. (2007). *Geometric Algebra for Computer Science: An Object-Oriented Approach to Geometry*. San Francisco, CA: Morgan Kaufmann.

Mayer, R. E., & Moreno, R. (2003). Nine Ways to Reduce Cognitive Load in Multimedia Learning. *Educational Psychologist*, *38*(1), 43-52. https://doi.org/10.1207/S15326985EP3801_6

Paas, F., Tuovinen, J. E., Tabbers, H., & Van Gerven, P. W. M. (2003). Cognitive Load Measurement as a Means to Advance Cognitive Load Theory. *Educational Psychologist*, *38*(1), 63-71. https://doi.org/10.1207/S15326985EP3801_8

Shepard, R. N., & Metzler, J. (1971). Mental rotation of three-dimensional objects. *Science, 171*(3972), 701-703. https://doi.org/10.1126/science.171.3972.701

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, *12*(2), 257-285. https://doi.org/10.1016/0364-0213(88)90023-7

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

ENHANCING EDUCATION IN GENETICS AND GENOMICS THROUGH A VIRTUAL CAMPUS

Javier Sierra
Universidad Francisco de Vitoria, Madrid (Spain)

Abstract

In the context of Erasmus KA220-HED program, the project HealthTEK was developed, consisting in the design of a virtual campus working around flipped learning, personalized learning and gamified immersion. The "Virtual Campus HealthTEK" includes a set of courses for life and health sciences and technology addressed to biomedical engineers and medicine students beyond others. In this scenario we have included a unit related to the Genetics field. The aim of the Genetics and Genomics unit is to provide students of medicine or biomedical engineering with a self-learning tool to interpret the structure, function and variation of the human genome and to understand the procedures related to precision medicine. The unit is divided into subunits addressing the areas of fundamentals of molecular genetics, genetic variation, structural genomics and functional genomics. Diverse learning resources are included such as video tutorials in which the contents of the sub-unit are developed, quizzes or exercises for self-assessment and gamified content. The game simulates a real case of pharmacogenomics in which a genetic analysis of the patient is carried out before prescription of a drug. Results related to the satisfaction of the users with the platform are provided.

Keywords: *Health technology, virtual campus, genetics.*

1. Introduction and methodology

The Health Technology sector is rapidly growing worldwide, and leading universities have started educational programs adapted to virtual education. However, they are finding some troubles while adapting to these, as moving clinical cases to the virtual space needs new methodologies and modules to teach their disciplines (Fraser, 2014). In the context of Erasmus KA220-HED program, the project HealthTEK was developed, consisting in the design of a virtual campus working around flipped learning, personalized learning and gamified immersion. The "Virtual Campus HealthTEK" includes a set of courses for life and health sciences and technology addressed to biomedical engineers and medicine students beyond others.

In this scenario we have included a unit related to the Genetics field. The aim of the Genetics and Genomics unit is to provide students of medicine or biomedical engineering with a self-learning tool to interpret the structure, function and variation of the human genome and to understand the procedures related to precision medicine. The unit is divided into the following subunits:

- Fundamentals of molecular genetics: basic content on the structure and expression of genetic material is covered.
- Structural genomics: the structure of the human genome and of a specific gene is analyzed using the European genome browser Ensembl.
- Mapping variation: an alteration in a gene is located within the human genome using the Ensembl genome browser[1] and the OMIM[2] and ClinVar[3] databases.
- Functional genomics: tools and procedures for precision medicine are introduced.

Each sub-unit contains the following training resources:

- Video tutorials in which the contents of the sub-unit are developed.
- Videos or cartoons to facilitate the learning of the contents in the videotutorials.
- Quizzes or exercises for self-assessment (solutions provided).

[1] Ensemble: https://www.ensembl.org/index.html
[2] Omim: https://www.omim.org/
[3] ClinVar: https://www.ncbi.nlm.nih.gov/clinvar/

- Further resources to deepen: articles that raise current issues, related to the content of the sub-unit.
- Gamified content.

Gamification is a powerful digital strategy that can be applied to the education system to enhance engagement, motivation, and learning outcomes (Dicheva et al., 2015). The game we propose simulates a real case of pharmacogenomics in which a patient has high cholesterol, and the student objective is to determine whether this patient can take the drug simvastatin, performing a genetic analysis before the drug can be prescribed. The student should have completed the course material before playing and two types of questions are offered to the student: text input questions in which the student needs to write down the answer and multiple-choice questions.This game will allow the student to self-assess and revise contents and tools previously worked with the video tutorials, videos and quizzes: gene structure and gene and variant mapping in Ensembl and use of OMIM and ClinVar databases.

2. Results

To assess the usability and effectiveness of the gamified content, a System Usability Scale (SUS) survey was administered to participants. The survey included 10 statements, rated on a scale from 1 to 5, where 1 indicates strong disagreement and 5 indicates strong agreement. The highest-rated statement was Q5 ("I found the various functions in this system were well integrated"), with a mean of 3.9, indicating strong integration of features in the system. Q9 ("I felt very confident using the system") also scored highly, with a mean of 3.6, reflecting a positive user experience and confidence. Statements related to complexity, such as Q6 ("I thought there was too much inconsistency in this system") and Q8 ("I found the system very cumbersome to use"), received low scores, with means of 1.4 and 1.9, respectively, indicating minimal usability challenges. Q4 ("I think that I would need the support of a technical person to be able to use this system") also received a low mean score of 1.9, suggesting that users did not feel they needed additional technical support.

3. Conclusions

The results of the SUS survey for the Genetics and Genomics game indicate overall positive feedback, with participants appreciating the integration of system functions and expressing confidence in its usability. Areas for improvement may include enhancing the simplicity and intuitiveness of the game to increase user engagement further. Nonetheless, the low scores on complexity and technical dependency reflect a user-friendly and well-designed gamified learning experience.

References

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in education: A systematic mapping study. *Educational Technology & Society, 18*(3), 75-88.

Fraser, K. (2014). *The future of learning and teaching in next generation learning spaces*. Bradford: Emerald Group Publishing Limited.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

DEVELOPMENT OF THE UNIVERSITY RESEARCH CENTER AND TRANSFER OF ITS RESULTS AND NEW KNOWLEDGE INTO TEACHING

Miloslav Kepka, & Vladislav Kemka
Faculty of Mechanical Engineering, University of West Bohemia (Czech Republic)

Abstract

Theoretical models of organizing research and development at technical faculties are presented. Their main advantages and disadvantages with respect to research performance and education quality are listed. The case study presents 3 main periods of the existence of one mechanical engineering research center at a technical faculty in an industrial region (from 2010 to the present). An overview of the main research results achieved, including income from contract research, is presented. An organizational change is suggested, which should bring about an improvement in the transfer of new research findings into student education.

Keywords: *Organizing research and development, impact of research results into education.*

1. Introduction

In practice, there are several approaches to organising research and development (R&D) at technical faculties. Each of them requires certain prerequisites, has advantages and disadvantages, and, of course, also has connections with the education of students. The paper generally characterises 3 typical schemes of organising R&D. It gives a concrete example of its transformation over the years at the Faculty of Mechanical Engineering of the University of West Bohemia in Pilsen, Czech Republic.

2. Organization of R&D at technical faculties

2.1. Model A

R&D is organised within departments, and the research team is usually centred around a key professor or several key professors if the department has several partial units. The advantage of this arrangement is the closeness of the implemented R&D to the teaching content provided by a specific department. Disadvantages include a certain professional monothematic nature and closedness and the necessity to organise ad hoc cooperation in a more complex project/contract assigned to the department.

2.2. Model B

The need to solve more complex R&D tasks leads to establishing research centres. Employees from various departments put their specialised competencies and capacities into them. Or equipment. This leads to the intermingling of knowledge and approaches from several scientific fields. In some cases, this can lead to a certain "weakening" of the departments in terms of capacity, on the other hand, the feedback from the implemented R&D is directly transferred to the teaching by specific personalities. An indisputable advantage of research teams organised this way is an interdisciplinary approach to solving specific research and development projects. Research centres are often product-oriented, so it is necessary/practical to be managed by an expert with deep professional knowledge and respect in the given industry. Such an expert is sometimes not easy to find. Its education takes many years and requires close cooperation with practice (if we are discussing applied research and industrial development).

2.3. Model C

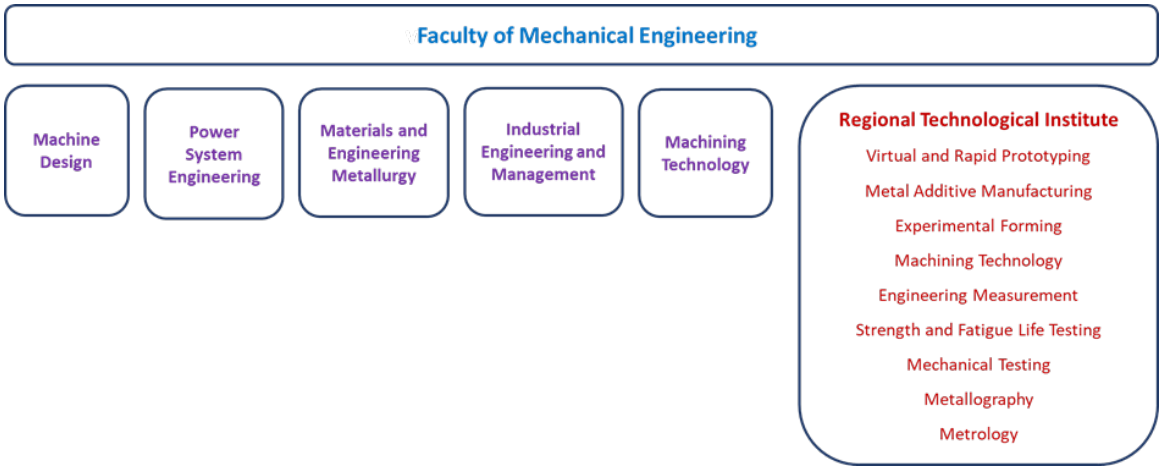
In some cases, faculties build their autonomous research institutes. These institutes differ from the above-mentioned research centres because they are larger and have a specific management and internal organisational structure similar to independent research organisations. Research institutes are mainly devoted to R&D and are organizationally next to the departments. It is advantageous if the structure of the laboratories of the research institute corresponds as much as possible with the teaching provided by the

departments. In such a case, verbal methods, which are always the basic starting point for teaching students, can easily be supplemented with demonstration methods within the framework of a nearby research institute. The best students can then be enabled for practical active work, typically within the framework of doctoral studies or even during the preparation of diploma theses.

3. Case study

With the support of the European Regional Development Fund, a separate unit called the Regional Technology Institute (RTI) was started in 2010 at the Faculty of Mechanical Engineering. The total investment was approximately EUR 20 million. New jobs were created in R&D (gradually up to 60 FTE), half of them for early-stage researchers under age 35, focused exclusively on research and development. A modern infrastructure (research equipment, supporting machines, hardware and software) was acquired, for example the laboratory of additive manufacturing. In the organisational structure of the faculty, RTI stands next to (at the same level as) the departments dealing mainly with education (see Figure 1).

Figure 1. Model C in praxis.



To date, the administrative and research team of the RTI has completed 3 characteristic five-year periods:

I - phase of building, period 2010-2014 (project design, construction of a new hall, acquisition and commissioning of new equipment with full financial support, start-up grant for gradual recruitment of research staff and step-by-step expansion of research and development activities);

II - sustainability phase, period 2015-2019 (mandatory full occupancy of newly created jobs and operation of purchased infrastructure, primarily for the implementation of research and development, were partially financially supported);

III - follow-up, independent operation, period 2020-2024 (research and development within the open market).

In all of the above phases, the measures of success of this relatively independent research center were the research results achieved. The results can be divided into two main categories: publications and application results. Cooperation with industrial companies is best measured by income from contract research or services such as accredited tests and expertise. Table 1 shows the structure of the results.

Table 1. Results of RTI research center.

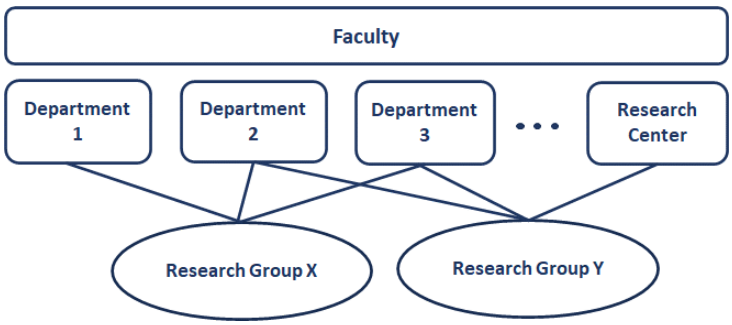
Main categories of results achieved in the evaluated periods of RTI operation	Period I 2010 - 2014	Period II 2015 - 2019	Period III 2020 - 2024
Publications	127	511	195
of which registered in WoS or Scopus	not registered	93	95
Applied results	88	295	235
of which patented	21	39	47
Contractual research *thousands of EUR*	584	3 815	3 701

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

The table shows stabilized cooperation with industry and increased quality of both main categories of results. This is evidenced by the higher percentage of publications registered in accepted scientific databases and the growing number of original patentable results.

In the above organizational structure, the faculty increased its research output, but this did not automatically lead to an improvement in the quality of education, in which the best researchers were only marginally involved. Therefore, research and teaching activities are currently being transformed into a model that is close to the above-described Model B (see Figure 2). Academics and researchers should collaborate in subject-oriented research groups. Their determination is now a matter of decision-making by the faculty management.

Figure 2. Plan for the reorganization of research activities.



Researchers will gradually become more involved in teaching. At the same time, it is respected that university teaching has its own specifics. The prerequisite for success is not only the deep knowledge of the field that new teachers have acquired during their time at the RTI research center, but also thorough preparation, communication and management skills, and the ability to motivate and improvise. University teachers should focus on issues of quality and effectiveness of their teaching. An important aspect of the professionalism of university teachers is interest in students and respect for their personalities. The decisive criterion for designing teaching should be the student, which is a very demanding area of the pedagogical work of a university teacher. If a university teacher can create appropriate conditions, students can bring innovative ideas and propose solutions to teaching and research.

For example, Ramsden and Ramsden (2003) formulated the main principles of higher education, which is an effort to respect as much as possible.

Acknowledgments

The contribution was created with the financial support of the Ministry of Education, Youth and Sports of the Czech Republic.

References

Ramsden, P., & Ramsden, P. (2003). *Learning to Teach in Higher Education* (2nd Edition). London: Routledge.

FEASIBILITY AND EFFICACY OF AN INTERVENTION PROMOTING COGNITIVE SKILLS OF SOCIOECONOMICALLY DISADVANTAGED ROMANI CHILDREN

Lili Madár[1], & Réka Kassai[2]
[1]*Doctoral School of Psychology, ELTE Eötvös Loránd University, Budapest (Hungary)*
[2]*Institute of Education, ELTE Eötvös Loránd University, Budapest (Hungary)*

Abstract

Children from a socioeconomically disadvantaged background often show a lack in cognitive skills, such as executive functions, early language, and numeracy skills. When socioeconomical differences intersect with ethnicity these barriers are often amplified. Interventions in an informal educational context have been proven to be an effective way of reducing disadvantages. Our study investigates the feasibility and efficacy of a mentoring program. The intervention was designed for preschool aged children from Romani families who live in a socioeconomically deprived environment in a segregated community. We collected data from 48 participants (52% male, aged 6-7), from which 26 participated in the mentoring program. Children in the intervention group participated in weekly sessions in their home environment. The sessions were led by volunteer mentors under the supervision of a psychologist. The sessions aimed to promote skills related to cognitive and socioemotional development. Children were assessed using the Cognitive Profile Test (Gyarmathy, 2009) upon transition to school in a single-point measure. Data obtained from the intervention group was compared to the control group using an independent samples T-test. Our preliminary analysis showed a significant difference on subtests measuring working memory, such as word repetition ($p = .002$, $t = -3.29$, $df = 45$), number repetition ($p < .001$, $t = -4.61$, $df = 44$) and nonword repetition ($p = .012$, $t = -2.6$, $df = 46$) test. Further details on implementation and feasibility will be presented orally. The mentoring program shows a promising way in reducing disadvantages of children living in low SES and ethnic minority households.

Keywords: *Pre-school, elementary school, low SES, ethnic minority, cognitive skills.*

1. Introduction

Children from a socioeconomically disadvantaged background often show a lack in cognitive skills. According to a meta-analysis there is a significant correlation between SES and executive functions, with a small-to-medium effect size (Lawson et al., 2018). Children in low SES households hear less child-directed speech than their peers in middle or high SES homes, that can affect their early language development (Dailey & Bergelson 2022). The SES and home learning environment are associated with the development of numeracy skills (Anders et al., 2012). Lower income and parental education level can lead to household stress, disparities in somatic and mental health affecting the developmental trajectory of children (Santiago et al., 2011). When socioeconomical differences intersect with ethnicity these barriers are often amplified (Dotson et al., 2009). Interventions that are more responsive of the children individual level and needs can be more effective in order to reduce this gap (Banerjee et al., 2016), which is often more applicable in an informal educational context than in a more structured formal school system, as there can be more space for differentiating practices and individual sensitivity to individual needs, so alternative educational approaches have been proven to be an effective way of reducing disadvantages (Dunn, 2012).

2. Objectives

Our study aims to investigate the feasibility and efficacy of a mentoring program designed for preschool aged children from Romani families who live in a socioeconomically deprived environment in a segregated community.

3. Methods

We collected data from 48 participants (52% male, aged 6-7). From the whole sample 26 children participated in the mentoring program (intervention group), and 22 children were allocated to the quasi-control group. The members of the control group were matched to the intervention group based on age, sex, and socioeconomic status. Children in the intervention group participated in weekly mentoring sessions in their home environment. The intervention was led by volunteer mentors under the supervision of a psychologist. Volunteers visited families in their home environment on a weekly basis and held one-hour sessions that were aimed to promote skills related to cognitive development. The sessions consisted of various age-appropriate playful activities such as card games, arts and crafts, or shared book reading. The volunteer mentors were encouraged to involve parents during the sessions and give feedback about the progress of the children. Children were assessed using the Cognitive Profile Test (Gyarmathy, 2009) upon transition to school in a single-point measure. Data obtained from the intervention group was compared to the control group using an independent samples T-test.

4. Results

Our preliminary analysis showed a significant difference on subtests measuring working memory, such as word repetition ($t(45) = -3.29$; $p = .002$), number repetition ($t(44) = -4.61$, $p < .001$) and nonword repetition ($t(46) = -2.6$, $p = .012$) test, meaning the intervention group outperformed the controls. No significant difference was measured in case of early numeracy skills and visuo-spatial attention skills.

5. Discussion

Findings of this study indicates that the program assessed can positively influence cognitive skills, particularly working memory of Romani children from a socioeconomically disadvantaged background. Previous studies have found interventions effective in improving working memory in children (Kellens et al., 2023; Zhao et al., 2022). There was no significant difference on early numeracy skills and visuo-spatial attention skills which findings are in line with previous meta-analytic results of Nelson et al. (2019) who suggest that math skills targeted interventions are less effective in case of at-risk population. Further details on implementation and feasibility will be presented orally.

6. Limitations

Our research investigates a unique population, that lead to certain limitations about the study design. The relatively small sample size that limits the generalizability of our findings. Furthermore, the single-point measure limits our capacity to control for developmental progress over time. The control and intervention groups were not randomized on an individual level. Variability in how the sessions were held by individual mentors could also influence the outcomes.

7. Conclusion

This study highlights the potential of community-based interventions in populations where children face multiple challenges limiting their potential development and further academic success.

Acknowledgments

This study was implemented in partnership with Bagázs Nonprofit Organization (Budapest, Hungary).

References

Anders, Y., Rossbach, H. G., Weinert, S., Ebert, S., Kuger, S., Lehrl, S., & Von Maurice, J. (2012). Home and preschool learning environments and their relations to the development of early numeracy skills. *Early childhood research quarterly, 27*(2), 231-244.

Banerjee, A., Banerji, R., Berry, J., Duflo, E., Kannan, H., Mukherji, S., & Walton, M. (2016). *Mainstreaming an effective intervention: Evidence from randomized evaluations of "Teaching at the Right Level" in India (No. w22746).* National Bureau of Economic Research.

Dailey, S., & Bergelson, E. (2022). Language input to infants of different socioeconomic statuses: A quantitative meta-analysis. *Developmental science*, *25*(3), e13192.

Dotson, V. M., Kitner-Triolo, M. H., Evans, M. K., & Zonderman, A. B. (2009). Effects of race and socioeconomic status on the relative influence of education and literacy on cognitive functioning. *Journal of the International Neuropsychological Society*, *15*(4), 580-589.

Dunn, M. (2012). Nonformal, Informal Education And Poverty Reduction–A Role For Tvet?. *International Journal of Education*, *6*(2), 97-106.

Gyarmathy É. (2009). Kognitív Profil Teszt. *Iskolakultúra 3-4*. 60-73.

Kellens, S., Dieusaert, F., De Wilde, J., Spilt, J. L., & Baeyens, D. (2023). The impact of an interaction-based classroom program on executive function development in low-SES preschoolers: first support for effectiveness. *Frontiers in Education*, *8*, 1149977. Frontiers Media SA.

Lawson, G. M., Hook, C. J., & Farah, M. J. (2018). A meta-analysis of the relationship between socioeconomic status and executive function performance among children. *Developmental science*, *21*(2), e12529.

Nelson, G., & McMaster, K. L. (2019). The effects of early numeracy interventions for students in preschool and early elementary: A meta-analysis. *Journal of Educational Psychology*, *111*(6), 1001-1022. https://doi.org/10.1037/edu0000334

Santiago, C. D., Wadsworth, M. E., & Stump, J. (2011). Socioeconomic status, neighborhood disadvantage, and poverty-related stress: Prospective effects on psychological syndromes among diverse low-income families. *Journal of economic psychology*, *32*(2), 218-230.

Varsik, S., & Gorochovskij, J. (2023). Intersectionality in education. In *OECD Education Working Papers*. https://doi.org/10.1787/dbb1e821-en

Zhao, X., Wang, Y., & Maes, J. H. (2022). The effect of working memory capacity and training on intertemporal decision making in children from low-socioeconomic-status families. *Journal of Experimental Child Psychology*, *216*, 105347.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

FACTORS INFLUENCING CAREER MOTIVATION IN THE LITHUANIAN ENERGY SECTOR

Tomas Butvilas, & Ugne Supranaviciene
Institute of Education and Social Work, Mykolas Romeris University (Lithuania)

Abstract

The energy sector in Lithuania faces persistent challenges in retaining and motivating its workforce, particularly regarding internal career development amid a rapidly transforming industry. This study aimed to identify the key factors that act as motivators and demotivators for employees within a leading energy group company in the country. The qualitative research methodology involved conducting eight focus groups with a total of 64 participants, ranging from junior-level to senior-level employees, of whom 25% were women and all were engineers. Ethical research standards were rigorously upheld throughout the study. The findings highlight critical motivators, such as the company's reputation, stability, innovative culture, and sense of safety, which are increasingly vital in the context of the sector's transition toward sustainability and technological advancement. However, the study also identifies key demotivators, including a lack of autonomy, insufficient access to resources, strained workplace relationships, and inconsistent leadership practices. Notably, the pressure on management to sustain motivation underscores the systemic nature of these challenges. The study concludes that to address demotivation effectively, organizations must prioritize fostering an inclusive and supportive work environment. This includes enhancing employee autonomy, improving resource availability, cultivating positive interpersonal relationships, and adopting consistent and transparent leadership strategies. These actions are particularly crucial during the ongoing energy sector transformation, as they ensure workforce adaptability and engagement. The insights gained provide valuable guidance for organizations in the energy sector and beyond to proactively tackle workforce challenges in dynamic environments.

Keywords: *Career development, employee motivation, energy sector, transformation, workforce.*

1. Introduction

The energy sector in Lithuania faces persistent challenges in retaining and motivating its workforce, particularly regarding internal career development amid a rapidly transforming industry. This study aimed to identify the key factors that act as motivators and demotivators for employees within a leading energy group company in the country. The qualitative research methodology involved conducting eight focus groups with a total of 64 participants, ranging from junior-level to senior-level employees, of whom 25% were women and all were engineers. Ethical research standards were rigorously upheld throughout the study.

The findings highlight critical motivators, such as the company's reputation, stability, innovative culture, and sense of safety, which are increasingly vital in the context of the sector's transition toward sustainability and technological advancement. However, the study also identifies key demotivators, including a lack of autonomy, insufficient access to resources, strained workplace relationships, and inconsistent leadership practices. Notably, the pressure on management to sustain motivation underscores the systemic nature of these challenges.

The study concludes that to address demotivation effectively, organizations must prioritize fostering an inclusive and supportive work environment. It is essential to recognize that employees are significantly affected by the nature of their work, the work context, and the overall working environment, all of which collectively influence their level of motivation and subsequent job performance (Ghaleb & Ordun, 2021).

This includes enhancing employee autonomy, improving resource availability, cultivating positive interpersonal relationships, and adopting consistent and transparent leadership strategies. Furthermore, the effectiveness of motivation systems is intrinsically linked to an organization's ability to attract, retain, and optimize the performance of its employees, thereby bolstering its competitive advantage and long-term sustainability (Hauer et al., 2021). These actions are particularly crucial during the ongoing energy sector transformation, as they ensure workforce adaptability and engagement. The insights gained provide valuable guidance for organizations in the energy sector and beyond to proactively tackle workforce challenges in dynamic environments.

2. Key components of career motivation in the Lithuanian energy sector

Employee motivation in large-scale energy enterprises is shaped by a complex interplay of intrinsic and extrinsic factors that contribute to professional satisfaction and long-term career commitment. Effective people management plays a crucial role in helping organizations succeed at higher levels, with motivation tactics emerging as one of the most essential contributors to long-term organizational success (Nadeak & Naibaho, 2020; Tiwari et al., 2023). This study identifies several core motivational components that are particularly relevant within the Lithuanian energy sector and examines their influence on employee engagement and retention.

Organizational Stability and Professional Prestige

A large and well-established company within the energy sector provides a sense of job security and long-term career sustainability. Employees are highly motivated by the stability associated with the energy profession, which is perceived as a critical pillar of national infrastructure. The security offered by the energy industry enhances employees' psychological safety, fostering a deep-rooted sense of professional belonging and purpose.

Passion for Engineering and Professional Identity

Individuals who pursue careers in energy engineering often exhibit a strong intrinsic motivation stemming from their passion for the field. The ability to engage in complex problem-solving, technological advancement, and the application of engineering principles contributes significantly to professional satisfaction. Moreover, the sector's unique activities, such as large-scale energy production, grid management, and renewable energy integration, reinforce a strong sense of professional identity and fulfilment.

Work Environment and Collegial Relationships

Social dynamics within the workplace, particularly interactions with colleagues, are fundamental to career motivation. A collaborative and intellectually stimulating work environment encourages knowledge sharing and mutual support among professionals. Employees who experience positive interpersonal relationships and a sense of teamwork are more likely to remain engaged and committed to their roles.

Complexity and Variety in Work Tasks

The dynamic nature of the energy sector presents professionals with intricate challenges that require innovative solutions. Employees are motivated by the intellectual stimulation associated with varied and complex work responsibilities, which prevent stagnation and monotony. The opportunity to tackle engineering challenges, optimize energy efficiency, and contribute to national sustainability goals enhances job satisfaction and professional engagement.

Technological Innovation and Industry Transformation

The Lithuanian energy sector is undergoing a period of rapid technological evolution, including advancements in smart grid technologies, renewable energy integration, and digitalization. Employees who are engaged in cutting-edge technological projects experience heightened motivation due to the continuous learning opportunities and professional growth associated with innovation-driven work environments.

National Importance and Societal Impact

The energy sector plays a pivotal role in national economic stability and environmental sustainability. Many employees are motivated by the broader societal impact of their work, recognizing that their contributions influence national energy security, sustainability, and public well-being. This sense of purpose enhances job satisfaction and long-term commitment to the industry.

Compensation and Career Development Opportunities

While intrinsic motivation factors are essential, extrinsic factors such as salary and career advancement opportunities also significantly influence employee retention. Competitive financial compensation, coupled with clear pathways for professional development, ensures that employees remain motivated to excel in their roles. Organizations that prioritize continuous learning, training, and leadership development foster an environment in which employees can achieve both professional and financial growth.

3. Demotivators affecting internal career development

Despite the importance of internal career mobility, several challenges hinder employees' career progression within the organization:

Employees' first choice is outside the organization – Many professionals seek career growth externally due to perceived limitations within the company, such as unclear promotion paths or lack of new challenges.

Lack of direct manager support – Insufficient guidance and encouragement from direct managers reduce employees' confidence and motivation to pursue internal career advancements.

Male employees are more proactive in pursuing internal career opportunities – Gender disparities in career advancement suggest that male employees are more likely to actively seek promotions, while female employees may encounter additional barriers or hesitate to pursue leadership roles.

Key demotivators – employees experience a lack of autonomy, insufficient access to resources, strained workplace relationships, and inconsistent leadership practices. These factors significantly impact motivation and career growth.

Pressure on management – the responsibility placed on management to sustain motivation highlights the systemic nature of these challenges, often leading to inconsistent support structures and career development pathways.

4. Conclusion

The Lithuanian energy sector's ability to retain and motivate its workforce depends on a multifaceted approach that integrates both intrinsic and extrinsic motivational factors. Meeting the needs of employees at work gives them the energy or strength that creates motivation, and an employee's motivation to do his job can be met when the need for satisfaction is achieved (Deomedes & Adam, 2021; Kashirina et al., 2020). By fostering a stable and innovative work environment, promoting professional growth, and recognizing the societal significance of the energy sector, organizations can enhance employee engagement and commitment. Future workforce strategies should emphasize inclusive leadership, technological adaptation, and continuous professional development to sustain motivation in an ever-evolving industry landscape.

References

Deomedes, S. D., & Adam, M. (2021). The effect of motivation, discipline, and the working environment on employee's job satisfaction. *Jurnal GeoEkonomi, 12*(1), 101-114. https://doi.org/10.36277/geoekonomi.v12i1.148

Ghaleb, M., & Ordun, G. (2021). The Mediating Role of Motivation Between Brand Citizenship Behavior and Employee Performance: A Study of Supervisors Perception. *Journal of Business Research - Turk, 13*(2), 1227-1241. https://doi.org/10.20491/isarder.2021.1195

Hauer, G., Quan, T. A. J., & Liang, Y. K. (2021). Leadership as an influencing factor in employee retention - a case study analysis in East Asian multinational corporations in the digital age. *Revista Română de Informatică Și Automatică, 31*(1), 89-100. https://doi.org/10.33436/v31i1y202107

Nadeak, B., & Naibaho, L. (2020). Motivation and HRM factors relation to the employee loyalty. *Polish Journal of Management Studies, 22*(2), 261-276. https://doi.org/10.17512/pjms.2020.22.2.18

ARTIFICIAL INTELLIGENCE AND INDIVIDUAL'S EDUCATION VALUES: LATVIAN EXPERIENCE

Lasma Balceraite, & Velta Ļubkina
Faculty of Education, Languages and Design, Rezekne Academy of Technologies (Latvia)

Abstract

The 21st century is a century characterised by rapid and diverse change that considerably affects both the technological and economical, and the social sphere, facilitating more diversity in human behaviours and choices in various fields of life. Spread of the artificial intelligence (AI) has become an important stimulus of these changes and creates new challenges related to the transformation of an individual's system of values, as people seek to adapt to the new technological environment and the possibilities and risks it creates. Development of AI creates possibilities to improve the quality of life while raising questions about human autonomy and social interaction, which in its turn impacts the hierarchy of human values. The system of individual's values is dynamic and subject to constant change, that is due to social, economic, technological, and cultural factors. *Research methods*. The article, based on the study of scientific literature and analysis of survey data, identifies factors that promotes value transformation in adults caused by the impact of AI. A comparative experiment was carried out based on the S. Schwarz's theories about individual's values before and after AI is being used in the everyday. The survey was organised in autumn 2024, and the respondents were adult inhabitants of Latvia aged 25–72, N=155 respondents. *Conclusions*. The theoretical study allowed to identify the factors that promote value transformation in adult education caused by the impact of AI. The survey presented the experience of Latvian inhabitants in relation to the impact AI has on their personal values. The data obtained shows that adults in Latvia actively integrate AI into their daily activities by using the possibilities it offers for study and work.

Keywords: *Artificial Intelligence, AI, value transformation, adult learning.*

1. Introduction

In recent years, the global advancement of AI has accelerated substantially. AI has become a global trend in education (Montenegro-Rueda et al., 2023), emulating human learning by continuously building upon acquired knowledge to solve problems independently.

The impact of AI on education, including lifelong learning, is complex and multifaceted. While AI holds immense potential (Ifenthaler et al., 2024) to enhance both access to and the quality of education, it is equally crucial to thoughtfully examine its ethical and social implications.

In today's digital age, AI has become a major player in shaping our daily lives and influencing human values. Research shows (Беликова, 2024) how integration fosters values related to rational thinking, innovation and personal growth. At the same time, there is a growing tendency to prioritise individual security and control, which can inadvertently undermine trust.

The aim of the study is to determine whether and how AI affects the transformation of educational values in adult learning.

2. Literature review

Researchers (Rokeach, 1973; Schwartz, 2017) have examined individual values in different ways and developed models to analyse their interdependencies and interactions. Today, research on individual values has been extensively carried out by Milton Rokeach and Shalom Schwartz.

Tonga (2016) defines values as factors that have a direct impact on human life and society in both positive and negative ways. Schwartz (2017) points out that values can be interpreted as motivating goals that drive individuals towards achieving an end result. Values are generally considered to be an individual's internal reality, reflected in their habits, behaviours, beliefs, expectations and relationships

(Schwartz, 2017). Values research is crucial for advancing the understanding of human behaviour, motivations, and beliefs. Its findings have broad applications across disciplines such as education, psychology, and political science.

Values are a relatively stable concept that retains its substantive integrity in the short term. However, it should be noted that these changes do not occur rapidly, but over a longer period of time – value transformation typically takes several decades (Foad, Maio & Hanel, 2020).

Researchers (Dempere et al., 2023) point out that education is one of the sectors where AI technologies can make the greatest changes. Research shows that this approach can significantly improve individual learning outcomes and provide educators with various benefits in their work (Mallik & Gangopadhyay, 2023). In line with the UNESCO report and the OECD review (OECD, 2021), AI has significant potential to improve education systems.

The importance of lifelong learning has increased significantly in a context of rapid technological development. AI plays a crucial role in adult and lifelong learning. Researchers (Palenski et al., 2024) point to the importance of lifelong learning to prepare the workforce for the future and promote responsible use of AI.

In light of the rapid changes that have unfolded in Latvia, Europe, and globally in recent years, examining the transformation of individuals' value systems in response to these shifts has become a particularly pertinent area of study. This is essential to better understand how individuals react to changes in their environment and how these reactions affect their behaviour, wellbeing and social interactions.

3. Methodology

Data collection took place from autumn 2024. The data were analysed using SPSS version 29.0, where descriptive statistics Kruskal-Wallis test and Kendall's correlation were used. The research included participants aged 25–72 years (M = 43.35, SD = 11.92). Total number of respondents 155. The survey covered the whole of the Republic of Latvia.

The Cronbach's alpha coefficient ($\alpha = 0.933$) indicates good internal consistency and reliability of the data. The results of the Kolmogorov-Smirnov test ($p<.05$) indicate that the results do not follow a normal distribution and non-normal tests will be used in the inferential statistics.

4. Research results

The research focused on the value system of the Latvian population based on Schwartz's values, analysing changes over time, especially in relation to the integration of AI into everyday life.

Table 1 illustrates the dynamics of changes in the respondents' value system. This comparison allowed us to identify which values have become more important and which have declined.

Table 1. Mean and standard deviation of Schwarz values for Latvian residents before and after wider use of AI in everyday life.

Value	N	Before AI		After AI	
		Mean	Standard deviation	Mean	Standard deviation
Security	155	8,07	2,475	8,12	2,445
Conformity	155	6,98	2,484	7,14	2,495
Tradition	155	7,07	2,475	7,11	2,591
Benevolence	155	7,81	2,264	7,76	2,371
Universalism	155	7,11	2,251	7,16	2,295
Self-direction	155	7,71	2,281	7,61	2,315
Stimulation	155	6,81	2,486	6,93	2,378
Hedonism	155	6,21	2,602	6,32	2,690
Achievement	155	6,98	2,507	7,00	2,675
Power	155	4,75	2,745	5,04	2,845
Valid N	155				

While the overall trend shows an increase in values after the introduction of AI, the study also reveals an interesting difference – the value of “Self-actualisation” has slightly decreased. Overall, the analysis of the data revealed small, but statistically significant differences in the respondents' value systems before and after the integration of AI into everyday life.

Using the Schwartz value model, a correlation analysis of individual values (see Table 2) was conducted after the introduction of artificial intelligence into daily processes to determine changes in people's priorities.

Table 2. Kendall rank correlation coefficients between Schwarz values for Latvian residents after wider use of AI in everyday life (from 2022).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Security	-									
(2) Conformity	,543**	-								
(3) Tradition	,488**	,593**	-							
(4) Benevolence	,575**	,543**	,721**	-						
(5) Universalism	,489**	,545**	,687**	,686**	-					
(6) Self-direction	,504**	,455**	,568**	,671**	,633**	-				
(7) Stimulation	,389**	,428**	,542**	,579**	,664**	,709**	-			
(8) Hedonism	,295**	,307**	,377**	,473**	,463**	,519**	,641**	-		
(9) Achievement	,357**	,375**	,496**	,530**	,552**	,637**	,711**	,600**	-	
(10) Power	,009	,155**	,147*	,122*	,293**	,199**	,367**	,414**	,385**	-

Source: Results of the empirical research. Note: * Correlation is significant at 0.05 level. ** Correlation is significant at 0.01

The correlation test results showed that the introduction of AI had an impact on the dynamics of values. The value of "stimulation" has become a more significant motivating factor, correlating strongly with both self-actualisation (r=.709; p=.001) and universalism (r=.664; p=.001). There is also a strong correlation between the values of "achievement" and "stimulation" (r=.711; p=.001).

5. Conclusions

The analysis of data from the Latvian population suggests that the introduction of AI has impacted the dynamics of value systems. The correlation test results showed that several factors correlate with each other and are indicative of the transformation of values today.

Acknowledgments

This research was carried out within the RTU-RTA doctoral grand programme "Implementation of Consolidation and Management Changes at Riga Technical University, Liepāja University, Rēzekne Academy of Technologies, the Latvian Maritime Academy and Liepāja Maritime College for the Progress Towards Excellence in Higher Education, Science and Innovation".

References

Dempere, J., Modugu, K., Hesham, A. et al. (2023). The impact of ChatGPT on higher education. Front. Educ., 8. https://doi.org/10.3389/feduc.2023.1206936

Foad, C., Maio, G., Hanel, P. (2020). Perceptions of values over time and why they matter. Journal of Personality. 89(3). 1–17. DOI: 10.1111/jopy.12608

Ifenthaler, D., Majumdar, R., Gorissen, P.,et al. (2024). Artificial Intelligence in Education: Implications for Policymakers, Researchers, and Practitioners. Tech Know Learn. https://doi.org/10.1007/s10758-024-09747-0

Mallik, S., & Gangopadhyay, A. (2023) Proactive and reactive engagement of artificial intelligence methods for education: a review. AI for Human Learning and Behavior Change, 28, 1–24. https://doi.org/10.3389/frai.2023.1151391

Montenegro-Rueda, M., Fernández-Cerero, J., Fernández-Batanero, J.M. et al. (2023) Impact of the Implementation of ChatGPT in Education: A Systematic Review. Computers 2, 12, 1-13. https://doi.org/10.3390/computers12080153

Palenski, T., Hills, L., Unnikrishnan, S. et.al. (2024) How AI Works: Reconfiguring Lifelong Learning. Postdigit Sci Educ 6, 1216–1239 (2024). https://doi.org/10.1007/s42438-024-00496-y

Rokeach, M. (1973) The nature of human values. – New York: The Free Press.

Schwartz, S. H. (2017) The Refined Theory of Basic Values. Values and Behavior, 51-72. https://doi.org/10.1007/978-3-319-56352-7_3

Tonga, D., (2016). Transforming Values into Behaviors: A Study on the Application of Values Education to Families in Turkey. Journal of Education and Learning, 5(2), DOI:10.5539/jel.v5n2p24

Беликова, Е. К. (2024). Искусственный интеллект как инструмент, встроенный в ценностную систему современной культуры. Человек и культура, 2, 18-31. doi: 10.25136/2409-8744.2024.2.70030

VIRTUAL PRESENTATIONS

Designed by Freepik

CHALLENGING GENDER ROLE STEREOTYPES IN 'PIGGY BOOK': A VISUAL LITERACY APPROACH ON FAMILY ROLE EQUALITY

Christina Kalaitzi[1], & Domna (Mika) Kakana[2]
Department of Early Childhood Education, Aristotle University of Thessaloniki (Greece)
[1]Adjunct Lecturer & Postdoctoral Researcher
[2]Professor

Abstract

In this study, we explore the diverse ways that children can think and learn in terms of images they encounter in Antony Browne's 'Piggy book', along with the related implications for learning and teaching, through an interdisciplinary inquiry-based approach of a picturebook that conveys both textual and visual messages about gender role equality within the family. The article presents a reading of how both textual and visual representations define the different gender roles that the members of a family have or should have. Household chores are portrayed as feminine, nevertheless, during the narration, a shift in this definition and in the family dynamics is implied. An expansion and complementarity between the visual and the textual mode impact gender role equality implications that this picturebook offers. The way in which the visual narrative frames and defines the male character's appearance and behaviour in terms of gender role equality is analyzed. In supporting teachers' attempts on approaching gender equality within family dynamics in kindergarten settings, the article presents an interdisciplinary teaching proposal by using 'Piggy book' as a means for encouraging discussion and promoting the notion of gender role equality. The contribution of the current work is that it raises discussion on and proposes approaches of gender role equality within family relations. The interdisciplinary teaching proposal could inspire teachers to engage kindergarten children in developing their own understandings of what constitutes a feminine and a masculine household role. Furthermore, children would be challenged to shape their own definitions of equality in gender roles within the family, while attempting to answer the question *'Does gender role equality start at home?'*.

Keywords: *'Piggy book', gender stereotypes, gender role equality, visual literacy, kindergarten.*

1. Introduction

Educational research related to visual literacy and its connections to children's reading and literature has flourished over the last two decades. Twenty years ago, research landscape had surfaced only a few systematic attempts to ask children about their reading/viewing of pictorial text in terms of their understanding of visual art, and appreciation of artistic techniques and their implications for the teaching and learning of visual literacy (Arizpe & Styles, 2003). After years of research, recent studies reflect on what could be described as an ethical or more explicitly political turn discernible within visual reading research that includes the foregrounding of issues of authenticity, inclusion and representation of socially marginalised communities, groups or even genders concerning children's literature and reading (Farrar, Arizpe, & Lees, 2024).

Taking into consideration that children's books play a key role in shaping children's gender perceptions and expectations (Lee & Chin, 2021), the exploration of the way children can think and learn in terms of images they encounter in Antony Browne's 'Piggy book', along with a proposal of an interdisciplinary inquiry-based approach of the messages conveyed by picturebook' s both textual and visual modes about gender role equality within the family is ventured in this study.

2. Literature review

2.1. Visual literacy: Children's responses to visual texts and the related significance to their learning

Visual literacy can be defined as 'the abilities to understand (read) and use (write) images, as well as to think and learn in terms of images' (Avgerinou & Pettersson 2020, 439). Visual texts for children might include picturebooks (both wordless and with words), comic books, posters, advertisements, art, film

or video games, that could be separated into two classifications: analogue (print-based) and digital (code-based).

Given the complex range of multimodal texts, Arizpe and Styles (2003) in their earlier work highlighted the sophisticated nature of children's responses to visual texts, and showcased the indispensable role that visual literacies can play in developing and supporting creative and critical thinking. This need has also been highlighted by Farrar, Arizpe, and Lees, (2024) who had supported the need to reframe traditional understandings about the relationship between words and pictures within education, through the skills that visual literacy offers.

Anthony Browne's works – as others created by those who serve as authors and illustrators, belong to those picturebooks that raise questions among adult readers, teachers and parents given the complex nature of some of the literary and aesthetic features that appeared in the play between words (or lack of words) and images, such as the use of irony, metafiction, metalepsis or symbolism (Arizpe & Styles, 2003). Regarding children's meaning-making process Arizpe and Styles (2003) showed that, after reading and discussing picturebooks enveloped to this category, the children were not only capable of understanding most of these features but were also able to engage in deep reflection about some of the more subtle aspects, such as the affective relationship between characters, ethical dimensions, gender and the environment. In recent research on the topic by Arizpe, Noble, and Styles (2023), it was found that children lack a vocabulary to describe the visual features and that, when supportive spaces were opened for sharing observations among peers and for learning some visual concepts and metalanguage, the children's understanding increases. Furthermore, these new findings examining children's responses to visual multimodal texts highlighted that the understanding of visual codes could help readers move beyond more literal responses and deepen engagement with a picturebook.

At this point it can be strongly argued that children need 'visual literacy skills, the ability to understand, to interpret, to engage critically and to create multimodal visual narratives.' (Arizpe, Noble, & Styles, 2023, 96). Those skills seem to be vital and urgently needed for the young citizens of the twenty-first century.

2.2. Gender role equality: Reading of textual and visual representation of gender roles in "Piggy book"

The tool 'Multimodal Social Semiotics' offered by Painter, Martin and Unsworth's (2013), is used in this study to explore the verbal and visual strategies that Anthony Browne, author and illustrator of 'Piggy book', has used to generate progressive messages. The analysis of text and images in this picturebook case shows that distinct sets of semantic features (i.e., repetitive words framing males' superiority, impersonal references to the female figure, choice of colours and details depicting male and female figures, repetitive facial expressions or absence of faces, etc.) are selected in multimodal constructions of husband, wife and sons, forming a consistent pattern of gender inequality across the pages of this picturebook. The gender-biased semantic choices make experiential content of family life unevenly distributed, where husband/wife roles are limited to restricted settings and household activities -chores in that case-, resulting in the perpetuation of gender role stereotypes as certain semantic features tend to be fossilised into gender specific ones.

Lee and Chin (2021) noticed the two sexes' differences in visual representations in terms of their interpersonal relationships. Their findings show stereotypical descriptions in male and female framings and, in particular, apparent gender differences in the child-father/mother relationship preventing gender equality in sexes relationships. The cover picture of "Piggy book" depicts a woman who carries in her back a man and two boys. The picture defines the inequality within their interpersonal relations. The message of the visual narrative is straightforward: the gender roles are non-equal, and the family balance is disrupted. The difference between the facial expressions of the male family members and the only female member implies the emotional extensions of this role inequality. The members of this family are depicted in different postures, with contrasting feelings, being unfairly treated. The poor treatment of the female family member is also implied by the absence of red checks – a sign of health- which, in contrast with the other three male members, can be interpreted as the lack of well-being.

Prior, Willson, and Martinez (2012) showed that children are drawn to images depicting characters' actions, facial expressions, body posture, colour and lines to explore characters' feelings. Based on these findings much information about gender inequality and its emotional consequences can be drawn by analysing 'Piggy book'. Males of this family are depicted performing the same actions, talking with the same imperative, and having similar dressing codes. What the pictures reveal more, by focusing on details like the figures with their mouths open in the newspaper Mr Piggott reads, is the universality of the definition of male gendered behaviour: males shouting and demanding from the female seems universal; seems natural. The textual narrative lists the household chores done by Mrs Piggott, while the visual narrative depicts in a stop care sequel of images a woman with her face hidden, executing one household chore after the other. The hazy colours in the female character's dressing combined with the monochrome background lacking details could imply the woman's assimilation with the house itself, like being part of

the furniture or the wallpaper; like being inanimate. The woman's visual depiction in the last two images implies that her equal treatment by the male members of her family has influenced her essence (face and feelings). The shift in gender roles which addresses mostly to males doing the chores that only the female was supposed to do, is extended towards the ending by the female doing something that didn't belong in the list of daily chores. Fixing the car could be also interpreted as a gender associated chore which is now feasible to the other gender as well. Ultimately, the narration ends with both genders expanding their abilities, skills and prospects; equally and fairly.

Regarding the analysis of text-image interaction, according to Moya-Guijarro's (2019) taxonomy, an expansion and complementarity between the visual and the textual modes is apparent. The gradual and imperceptible transformation the visual narration reveals could be read as a parallel narrative. Only the pictures show the male family members' transformation into a different nature, like the one their name implies. This transformation may be interpreted as either a natural outcome to which their manners and habits led to, or as the interpretation of the males' non-equal treatment towards females. The relationship between text and image is worth noticing for images fill in the gaps and messages of the text. At some points, visual text offers such levels of complementarity that function as an autonomous, independent narration. Males' visual transformation into pigs, a change which can be interpreted as appropriate and expected punishment due to their behaviour could be implied as the behaviour's impact on appearance. So, is it the message conveyed by the visual representation the affirmation '*we are what we do*'?.

2.3. Aim of the current study

Gender stereotypes, gender equality and inclusion are concepts to be addressed from childhood in school and family settings. Certainly, picturebooks are, without a doubt, essential resources to familiarise young children with these aspects and, in turn, develop their visual literacy (Moya-Guijarro & Ventola, 2022). Aligning with this assumption, in this study we explore the diverse ways that children can think and learn in terms of images they encounter in Antony Browne's 'Piggy book', along with the related implications for learning and teaching, through an interdisciplinary inquiry-based approach of a picturebook that conveys both textual and visual messages about gender role equality within the family.

3. Methodology

For the study, an inquiry-based curriculum is proposed. The inquiry-based teaching method unravels through the following phases: orientation, conceptualisation, investigation, conclusion, and discussion (Stacey, 2018). The notions of gender role equality within the family are explored through literature, mathematics, natural and social science, and ICT learning areas (Greek Curriculum for Preschool Education, 2022). 'Piggy book', used for critical reading in the first part of this paper, is recommended in the second part as means for encouraging discussion, promoting empathy, and gathering information during the inquiry. A detailed outline of the structure of the inquiry-based teaching approach is presented below.

Table 1. Interdisciplinary teaching proposal of gender role equality using 'Piggy book'.

<table>
<tr><th colspan="6">INTERDISCIPLINARY TEACHING PROPOSAL</th></tr>
<tr><td>Orientation</td><td colspan="5">The topic of gender role equality is addressed by the picturebook "Piggy book". The book can be either placed in the library corner to offer the students the space to explore the pictures, or it can be used in read-aloud sessions by the teacher.</td></tr>
<tr><td rowspan="2">Conceptualisation</td><td>Literature</td><td>Mathematics</td><td>Social Science</td><td>Natural Science</td><td>ICT</td></tr>
<tr><td>What does gender role equality mean?</td><td>How can household chores be equally divided between members of the family?</td><td>Household chores in the past and in the present – Occupational gender roles and gender career prospects. Similarities and differences?</td><td>Does gender role equality exist in animal species?</td><td>In what ways has technology improved household chores?</td></tr>
<tr><td rowspan="2">I</td><td colspan="2">Literature</td><td>Mathematics</td><td colspan="2">Social Science (1/2)</td></tr>
<tr><td colspan="2">"Piggy book" read aloud. Brainstorming definitions of gender role equality.
———
Creating a family collage of household chores [Students assembly photos, drawings and texts presenting their family's daily household routine]</td><td>Sorting cards with household chores according to genders.
———
Dividing and matching chores to all members of one's family to equally distribute them</td><td colspan="2">Exploring similarities and differences between household chores in the past and the present. (e.g., household in the past: cleaning the freezer, cooking in the wooden stove, washing the carpet, ironing with the charcoal iron, washing dishes/clothes in the vessel, etc.)
———
Exploring posters showing household chores & occupations – discuss the stereotyped representations</td></tr>
</table>

	Social Science (1/2)	Natural Science	ICT
	Exploring gender equality in occupations. Sorting cards of professionals with their heads covered according to genders. Revealing of heads – resorting the cards and discuss each gender's career prospects. 'The occupation I would like to do / The occupation I wish I could do / The occupation I can do' Depicting the occupations of one's own choice before and after the read aloud	Exploring gender role equality in wild species. Gathering information about the roles of female and male lions, penguins & seahorses, their mating rituals, incubating of eggs and newborns, feeding responsibilities, construction of the nest, etc.– Creating an album for wild animals' gender roles.	Watching documentaries of traditional household chores (e.g. washing of clothes in the river, drying the meat in the cellar). Exploring pictures of new technological appliances that transformed household chores. (e.g. non-frost fridge, ceramic stove, electric iron, robot vacuum, dish-washing machine, washing and dryer machine, etc.) Watching 'Married life'- short film – Discuss on gender role equality
Conclusion	Conclusions are drawn regarding: • The transformation of household roles from the past to the present • Definitions of gender role equality within the family • Equality's significance in occupational roles and career prospects		
Discussion	Intervention's outcomes could be shared in the following ways: • Exhibition of household chores/ gender roles within their family collage & occupation choices board • A digital poster of gender roles in wild species.		

The interdisciplinary activities described above were implemented in a Greek public kindergarten classroom of nineteen children. Provided that the article primarily focuses on proposing an inquiry-based teaching using the picturebook 'Piggy book' to approach the topic of gender role equality in early childhood education, there is no analysis of results. Due to the word limit, the study only includes discussion of some of the most indicative tokens of children's performance on the activities.

4. Discussion

This study, aligning with previous research by Arizpe and Styles (2003), confirms that picturebooks' multimodality makes it an indispensable tool for developing and supporting creative and critical thinking, through visual literacy that, according to Farrar, Arizpe, and Lees (2024), offers the skillset to reframe traditional understandings about the relationship between words and pictures. Children's responses during the interdisciplinary inquiry-based teaching showcase their ability to stand critically towards the notions of stereotyping, gender roles, and family role equality. A characteristic example of that understanding and critical thinking is the outcome in one of the mathematics activities regarding the division and matching of chores to all members of one's family. Before the 'Piggy book' read aloud, children were asked to draw who does the chores in their household. The child's visual representation depicts family members' actions, and his vocal justification reflects members' feelings (Prior, Willson, & Martinez, 2012). The inequality and disturbance of balance is obvious as the child drew only the mother linking her with all the chores and stated that there was no need to depict any other member since no one else does chores in his family. After the picturebook reading, there is a notable difference on the way the child understands the notion of equality within the dynamics of his own family, which confirms, according to Arizpe, Noble, and Styles (2023), children's ability to understand and create multimodal visual narratives. The shift in the child's perspective regarding notions of gender role equality can be interpreted by both the visual representation and the justification accompanying it, and it proves the impact of the picturebook message.

	[Before reading aloud the 'Piggy book'] A_Boy: *'Mom is doing the laundry, making the beds, picking up my room, washing the dishes, making all the other beds, cooking and mopping. I didn't draw dad and my brother and me because we are doing nothing.'*
	[After reading aloud the 'Piggy book'] A_Boy: '*Every two are doing the same chores to help each other. Mom and my brother are making the beds, me and my brother are doing the laundry and mom, my brother, me and dad are cooking all together.'*

The imperceptible way in which implications of gender role stereotypes and gender role equality are formed throughout the visual narrative of 'Piggy book' confirms Lee and Chin's (2021) point that children's books play important roles in shaping children's gender perceptions and expectations. Their prospects regarding occupations are enriched which is reflected in children's drawings regarding 'The occupation I would like to do/ The occupation I wish I could do/ The occupation I can do'. Children depicted the

occupations of their choice before and after their exposure to the picturebook. Their initial choices changed after they discussed both textual and visual messages of the picturebook. Tokens of children's occupation choices below reflect their influence regarding the possibilities of career prospects of their own gender. According to children's justification of their career prospects, the boy's choice of cook occupation and the girl's choice of car mechanic occupation are notable reflections derived from the role models presented in 'Piggy book', a reflection that complies with previous findings that the understanding of visual codes could increase children's understanding of concepts and help them deepen their engagement with a picturebook (Arizpe, Noble, & Styles, 2023).

M_Girl		'The occupation I would like to do: **Painter**' / 'The occupation I wish I could do: **Pilot**' / 'The occupation I can do: **Painter**, **Pilot**, **Mechanic**, **Firefighter**'.
N_Boy		'The occupation I would like to do: **Police officer**' / 'The occupation I wish I could do: **Tailor**' / 'The occupation I can do: **Police officer**, **Cook**, **Firefighter**'.

The impact of visual literacy in terms of gender issues is also highlighted in this study. Visual narratives like Anthony Browne's 'Piggy book' may contribute to the development of young readers' visual literacy and become essential to comprehend discourses which promote social inclusion and equality (Farrar, Arizpe, & Lees, 2024). As Painter, Martin, and Unsworth (2013) put it, children's picturebooks, as models of shared cultural values and meanings, may influence their readers' attitudes and beliefs and boost the acceptance of the non-traditional gender models or family interpersonal dynamics that are progressively emerging today.

5. Conclusion

The contribution of the current work to early childhood education is that it raises discussion on gender-typed roles within family relations. The interdisciplinary teaching proposal could inspire teachers to engage kindergarten children in developing their own understandings of what constitutes a feminine and a masculine household role. Furthermore, children would be challenged to shape their own definitions of equality in gender roles within the family, while attempting to answer the question 'Does gender role equality start at home?'.

References

Arizpe, E., Noble, K., & Styles. M. (2023). *Children Reading Pictures: New Contexts and Approaches to Picturebooks*. London: Routledge.

Arizpe, E., & Styles, M. (2003). *Children Reading Pictures: Interpreting Visual Texts*. London and New York: Routledge/Falmer.

Avgerinou, M. D., & Pettersson. R. (2020). Visual Literacy Theory: Moving Forward. In S. Josephson, J. Kelly, & K. Smith (Eds.), *Handbook of Visual Communication: Theory, Methods and Media* (2nd ed.) (pp. 433-464). New York: Routledge.

Curriculum for preschool education (extended version). (2022). Act "Upgrading the Curriculum and Creating Educational Materials for Primary and Secondary Education" - MIS: 5035542. Athens: Institute of Education Policy.

Farrar, J., Arizpe, E., & Lees, R. (2024) Thinking and learning through images: a review of research related to visual literacy, children's reading and children's literature, *Education, 52*(7), 993-1005.

Moya-Guijarro, A. J., & Ventola E. (2022). Picture Books, Gender and Multimodality. An Introduction. In A. Jesús Moya- Guijarro, & E. Ventola (Eds.), *A Multimodal Approach to Challenging Gender Stereotypes in Children's Picture Books* (pp. 1-19). New York, London: Routledge.

Lee, J. F. K., & Chin, A.C.O. (2021). Constructing gender using visual imagery–a study of early readers. *Language & Communication, 78*, 1-18. https://doi.org/10.1016/j.langcom.2021.01.005

Moya-Guijarro, A. J. (2019). Textual Functions of Metonymies in Anthony Browne's Picture Books: A Multimodal Approach. *Text and Talk, 39*(3), 389- 413.

Painter, C., Martin, J., & Unsworth, L. (2013). *Reading Visual Narratives. Image Analysis of Children's Picture Books*. Sheffield: Equinox.

Prior, L. A., Willson, A., & Martinez. M. (2012). Picture This: Visual Literacy as a Pathway to Character Understanding. *The Reading Teacher, 66*(3), 195-206. https://doi.org/10.1002/TRTR.01098

Stacey, S. (2018). *Inquiry-Based Early Learning Environments: Creating, Supporting, and Collaborating*. St. Paul, MN: Redleaf Press.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

SPATIAL REASONING WITH A HUMAN-SCALED GEOMETRIC PUZZLE

Elise Levin-Güracar, Teresa Lara-Meloy, Ken Rafanan, & Jennifer Knudsen
TERC, Inc. (USA)

Abstract

As our world interactions become more digital, youth have fewer opportunities to engage in physical activities that provide contexts for mathematics. Most school math is done on paper or computer screen—2D environments with little opportunity for embodied learning. This paper describes how activities with human-scale geometric objects offer youth opportunities to strengthen, challenge, and contextualize what they have learned in school. Using a human-sized 3D puzzle made of cardboard boxes, youth engaged in embodied learning experiences that involved spatial perception, mental rotation, spatial visualization, and joy. The activity, conducted in an afterschool program, fostered collaboration and deeper engagement through physical manipulation of the puzzle pieces. This case study shows the promise of large-scale objects for supporting the development of spatial reasoning skills in ways that engage youth. Because spatial thinking is associated with success in STEM disciplines, including mathematics, these activities are particularly important for students who are historically marginalized.

Keywords: *Spatial reasoning, geometry, out-of-school learning, STEM, curriculum.*

1. Introduction

There is strong evidence that concrete manipulatives—physical objects that offer learners sensory experiences of mathematical ideas—support learning when effectively integrated into learning activities (Carbonneau, Marley & Selig, 2013; Moyer, 2001). This case study focuses on the scale of 3D manipulatives, specifically examining whether human-scale versions have differential impacts on student engagement and spatial reasoning. In afterschool environments, fostering engagement is particularly important, as learners may disengage if an activity feels overly taxing or too similar to school.

We present activities from a co-design project that adapted in-school set of curricular materials focusing on mathematics, spatial reasoning, and making—for the use in an afterschool program at a community-based organization (CBO) in California, USA. TERC researchers supported facilitators through three hands-on 3-hour professional development sessions and on-site implementation during implementation in the fall of 2024.

Our study explores the affordances of differently scaled objects—cube puzzles made up of pieces created with one-inch linking cubes and one-foot boxes—for learners' participation in spatial activities and embodying spatial concepts and thinking. To assemble the linking cube pieces, youth had to use all three types of spatial reasoning skills: spatial perception, mental rotation, and spatial visualization (Linn & Peterson, 1985; Shriki & Patkin, 2021). In making the human-sized Soma Cube puzzle (one-foot boxes), youth embodied the spatial concepts of 3D rigid transformations: rotation and translation. In the large Soma Cube, youth step in and out of two perspectives: an embodied perspective as they move the puzzle pieces, and an observer stance, when they move back to observe someone else putting in a puzzle piece, offering a bird's eye view.

2. Literature review

Embodied learning theory posits that humans learn with their whole bodies, in experiences with tools and with other people, through which they develop concepts with analogous components in the world (Hall & Nemirovsky, 2012).

Opportunities to develop spatial reasoning are rare in the school mathematics curriculum, where one might expect them (see CCSS-Math to observe how rare they are). Yet spatial reasoning has been linked to success in STEM (Wai, et al., 2009) and in mathematics (Atit et al., 2022) and is recommended by NCTM for all grade levels (2000). Qualitive research has demonstrated that *making* activities provide rich opportunities to develop and use spatial reasoning (Ramey, K. E., Stevens, R., & Uttal, D. H., 2020). The out-of-school activities in this study have a strong focus on mental rotation, one category of spatial reasoning, (Shriki & Patkin, 2021), through students performing physical rotations, which have been identified as useful activities in developing mental rotation skills (e.g., Bruce, C. D., & Hawes, Z., 2015).

3. Design and methodology

We present activities from a co-design project to explore how an in-school set of curricular materials (MPACT) addressing mathematics, spatial reasoning, and making could be modified for use by informal learning facilitators in an afterschool program provided at a community-based organization (CBO) in California. TERC researchers provided hands-on professional development through three 3-hour trainings and on-site support during implementation in the fall of 2024.

Two pilots occurred of the human-sized puzzle activity. The first pilot took place at an established after-school homework club. Youth engaged in a variety of activities to develop spatial reasoning skills. They 3D printed their own designs in the first few sessions, and then in a session, they created a human-scale Soma Cube, made of 1'x1'x1' cardboard boxes. A Soma Cube is a 3x3x3 cube created from seven unique puzzle pieces, each made with 3- or 4- unit-cubes. During the first week of the Soma Cube activity, youth work individually or with tablemates with small 1-inch linking-cubes to create the seven puzzle pieces (Figure 1a). During the second week, teams of 3-4 youth each created one of the seven puzzle pieces with large carboard boxes as unit cubes (Figure 1b). Then, they collaborated as a whole class to build the 3' × 3' × 3' Soma Cube puzzle (Figure 1c). A second pilot occurred at an additional site during their weeklong Spring break camp. These youth participated in the bookmark activity and Soma Cube activity over two days.

Figure 1. Pilot 1 (a) 1-inch linking cubes, (b) puzzle piece with large box, (c) large complete Soma Cube.

Researchers were present for key sessions with youth, and these sessions were photo- and video-recorded. Researchers asked youth about their methods for putting together the cube as they supported facilitation. The researchers wrote up descriptive notes after the session, and facilitators participated in post-session interviews. A larger research team watched the session videos together to identify key interactions around the Soma Cube construction, including verbal and non-verbal communication amongst the youth, and between youth and facilitator (Merriam & Tisdell, 2016, Lincoln & Guba, 1985).

4. Findings

Pilot 1

During the linking cubes activity, each youth successfully created a set of seven puzzle pieces, occasionally with hints or referencing peer's solutions. Most went on to find and assemble at least one full Soma Cube solution, although a few lost interest as they struggled to complete the cube.

Engagement was more sustained during the large cardboard cube assembly. Most youth remained engaged for over an hour as they constructed the human-sized individual puzzle pieces and the assembled Soma Cube. Working in pairs or trios, they used the small linking-cube versions as guides to build the cardboard pieces. Notably, youth who had previously disengaged were now actively participating with their peers. The scale of the cardboard pieces demanded collaboration. All 18 youth initially worked together to assemble the cardboard Soma Cube, following the lead from the one youth who had completed the smaller version. Despite the challenges of working in a large group, they completed the task successfully.

To promote deeper individual engagement, the facilitator later divided the class into small groups of 5-6, each taking turns to build the cube, ideally using alternative solutions—of which there are over 200. Compared to the previous week's smaller linking cube activity, youth progressed further with the larger version. They also showed visible excitement, joy, celebrating their progress by cheering and playfully drumming on the puzzle pieces and the assembled cardboard Soma Cube.

Pilot 2

In the second pilot, Soma Cube building took place over two days. On the first day, youth created the puzzle pieces with linking cubes. Some quickly found the seven pieces, while others struggled to keep track of the design constraints and required more frequent hints from facilitators. Several youths successfully assembled the 3x3x3 cube after multiple attempts, demonstrating persistence. Others, however, gave up after their first failed attempt.

On the second day, pairs or trios collaborated to build each Soma Cube pieces with one cubic foot cardboard boxes. The large-scale pieces invited joyful make-believe interactions. Some youth used two of the large puzzle pieces to build a "lemonade stand" and 'served' lemonade from the T shaped puzzle piece. As a whole group, they spent 30 minutes trying to build the Soma Cube. While some youth persisted the entire time, others moved in and out of the activity. One or two youth chose to solve the cube with a smaller 3D printed version, intending the whole group to replicate their solution.

Meanwhile, those working with the large pieces attempted several iterations without success. Once the small-scale team arrived at a solution, they shared it with the group. Mapping the small solution to the large solution proved challenging and required extensive communication, including naming pieces for clarity. A particular linguistic mathematical challenge was communicating how pieces should be rotated. Words like turn and flip were used often, but which axis of rotation was not typically specified. This sometimes resulted in repeated requests, yelling, and occasionally, youth taking over rotating the piece. This group only completed one solution of the Soma Cube puzzle before the end of program time.

Figure 2. Pilot 2: Make-believe lemonade stand made from two puzzle pieces.

5. Discussion

Both groups of youth showed increased engagement with the Soma Cube activity with the human-scaled version of the puzzle. We conjecture that this has to do with the novelty of having such large manipulatives as well as the desire for and the space given to imaginative play during the activities.

Assembling the larger puzzle resulted in more active participation and more successful solutions. This may be in part because it is the second time youth engaged with the puzzle pieces, albeit at different scales. We conjecture that that the performative nature of such a collaborative project keeps most youth motivated and engaged for a longer time on the task.

Both groups struggled with communicating how to move the large cardboard pieces to complete the Soma Cube puzzle. This is not a surprise, given that we do not really teach 3D manipulations in elementary school, or really ever (e.g., Smith, 2005). Youth used everyday language to try to convey what they were envisioning in their heads: "Turn it this way." In many cases, the object referred to by the word "it" was understood – as there was pointing or touching of the piece. However, it was not always clear which axis the piece should be turned over. Often the turn happened as a rotation around the z-axis, keeping the base of the piece oriented towards the ground. And just as often, the intended move required a rotation around a horizontal axis.

The learning activity along with the human-sized Soma Cube puzzle offered three key features as follows: 1) the scale encourages collaboration along with the associated communication work; 2) the size may encourage learners to mentally rotate an object due to the effort needed to physically rotate it; and 3) the manipulation of large size pieces may engage different embodied learning as it involves different muscle groups and movements for the different rigid transformations.

This case shows the promise of large-scale objects for supporting the development of spatial reasoning skills in ways that engage youth. Because spatial thinking is associated with success in STEM disciplines, including mathematics, these activities are particularly important for students who are historically marginalized.

6. Limitations

The informal learning settings for the activities we described constrained (perhaps productively so) the mathematical activities to those that would be actively engaging to the participants. Participants, even when they are at an age where their families choose their afterschool settings, have little incentive to engage in activities that they would not enjoy. It is possible that in a formal school setting that large scale manipulatives could support even more challenging spatial reasoning tasks along with the associated need for group mathematical communication. The participants' general expectations of the kind of learning they would be engaging in could have also affected participants' willingness to engage with what can sometimes be frustrating mathematical puzzles. Similarly, the research team did not have resources available to study the socio-mathematical norms of the programs. These norms, of course, can have a significant impact when participants (and their facilitators) engage in group math activities.

Further research with large scale manipulatives is certainly warranted given the joyful engagement and active spatial reasoning we have observed. Given the strong connection between spatial reasoning and successful STEM learning, the promise of building spatial reasoning skills and mathematical language, the promise of productive learning with large scale manipulatives is too great to ignore.

Acknowledgments

We'd like to thank the facilitators, staff, and youth at Family Connections Center. We also thank the Mathematics, Spatial Reasoning, and Computational Thinking Through 3D Making (MPACT) research project for the materials, and TERC for the internal research grant that supports this work. The work presented here was also in part inspired by the Making Math Visible project from George Hart and Elisabeth Heathfield (https://makingmathvisible.com/index.html).

References

Atit, K., Power, J. R., Pigott, T., Lee, J., Geer, E. A., Uttal, D. H., ... & Sorby, S. A. (2022). Examining the relations between spatial skills and mathematical performance: A meta-analysis. *Psychonomic bulletin & review*, 1-22.

Bruce, C. D., & Hawes, Z. (2015). The role of 2D and 3D mental rotation in mathematics for young children: what is it? Why does it matter? And what can we do about it?. *ZDM*, *47*, 331-343.

Carbonneau, K. J., Marley, S. C., & Selig, J. P. (2013). A meta-analysis of the efficacy of teaching mathematics with concrete manipulatives. *Journal of educational psychology*, *105*(2), 380.

Hall, R., & Nemirovsky, R. (2012). Introduction to the special issue: Modalities of body engagement in mathematical activity and learning. *Journal of the learning sciences*, *21*(2), 207-215.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. India: SAGE Publications.

Linn, M. C., & Petersen, A. C. (1985). Emergence and Characterization of Sex Differences in Spatial Ability: A Meta-Analysis. *Child Development*, *56*(6), 1479. https://doi.org/10.2307/1130467

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative Research: A Guide to Design and Implementation*. United Kingdom: Wiley.

Moyer, P. S. (2001). Are we having fun yet? How teachers use manipulatives to teach mathematics. *Educational Studies in mathematics*, *47*(2), 175-197.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards for Mathematics*. Washington, DC: Authors.

NCTM. (2000). *Principles and standards for school mathematics*. Reston, VA: NCTM.

Ramey, K. E., Stevens, R., & Uttal, D. H. (2020). In-FUSE-ing STEAM learning with spatial reasoning: Distributed spatial sensemaking in school-based making activities. *Journal of educational psychology*, *112*(3), 466.

Shriki, A., & Patkin, D. (2021). Developing Spatial Skills through Mental Rotation Activities. *Mathematics Teacher: Learning and Teaching PK-12*, *114*(7), 536-544.

Smith III, J. P. (2005). Chapter 5: Mathematics at Work: Spatial and Geometric Reasoning in Tool-and-Die Machining. *Journal for Research in Mathematics Education* (Monograph).

Wai, J., Lubinski, D., & Benbow, C. P. (2009). Spatial ability for STEM domains: Aligning over 50 years of cumulative psychological knowledge solidifies its importance. *Journal of educational Psychology*, *101*(4), 817.

PEDAGOGICAL INTERPRETATION IN TEACHING GRADE 10 ACCOUNTING USING ADVANCED TECHNOLOGY: SOUTH AFRICAN PERSPECTIVE

Olwethu Solundwana, & Limkani Sincuba
Faculty of Education, Walter Sisulu University (South Africa)

Abstract

The qualitative study investigated the integration of technology in teaching Grade 10 accounting, focusing on a purposive sample of 15 accounting teachers from five schools in the OR Tambo Coastal region. The research explored how educators adapted their methodologies to incorporate various technological tools, such as online platforms and interactive software, following transformations prompted by the COVID-19 pandemic. Data were collected through in-depth interviews, revealing that while many educators adopted blended learning approaches that enhanced student engagement and promoted critical thinking, they faced challenges, including inadequate training, technical difficulties, and limited access to resources. Students also encountered barriers such as disparities in technological proficiency and access to devices. The study adopted a constructivist learning theory framework, suggesting that students learn best when they actively engage with the material and build understanding through experiences. To address these challenges, the study recommended ongoing professional development programs tailored for accounting teachers, prioritizing resource allocation for technology access, and establishing collaborative learning communities among educators. Additionally, training programs for students were developed to enhance their technological skills. Updating the curriculum to emphasize digital literacy and creating robust support systems for technical issues was essential. The study concluded that while technology integration offered significant benefits for educational outcomes in accounting, it revealed challenges requiring comprehensive training programs and strategic investments in resources. Future research should explore the long-term impacts of technology integration on student performance and identify best practices for teacher professional development.

Keywords: *Technology integration, blended learning, teacher training, student engagement, accounting education.*

1. Introduction

The integration of technology in teaching Grade 10 accounting has gained significance, particularly after the COVID-19 pandemic. The subject is crucial as it provides students with essential skills for the business world (Agustina & Setiawan, 2020). The pandemic required a shift from traditional classrooms to online learning, prompting educators to adopt innovative strategies to engage students effectively(Ahshan, 2021). Various technological tools, such as online platforms and interactive software, were utilized to enhance the learning experience (Haleem, Javaid, Qadri, & Suman, 2022). These changes aimed to maintain educational standards during challenging times while preparing students for a future where technology is integral to accounting practices (Agustina & Setiawan, 2020). Understanding these strategies was vital for improving teaching methods and ensuring students acquire necessary accounting skills (Ahshan, 2021). The research question identifies the teaching approaches educators employed to integrate technology into Grade 10 accounting instruction.

Research questions

1. What teaching approaches were employed by educators to incorporate technology in instructing Grade 10 Accounting students?
2. How do Grade 10 accounting teachers in South Africa perceive and implement advanced technology in their pedagogical practices?

2. Literature review

Recent studies highlight the transformative impact of technology in education, particularly in enhancing student engagement and critical thinking while improving access to learning materials (Okolie

et al., 2022). Innovative methods such as project-based learning and flipped classrooms have gained traction, promoting active student participation (Nkomo, Daniel, & Butson, 2021). However, many educators continue to rely on traditional teaching methods, indicating a need for effective training programs to facilitate meaningful technology integration. In Grade 10 accounting, the use of technology has become increasingly important post-COVID-19, yet its implementation remains inconsistent (Sangster, Stoner, & Flood, 2020). Teachers often struggle with modern technology despite acknowledging its significance for future job preparation. Addressing challenges such as technical issues, limited resources, and gaps in student technical skills is crucial for successful integration (Onyema, 2020).

2.1. Challenges faced by teachers in using advanced technology to teach grade 10 accounting

Recent research underlined the transformative role of technology in education, particularly in enhancing student engagement and critical thinking while improving access to learning resources (Nkomo, Daniel, & Butson, 2021). Innovative instructional methods, such as project-based learning and flipped classrooms, have gained popularity for fostering active student participation (Rothwell, 2020). However, many educators still rely on traditional teaching approaches, highlighting the necessity for effective training programs to support meaningful technology integration. In Grade 10 accounting, the importance of technology has increased post-COVID-19, yet its implementation remains inconsistent. Teachers often face challenges with modern technology, necessitating improved training and support to address technical issues and resource limitations effectively.

2.2. Challenges faced by grade 10 learners in learning accounting using advanced technology

Grade 10 learners face several challenges when using advanced technology to learn accounting, which can hinder their understanding of key concepts (Sangster, Stoner, & Flood, 2020). A significant issue is the gap in technical skills; many students lack the necessary abilities to operate advanced accounting software, leading to frustration. Additionally, unequal access to technology, such as computers and reliable internet connections, creates disparities in learning opportunities. The complexity of advanced software can also present a steep learning curve for beginners, discouraging participation (Rothwell, 2020). Furthermore, some students may resist using technology due to discomfort with change or a preference for traditional methods. A lack of teacher support further complicates these challenges, making it difficult for students to navigate software effectively (Nkomo, Daniel, & Butson, 2021). Addressing these issues requires enhanced training, improved access to resources, and robust support systems.

3. Theoretical framework

The study adopted constructivist learning theory, which posits that students learn most effectively through active engagement and personal experience (Banihashem, Farrokhnia, Badali, & Noroozi, 2022). Within the framework, students were encouraged to utilize technology to explore and apply accounting concepts rather than passively receive information. Tools such as interactive simulations and accounting software facilitate practice in real-world scenarios. Learner-centered pedagogy emphasizes active student participation, enabling teachers to create collaborative environments where students can ask questions and solve problems together (Banihashem, Farrokhnia, Badali, & Noroozi, 2022). Techniques like flipped classrooms and project-based learning further promote engagement and critical thinking. To effectively integrate technology, educators can employ models that evaluate technology use in lessons. Collaborative learning through online tools enhances understanding while developing essential workplace skills. Addressing challenges such as technical issues and inadequate teacher training is crucial for successful implementation.

4. Methods

4.1. Research approach

The study, titled "Pedagogical Interpretation in Teaching Grade 10 Accounting Using Advanced Technology," employed a qualitative research approach to investigate how teachers interpret and utilize advanced technology in their instruction (Chong & Reinders, 2020). A case study design focuses on specific educators and their methods, allowing for an in-depth examination of technology integration in accounting lessons. An interpretive approach was used to understand the meanings attributed to experiences with technology, exploring how both educators and students engaged with advanced tools in accounting education. Ethical guidelines were strictly followed, including obtaining participant consent and ensuring confidentiality. The study acknowledges potential limitations, such as a small participant pool that may affect generalizability (Chong & Reinders, 2020). Nevertheless, the approach aims to provide valuable insights into teaching practices in Grade 10 accounting through the use of advanced technology.

4.2. Population and sample size

For the qualitative study on integrating advanced technology in teaching Grade 10 accounting, the population consisted of 15 accounting teachers from various schools within the OR Tambo Coastal region that had incorporated technology into their lessons. The group was crucial as they directly experienced the impacts of technology on teaching and learning processes. The sample size was limited to facilitate in-depth insights into their experiences, providing a diverse range of perspectives on how they utilized technology in their classrooms. The sample size was suitable for qualitative research, emphasizing a deep understanding of experiences and opinions. By gathering data completely from teachers, the study uncovered effective strategies for technology use in accounting education while identifying the challenges they encountered. The focused approach enhanced teaching methodologies and ensured that educators were equipped to prepare students with the necessary skills for careers in accounting.

4.3. Data collection

Interviews were employed as the primary data collection method in the study, specifically through semi-structured interviews with Grade 10 accounting teachers (Mkhize, Mtshali, & Ntombela, 2023). The approach involved posing open-ended questions that enabled teachers to articulate their thoughts, experiences, challenges, and strategies regarding the use of technology in their instruction (Braun & Clarke, 2021). Such a method facilitated a deeper understanding of how educators integrate technology into their teaching practices and the various factors influencing their experiences.

4.4. Data analysis

The study employed thematic analysis to identify patterns and themes within the collected data (Braun & Clarke, 2021). The process involved systematically organizing information obtained from interviews, focus groups, observations, and documents to highlight key insights regarding the use of technology in the teaching of Grade 10 accounting (Mkhize, Mtshali, & Ntombela, 2023). By analyzing the data thematically, the research aimed to uncover significant trends and understand how technology is integrated into instructional practices.

5. Findings

Figure 1. Traditional vs. Modern Pedagogies in Accounting Education.

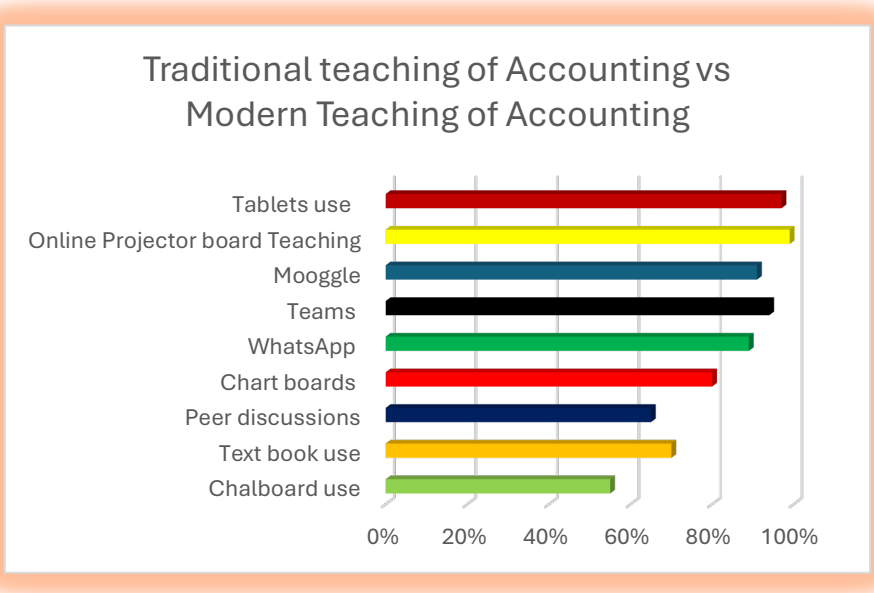


Figure 1 shows usage rates: chalkboards 55%, textbooks 70%, peer discussions 65%, chart boards 80%, WhatsApp 89%, Teams 94%, Mooggle 91%, tablets 97%, and online projectors 99%.

Figure 2. Pedagogy Challenges in Accounting.

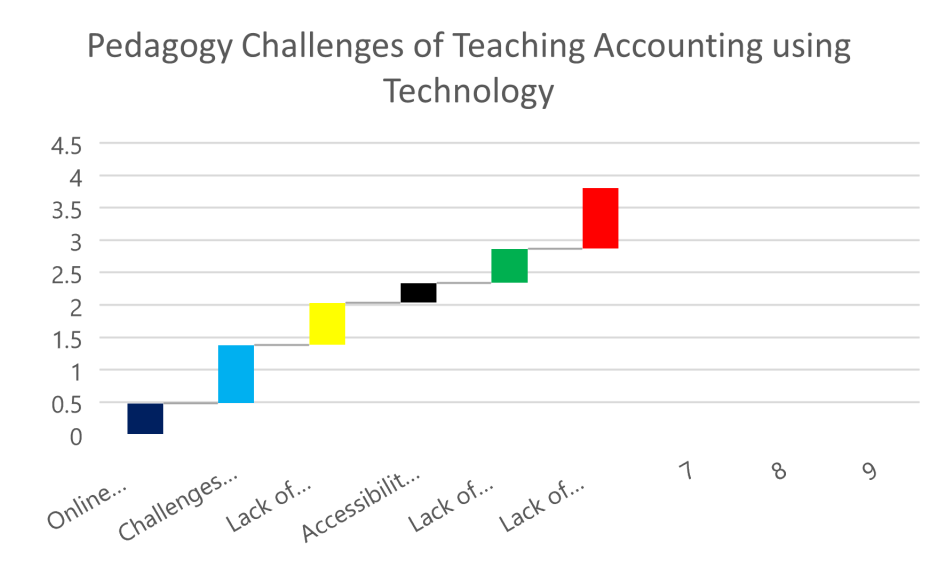


Figure 2 illustrates the challenges of pedagogy in teaching accounting with technology, highlighting issues such as teacher preparedness, resource limitations, and varying student readiness that hinder effective technology integration.

Figure 3. Effective Accounting Teaching Strategies.

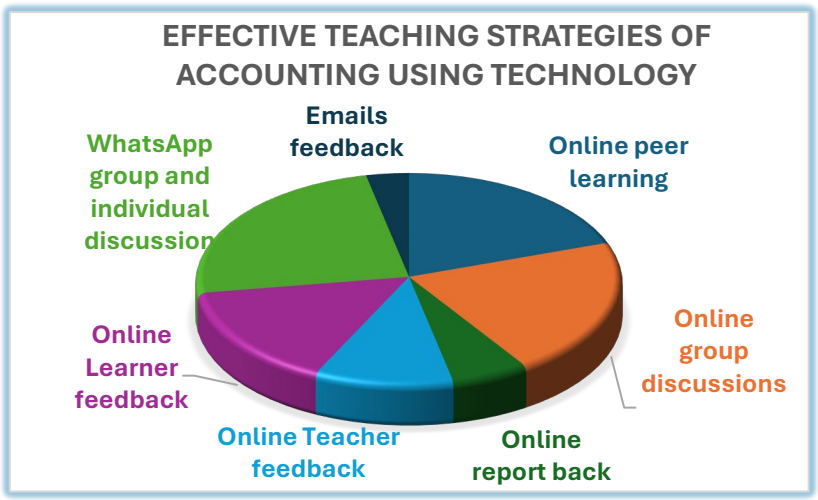


Figure 3 shows effective accounting teaching strategies: Email feedback 13%, WhatsApp discussions 94%, online learner feedback 60%, teacher feedback 41%, report back 23%, group discussions 82%, and peer learning 77%.

6. Discussions

The data revealed varying degrees of technology integration in accounting education, with significant preferences for digital tools (Onyema, 2020). Online Projector Board Teaching was the most utilized method at 99%, followed by Tablets at 97% and Microsoft Teams at 94% (Das, 2024). However, traditional methods such as chalkboards (55%) and textbooks (70%) remained common, indicating resistance to digital transformation (Oyinloye, 2022). The findings highlighted critical gaps in resources, teacher preparedness, and technological accessibility (Starkey, 2020). 94% of schools lacked projector boards, limiting educators' ability to present complex concepts effectively. Approximately 53% of teachers reported insufficient knowledge of online teaching methodologies, emphasizing the need for professional development (Sangster, Stoner, & Flood, 2020). Connectivity issues further complicated the landscape, with 90% of teachers experiencing online connectivity challenges. Effective teaching strategies emerged, with WhatsApp groups and individual discussions favored by 94% of participants (Nkomo, Daniel, & Butson, 2021). Adapting teaching strategies to incorporate interactive communication tools is essential for enhancing student satisfaction and improving learning outcomes in accounting education.

7. Conclusion

In conclusion, the qualitative study underlined the importance of effectively integrating technology into Grade 10 accounting education. While many teachers adopted blended learning approaches that enhanced student engagement and critical thinking, significant challenges persisted, including inadequate training, technical difficulties, and limited access to resources. These barriers not only affected educators but also created disparities in students' technological proficiency and access to devices. To address these issues, the study recommends ongoing professional development for teachers, improved resource allocation, and the establishment of collaborative learning communities. Additionally, enhancing students' technological skills and updating the curriculum to emphasize digital literacy are essential for successful technology integration in accounting education.

8. Recommendations

The study recommends implementing ongoing professional development programs specifically designed for accounting teachers to enhance their technological skills. It emphasizes the importance of prioritizing resource allocation to improve access to technology for both educators and students. Establishing collaborative learning communities among teachers is also suggested to foster shared experiences and strategies. Additionally, training programs should be developed for students to improve their technological proficiency. Updating the curriculum to emphasize digital literacy and creating robust support systems for addressing technical issues are essential steps. Future research should investigate the long-term effects of technology integration on student performance and identify effective practices for teacher development.

References

Agustina, L., & Setiawan, R. (2020). Fostering a natural atmosphere; improving students' communication skill in a business meeting. *Journal of Languages and Language Teaching, 8*(3), 307-314.

Ahshan, R. (2021). A framework of implementing strategies for active student engagement in remote/online teaching and learning during the COVID-19 pandemic. *Education Sciences, 11*(9), 483.

Banihashem, S. K., Farrokhnia, M., Badali, M., & Noroozi, O. (2022). The impacts of constructivist learning design and learning analytics on students' engagement and self-regulation. *Innovations in Education and Teaching International, 59*(4), 442-452.

Braun, V., & Clarke, V. (2021). Can I use TA? Should I use TA? Should I not use TA? Comparing reflexive thematic analysis and other pattern-based qualitative analytic approaches. *Counselling and psychotherapy research, 21*(1), 37-47.

Chong, S. W., & Reinders, H. (2020). Technology-mediated task-based language teaching: A qualitative research synthesis. *Language Learning and Technology, 24*(3), 70-86.

Das, M. K. (2024). *Teacher Education with ICT Tools and Techniques*: Academic Guru Publishing House.

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable operations and computers, 3*, 275-285.

Mkhize, M. V., Mtshali, M., & Ntombela, N. (2023). Teachers' Perceptions and Experiences of Teaching Accounting. *African Perspectives of Research in Teaching and Learning, 7*(1), 85-100.

Nkomo, L. M., Daniel, B. K., & Butson, R. J. (2021). Synthesis of student engagement with digital technologies: a systematic review of the literature. *International Journal of Educational Technology in Higher Education, 18*, 1-26.

Okolie, U. C., Igwe, P. A., Mong, I. K., Nwosu, H. E., Kanu, C., & Ojemuyide, C. C. (2022). Enhancing students' critical thinking skills through engagement with innovative pedagogical practices in Global South. *Higher Education Research & Development, 41*(4), 1184-1198.

Onyema, E. M. (2020). Integration of emerging technologies in teaching and learning process in Nigeria: the challenges. *Central Asian Journal of Mathematical Theory and Computer Sciences, 1*(11), 35-39.

Oyinloye, O. T. (2022). *Skills, Benefits and Challenges of Moving from On-Ground to Online Teaching and Learning of Office Technology and Management Courses.* Kwara State University (Nigeria),

Rothwell, W. J. (2020). *Adult learning basics*: Association for Talent Development.

Sangster, A., Stoner, G., & Flood, B. (2020). Insights into accounting education in a COVID-19 world. *Accounting Education, 29*(5), 431-562.

Starkey, L. (2020). A review of research exploring teacher preparation for the digital age. *Cambridge Journal of Education, 50*(1), 37-56.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

GENERATIVE AI AND CURRICULUM INTEGRATION POSSIBILITIES

Ronald J. Glotzbach
Purdue University / Associate Professor (USA)

Abstract

Generative AI is transforming industries through its ability to create new and original content, spanning text, images, audio, and video. Technologies such as Generative Adversarial Networks (GANs) and Natural Language Processing (NLP) models drive applications ranging from artistic creation to pharmaceutical innovation. The growing influence of generative AI presents an opportunity to reshape educational curricula, equipping students with the skills and knowledge to thrive in a technology-driven world. Integrating generative AI into the curriculum offers a hands-on approach to teaching essential concepts, bridging theoretical knowledge with practical applications and preparing students for real-world challenges. Curriculum integration can include practical projects such as chatbot development and image recognition systems, enabling students to apply AI techniques to tangible outcomes. These projects not only foster technical proficiency but also cultivate creativity, critical thinking, and problem-solving skills. Moreover, generative AI-powered tools, such as adaptive learning platforms, can enhance the educational experience by personalizing content to meet individual learning needs, ensuring that students build strong foundational knowledge while advancing in areas aligned with their interests and abilities. Incorporating generative AI into education also emphasizes interdisciplinary learning and ethical awareness. Students explore its applications across diverse fields, from healthcare to environmental science, while addressing issues such as algorithmic bias, data privacy, and responsible use. By embedding generative AI into the curriculum, educators can inspire students to innovate responsibly, preparing them to lead in a future where AI plays an increasingly central role in shaping industries and society.

Keywords: *Artificial Intelligence, AI, Generative AI, curriculum.*

1. Introduction

In the past few years, the rapid progress of generative artificial intelligence (AI) has created a transformative wave in many areas (Alasadi & Baiz, 2023), and education is no exception. Instructors are looking for innovative ways to engage students and trying to find the sweet spot where student creativity and better learning outcomes intersect. One of the potentially great opportunities that has surfaced along the way is the idea of integrating generative AI into our curriculum. This is a technology that can create not just text, but also images and, in some cases, music. And as impressive as the output is, the stronger selling point for us is the idea that this technology can help foster even more creativity and critical thinking on the part of our students.

Picture a classroom where students work with artificial intelligence to generate ideas for their projects or to get specialized feedback on their written work. Such collaboration could enrich the learning environment and give students a taste of the not-so-distant future when AI will fill all sorts of jobs, many of them potentially better than humans. Using the immersive or generative kind of AI, which across-the-board enriches the learning environment, poses some challenges.

When we investigate the promise of generative AI for curriculum integration, we must pay close attention to both the upsides and the downsides that teachers have to consider. Only then can we truly illuminate the pathways through which generative AI might be effectively integrated into educational settings, curricula, in particular, enriching the learning experience as it goes.

2. What is generative AI?

Content-creation systems made with generative AI algorithms are capable of creating all kinds of content – text, images, music, and much more – by learning the patterns of existing data. When given a prompt, these systems will produce a response that closely follows the patterns they have learned and, importantly, that also makes some sort of coherent sense. Generative AI relies on advanced algorithms,

particularly those that use deep learning and neural networks. Language models like OpenAI's GPT have revolutionized the generation of text (Zhang & Kamel Boulos, 2023). These algorithms are trained on large amounts of data, making them adept at dealing with the kinds of problems that require a human-level understanding of language, visual, and auditory elements. A large language model, for example, can produce text that is as yet indistinguishable from the kind a human author would produce (Baidoo-Anu & Ansah, 2023). The models that use visual art as their training base can generate original pieces that might mix and match elements from well-known or obscure figures across art history.

Perhaps the best-known instance of generative AI at work is in the use of Generative Adversarial Networks (GANs), which a company such as NVIDIA might use. GANs involve two neural networks, working against each other, that serve as quality control for the synthesized content (Fui-Hoon Nah, et al., 2023). In that regard, you could analogize GANs to a two-party government, working against each other to eventually render something appreciable to most. Generative AI has found applications in a number of areas, including but not limited to entertainment, education, and marketing, where it can assist in content creation, help with learning conditions, and make interactions more personal. Still, for curriculum developers, its ability to innovate and produce unique outputs is what really matters.

3. Enhancing curriculum through course integration

The last few years have seen the emergence of the integration of generative artificial intelligence into higher education curricula as a revolutionary method of augmenting the learning experience. This approach does not just pump up the content delivered to students, it pushes them to think and be creative at a level that is even more essential in the fast-paced, technology-driven world we live in. Using courses that cover a spectrum of disciplines as the stage, this method acts almost like a virtual low-risk, high-reward way of stimulating students to learn by engaging in with generative AI.

One of the main benefits of adding generative AI to the curriculum is its capacity to deliver personalized learning. It is a basic premise of education that it should be tailored to the individual. Yet, when we think about it, personalized education happens at only a few points during the day. One of those is during class, when teachers can be present for individual moments to help a student understand better. Another moment for this is during office hours and, by extension, during the moments when some privileged students get time with tutors. But all of this is a cap on the amount of personalized education that can happen.

In addition, generative AI can enhance cooperative learning. When AI tools that allow real-time collaboration are integrated, students can do much of the work of learning together. They can share ideas and receive instant feedback. This has the potential, I think, to take collaborative learning to a new level.

But what are we really talking about when we say collaborative learning? It has to start with some kind of foundation built on peer-to-peer learning. And the kind of interaction that students might have in using generative AI, if its use is monitored and directed by teachers, could lead to much more sustained, and more rigorous, interaction than has often been the case with collaborative learning.

Apart from offering individualized and cooperative learning experiences (Alasadi & Baiz, 2023), generative AI can significantly enhance the curriculum of several course disciplines. Within areas such as literature, history, or the sciences, it can produce simulations, creative writing prompts, or historical scenarios that incite students to immerse themselves in the subject matter. For example, in a literature course, AI can generate alternative endings to great novels. Such a prompt could not only enhance the creativity of mode of thought associated with the course but could also push students to think about the novel's themes and character motivations with a different intensity.

Additionally, incorporating generative AI into the curriculum prepares students for future careers in which they will rely heavily on this sort of technology. As the industries move forward, the demand for individuals who effectively use AI tools is going up. By using the tool in the classroom, we are equipping our students with a skillset that will serve them in the ultimately technology-infused job market of the near future. Students are not just using tools. They are using them to create and to innovate.

The successful integration of generative AI into the curriculum offers many advantages but also necessitates some careful consideration of ethical and other potential pesky implications. For the most part, the successful (or unsuccessful) implementation of AI will depend on how (and how well) educators themselves use the tools and technologies that will be available. Therefore, there is a strong push for professional development. Ongoing is the key word here: these tools will change (as will the ways in which we can use them), and our understanding of them will deepen.

The integration of generative AI into educational curricula brings a multitude of prospects for intensifying learning experiences. Generative AI can make education more personalized, enable collaboration among students, improve the richness of the content they study, and, in general, prepare them

for a future in which the use of AI will be ubiquitous. As with any technology, its effectiveness will be determined by the way it is harnessed in the service of better teaching and learning.

4. Implementing practical projects in curriculum

The infusion of generative AI into educational curricula provides an extraordinary opportunity to realize student engagement and learning outcomes. If the greatest potential of this technology is to be reached, then it will take much more than simply transforming student tasks through a new, fancy interface. It might be easy (and somewhat disingenuous) to label generative AI as magical or capable of doing the impossible, but if we step back and consider the outputs of this technology, they should be understood in the context of a more mundane input/output relationship.

There are several different kinds of practical projects, and they can take several different forms. Some practical projects are done in groups, while others are accomplished by individuals working alone. Some projects may invite students to do something close to traditional brainstorming (and even simulated group dynamics), while other types of projects may ask for a more straightforward application of generative tools. Regardless of kind or form, the project as a whole can benefit from the inclusion of generative AI.

In addition, hands-on projects can be crafted to solve actual problems, thus rendering the learning experience all the more pertinent and significant. Students can tackle matters that directly affect their communities or industries, allowing them to witness firsthand the relevance of their rigorous scholarly efforts. Generative AI can be used in this circumstance to provide data analysis, to come up with plausible solutions, or even to simulate what might happen if different decisions were made. In all these ways, the potential of generative AI to assist students in problem-solving becomes a direct benefit to the sharpness of their undergraduate experiences.

Another vital aspect of practical projects is collaboration. When students work in teams, they learn to communicate effectively, share responsibilities, and leverage each other's strengths. Generative AI can facilitate collaboration by offering platforms where students can do the above and also think up ideas, share resources, and give one another feedback, as well. And this is not only a remarkable, efficient, AI-generated platform for collaboration; it is also an enrichingly emissive, often enlightening one. What happens next serves as yet another helpful rehearsal for the real world.

Moreover, the inclusion of generative artificial intelligence in real-world applications can augment the evaluation of those projects. Real-world projects allow students to cultivate skills in digital literacy. Having the experience of working with AI during their coursework will allow them to become more efficient and more employable. When technology saturates society, knowing how to interact with and make the most of AI tools is essential. Students who engage with generative AI during the course of a practical project not only learn the ins and outs of using such tools but also contemplate what it means on an ethical level for us to be deploying AI in society. That sort of reckoning feels especially crucial for digital-first graduates who are about to enter a labor market that will increasingly reward prowess in working with AI.

The use of generative AI to augment practical projects in the curriculum allows a multidimensional form of education. It lets our students work with real problems; it helps our students to learn how to interact with one another in a virtual space; and it truly asks our students to engage with the tools of the modern world as they solve the problems put before them. This format is one way to adapt along with an ever-changing landscape.

5. Considerations

Incorporating generative AI into college curricula is not without its difficulties and potential pitfalls. But it is an endeavor that presents ample opportunity to enrich the learning experience when several key considerations are mindfully navigated by educators (Alasadi & Baiz, 2023). That navigation occurs here, and the considerations such as thoughtfulness, intentionality, valid uses, and instructional alignment are spelled out in ways that make sense for successful implementation of the technologies.

One of the vital factors to consider is the AI alignment with educational aims. Educators must ensure that the AI integration into their classes is in service of, and not a distraction from, the learning objectives they have already set. Integrating AI into the classroom is not a standalone initiative; it must work alongside pedagogies that have already been proven scalable. Among those, of course, is personalized learning. AI has the potential to make that promise even more real, if not more potent.

Another major factor is the ethical side of using AI in education. Because AI systems can create content that looks like it came from a human, there are worries about things like plagiarism, academic integrity, and whether the work being done by students is actually their work. Colleges and universities need to come up with clear policies that tell not just students but everyone what is okay and what is not when it comes to using AI. And they need to have these conversations in a way that does allow for using

AI as a sort of educational assistive device, while still making clear that it cannot be used in any way that could be seen as violating the long-held tradition of academic integrity.

Questioning bias in AI algorithms raises important equity issues for education. AI systems are only as good as the data they are trained on, and if this data is even slightly biased, the AI will likely be biased too (Baidoo-Anu & Ansah, 2023). Because the potential for bias, and poor outcomes for students, is such a fundamental issue, colleges must be proactive in selecting AI tools that are transparent, understandable, and fair. Ensuring these three qualities may not be easy and could require collaborating with the developers of the AIs being considered for use.

Another critical consideration is the professional development of faculty. Many educators may feel apprehensive about integrating AI into their teaching practices because they are not familiar with the technology. But providing training and resources can empower faculty to effectively incorporate AI into their curricula. This develops their enhanced teaching strategies, yes, but it also equips them to help students work through the many ways AI will affect the students' academic lives.

Moreover, the infusion of AI into programs of study requires examining where the current institutions stand, technologically speaking. The colleges that make up this country must invest in the application tools and resources necessary to support AI, so that both students and faculty can access dependable technology. Assessing and giving feedback on the integration of AI into the curriculum can help evaluate its effectiveness. Input from students and faculty can offer valuable insights into which aspects of AI integration are effective and which need improvement. This is a mechanism for assessment, but assessment can also happen at a higher level, almost like holistic AI integration baked into the curriculum. When institutions do this and, importantly, include students in the conversation, they foster an environment of open dialogue and reflection.

6. Future implications

Curriculum generation may be transformed by the inclusion of AI. Utilizing AI to help model curriculum, generate course components, and assist with course materials may be a game-changer for educators and the programs they work for. The integration of artificial intelligence into educational curricula has profound implications for the future of learning and workforce development. As colleges and universities increasingly adopt AI-driven tools, they seem all but certain to evolve toward more personalized, pedagogically sound models of curricula that stress problem-solving, critical thinking, and digital literacy. AI continues to shape industries and redefine job roles, equipping students with AI knowledge and skills ensures they are prepared to thrive in a technology-driven world. By embedding AI into the curriculum, educators can foster a generation of learners who not only understand AI’s capabilities but also its ethical and societal impacts. This forward-looking approach positions education as a critical enabler of innovation and adaptability.

The future of meaningful work is also uncertain (Bankins & Formosa, 2023). Meaningful work is the degree to which a person, teacher, or student feels their work has some worth, or meaning, in terms of what they are doing (Lysova et al., 2019). As AI makes answering questions or accomplishing tasks more trivial, how a person handles the quick responses and utilizes them will have an impact on how much worth they feel their work has (Bankins & Formosa, 2023).

One significant implication is the democratization of technology skills. As AI becomes more accessible, students from diverse backgrounds can gain proficiency in tools and techniques previously limited to specialists. This inclusivity can help bridge the digital skills gap, enabling a broader workforce to participate in the growing AI economy. Utilizing AI as an assistive agent can help teachers with high student-to-teacher loads be able to provide the type of inclusive education that will in turn make it more equitable. Moreover, introducing AI concepts early in education encourages students to pursue careers in STEM fields, fostering a pipeline of skilled professionals equipped to meet future demands.

How students learn is being reshaped by AI as it brings new opportunities for creating adaptive learning systems and more personalized educational experiences. These new AI tools are smarter than ever, they can get to know an individual student and understand how he or she learns best, which would benefit instructors in creating individual education plans (Alasadi & Baiz, 2023). The potential of AI to engage students and retain the knowledge that they are learning is exciting. Beyond that, students will be introduced earlier to AI in a world where knowledge of technology is more important than ever before.

Properly prepared students are the most important aspect of a good curriculum. Prior to AI, institutions have spent countless hours developing curriculum that meets the standards of prospective employers, but with the help of AI, that development time may decrease significantly. Integrating AI into curricula prepares students to be not just consumers of technology but active contributors to its development, ensuring they play a pivotal role in shaping a future influenced by AI innovations.

7. Conclusions

Artificial intelligence, indeed, has tremendous capabilities and implications. This technology could reshape our professions, especially education, and how we perform at our jobs (Alasadi & Baiz, 2023). It is not often that something comes along that has educators learning how it can be used while simultaneously needing to teach students how they can use it and be better prepared for the job market. The integration of generative AI into educational curricula is a critical step toward preparing students for a future where technology plays an even bigger role than it currently does. Generative AI allows us to approach the truly hard problems in life in new ways. We can use it to work through the kinds of complex, multidisciplinary challenges that call for not just one or two clean solutions but many potential paths toward resolution. Upon graduation, students will be faced with job prospects that are vastly different from just a few years ago because of AI. By embedding AI concepts into academic programs, educators can foster not only technical skills but also creativity, critical thinking, and ethical awareness skills (Alasadi & Baiz, 2023). Additionally, student collaborations on assignments and projects will produce works that embody diverse ideas and backgrounds that will lead to innovative solutions.

Projects that have practical applications, such as integrating AI behind the scenes of a web user interface or creating an image recognition system that automatically classifies and organizes uploaded images, give students the opportunity to obtain valuable hands-on experience that connects theory with real-world applications. When working on these kinds of projects, students build problem-solving skills, increase their technical abilities, and learn to work in teams – all essential attributes in today's job market. More often than not, these projects are also interdisciplinary and push students to think critically about the challenges that various fields of science and engineering face, from healthcare to the environment, and to use the technology at their disposal to come up with solutions that positively impact the world.

Using AI affects meaningful learning and work. For students, the use of AI to assist in completing assignments and projects may have them beginning to question the meaningfulness of their learning and of the work they completed. Similarly, instructors utilizing AI to assist in curriculum development, assignment development, and other tasks may begin to feel that the worth of their work has diminished. Meaningful work engages instructors and students alike (Lysova et al., 2019). With a decreased feeling of worth, students and instructors could experience mental and health challenges as a result. While AI may increase productivity, if it takes away from a person’s feeling of accomplishment, the overall result could be negative.

Transforming education, generative AI can provide tools to create adaptive, personalized, and unique content that meets the distinct needs of the individual learner. Personalized content provides a custom and individual learning experience that is more inclusive to all students (Alasadi & Baiz, 2023). These advancements democratize access to quality education, empowering students from diverse backgrounds to excel. Furthermore, by introducing AI concepts early in education, institutions inspire a new generation of innovators who will shape the future of industries and drive technological progress. The inclusion of generative AI into curricula highlights the importance of adaptability and continuous learning, ensuring that students are equipped to thrive in an era where AI permeates every aspect of life.

References

Alasadi, E. A., & Baiz, C. R. (2023). Generative AI in education and research: Opportunities, concerns, and solutions. *Journal of Chemical Education*, *100*(8), 2965-2971.

Baidoo-Anu, D., & Ansah, L. O. (2023). Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. *Journal of AI*, *7*(1), 52-62.

Bankins, S., & Formosa, P. (2023). The ethical implications of artificial intelligence (AI) for meaningful work. *Journal of Business Ethics*, *185*(4), 725-740.

Fui-Hoon Nah, F., Zheng, R., Cai, J., Siau, K., & Chen, L. (2023). Generative AI and ChatGPT: Applications, challenges, and AI-human collaboration. *Journal of Information Technology Case and Application Research*, *25*(3), 277-304.

Lysova, E. I., Allan, B. A., Dik, B. J., Duffy, R. D., & Steger, M. F. (2019). Fostering meaningful work in organizations: A multi-level review and integration. *Journal of vocational behavior*, *110*, 374-389.

Zhang, P., & Kamel Boulos, M. N. (2023). Generative AI in medicine and healthcare: Promises, opportunities and challenges. *Future Internet*, *15*(9), 286.

LIFE SCIENCES TEACHERS' NEEDS AND CHALLENGES WHEN INTEGRATING INDIGENOUS KNOWLEDGE USING INTERACTIVE WHITEBOARDS

Lwazi Nsindiso Mkhwebane, Lydia Mavuru,
Patrick Thabo Makhubalo, & Khanyisile Nolwazi Sethole
Department of Mathematics, Science & Technology Education, University of Johannesburg (South Africa)

Abstract

The South African Curriculum and Assessment Policy Statement (CAPS) document for Life Sciences mandates the integration of Indigenous Knowledge (IK) in teaching to foster inclusivity and relevance of concepts taught. However, previous studies reveal that the meaningful and effective integration of IK remains challenging for Life Sciences teachers, particularly when using tools like Interactive Whiteboards (IWBs). The study reported herein sought to determine Life Sciences teachers' needs and challenges in using IWBs to integrate IK into teaching cellular respiration in Grade 11 classrooms. The study was underpinned by the Cognitive Justice framework, which advocates for equal recognition of diverse knowledge systems, and the Cognitive Theory of Multimedia Learning (CTML), which emphasizes the role of multimedia in enhancing learners' understanding. Using qualitative case study research design, 10 Grade 11 Life Sciences teachers were purposefully selected as participants from Johannesburg and Ekurhuleni Districts. Each teacher was interviewed once using a semi-structured interview schedule to establish their perceived needs and challenges using interactive whiteboards to integrate IK. Thereafter, each teacher was observed twice when teaching cellular respiration whilst integrating IK using an interactive whiteboard to examine their practices. Data was analyzed thematically, and two themes emerged: 1. Life Sciences teachers encounter challenges when using IWBs to integrate IK; and 2. Life Sciences teachers' needs in using IWBs to integrate IK. The findings revealed many challenges teachers encountered, which included a lack of appropriate infrastructure, persistent electricity cuts, unreliable internet connectivity, and insufficient institutional and policy support. Some teachers also acknowledged and demonstrated the affordances of IWBs when integrating IK. Based on the findings, it is recommended that: 1. There be an alignment between the Life Sciences curriculum stipulations and infrastructural development in schools and resource provisions for effective implementation; 2. There should be collaborative initiatives like Professional Learning Communities (PLCs) to facilitate the sharing of best practices and foster peer learning among teachers; and 3. Both pre-service and in-service teacher professional development programs should incorporate Information and Communication Technology (ICT) tools and IK integration as core components to provide practical, hands-on training to teachers.

Keywords: *Indigenous knowledge, interactive whiteboards, Life Sciences teachers, teachers' needs and challenges.*

1. Introduction

South Africa, often referred to as the "rainbow nation," is renowned for its rich diversity in racial, ethnic, linguistic, socio-economic, and cultural backgrounds. This diversity is mirrored in Life Sciences classrooms, which comprise learners from varied cultural, ethnic, and socio-economic contexts. Consequently, Life Sciences teachers face the critical task of cultivating a learning environment that reflects and responds to this diversity through both content knowledge and pedagogical approaches. The current South African curriculum, articulated in the Curriculum and Assessment Policy Statement (CAPS) for Life Sciences, emphasizes the integration of Indigenous Knowledge (IK) into teaching (Department of Basic Education [DBE], 2011). Steenkamp et al. (2019) define IK as a body of knowledge and practices developed within and passed down through local communities over generations. The call for IK integration is intended to foster culturally responsive and relatable learning environments, particularly benefiting learners from underprivileged and indigenous communities (Cronje et al., 2015; Mavuru, 2022). According to Sitsha (2023), indigenous learners often struggle to comprehend Life Sciences content due to its misalignment

with their cultural contexts. Mkhwebane (2024) similarly observed that many African learners struggle to connect scientific knowledge with their lived experiences and local contexts. de Beer and Whitlock (2009) attribute this challenge to the abstract and complex nature of Life Sciences concepts, which can obscure understanding and complicate learning. Additionally, Edson and Govender (2021) noted that Life Sciences content is predominantly rooted in European languages (e.g., Latin), practices, worldviews, and beliefs, thereby imposing additional cognitive demands on non-European learners. These learners often exert significant effort to decode and internalize scientific concepts and processes, further exacerbating educational inequities.

According to Slay et al. (2008), the current generation of learners exhibit a strong preference for interactive multimedia information and communication technologies (ICTs), such as IWBs). For this reason, this study strongly argues that by leveraging IWBs to support the integration of IK, Life Sciences teachers, and learners can benefit from a range of pedagogical affordances. Moreover, using IWBs facilitates the meaningful integration of IK and equips learners with essential 21st-century competencies, including digital literacy (Mokoena et al., 2021). Selepe et al. (2022) emphasize that IK is inherently characterized by familiar vocabulary and language accessible to learners. As such, its integration into Western science enables learners to comprehend scientific concepts more readily, rendering the subject more meaningful and relevant to their lived experiences and local contexts (Edson & Govender, 2021). This relevance is crucial, as indigenous learners lack motivation and interest in Science, Technology, Engineering, and Mathematics (STEM) disciplines, as da Silva et al. (2023) reported. In response, Nwokocha and Jegg-Lack (2024) advocate strongly for the integration of IK into STEM education, suggesting that it has the potential to rekindle learners' interest and motivation by bridging scientific content with their home environments.

Despite these benefits, existing research highlights that integrating IK in Life Sciences classrooms remains inadequate or poorly implemented by Life Sciences teachers (Mkhwebane, 2024; Cronje et al., 2015). Many teachers rely on traditional teaching methods, which often fail to sustain learner engagement and interest (Cronje et al., 2015). Moreover, the potential of ICT tools, such as IWBs, for facilitating IK integration is yet to be fully explored in Life Sciences teaching. Furthermore, Sitsha (2023) noted a persistent gap in the use of IWBs to support culturally responsive teaching, underscoring the need for further research and professional development initiatives aimed at equipping teachers to effectively integrate both ICTs and IK in Life Sciences education. Hence, the current study sought to determine Life Sciences teachers' needs and challenges in using IWBs to integrate IK. The following questions guided the study:

1. what are Life Sciences teachers' perceived needs and challenges in using interactive whiteboards to integrate indigenous knowledge?

2. How do Life Sciences teachers use interactive whiteboards to integrate indigenous knowledge?

2. Theoretical frameworks

This study is grounded in two theoretical frameworks: cognitive justice as pioneered by Visvanathan (1997) and the Cognitive Theory of Multimedia Learning (CTML) developed by Mayer (2024). Cognitive justice emphasizes the need for recognizing, respecting, and equally valuing diverse knowledge systems within society (Odora-Hoppers, 2015). Aligning with this principle, this study advocates for Life Sciences teachers to acknowledge and integrate marginalized knowledge systems, particularly Indigenous Knowledge Systems (IKS), into their teaching practices.

CTML, on the other hand, explains how learners construct meaning from multiple modes of representation, guided by three cognitive principles: dual-channel assumption, active processing, and limited capacity (Mayer, 2024). The theory emphasizes the importance of using multimedia learning tools, such as Interactive Whiteboards (IWBs), enabling learners to engage with content through visual and auditory modalities (de Silva et al., 2016). IWBs allow educators to present content using diverse media, including diagrams, text, sound, videos, and films, facilitating deeper comprehension through multimodal interaction.

3. Methodology

The current study followed a qualitative case study design (Creswell & Creswell, 2018). This design is more appropriate for studies exploring social or human phenomena. The current study explores Life Sciences teachers' needs and challenges in using IWBs for IK integration. Using purposive sampling (Cohen et al., 2017), 10 Grade 11 Life Sciences teachers from Johannesburg and Ekurhuleni from schools furnished with functional IWBs and more than two years of teaching experience were selected for this study. Semi-structured interviews followed by two lesson observations for each teacher were conducted for data collection. This data collection process enabled the researchers to gain elaborate and deeper insights

into Life Sciences teachers' challenges and needs when using IWBs for IK integration (Creswell & Creswell, 2018). Focus on the Integration of Technology Classroom Observation Measurement (FIT: COM) was used as a lesson observation protocol in conjunction with field notes to document the episodes that transpired amid the observations, especially how teachers employed IWBs when integrating IK.

Following Braun and Clarke's (2006) six-step approach, thematic analysis was used to analyze teachers' interview transcripts and lesson observation field notes. This method facilitated the identification of codes, themes, and patterns, ensuring a rigorous and systematic interpretation of the data. Dependability, confirmability, transferability, and credibility were employed to improve the findings' rigor, trustworthiness, reliability, and validity.

Different measures were implemented to ensure the study's compliance with the universal research ethical standards. Before data collection, the faculty of education ethics committee obtained an ethical clearance certificate (Sem-1-2024-084/10 May 2024). All the participants were informed about the study and requested to partake voluntarily without undue influence. Lastly, pseudonyms are used to protect the participants' confidentiality.

4. Research findings

The analysis of the findings led to the emergence of three themes in line with the study's research questions: 1. Life Sciences teachers encounter challenges when using IWBs to integrate IK and 2. Life Sciences teachers need to use IWBs to integrate IK. Each theme is discussed in detail below.

4.1. Life Sciences teachers encounter challenges when using IWBs to integrate IK

Findings from the semi-structured interviews revealed that Life Sciences teachers encounter numerous challenges when using IWBs to integrate IK. Teachers have raised concerns about learners' negative attitudes toward IK, particularly in the context of Life Sciences teaching. Xolani highlighted that learners often perceive IK as "traditional" and "outdated," knowledge deeming it irrelevant for inclusion in modern school curricula. This perception is especially pronounced in Life Sciences, a subject commonly associated with content grounded in Western scientific paradigms. He further noted that learners frequently question the relevance of IK by asking, "How is this relevant in 2024?" and subsequently lose interest in the topic. This indicates that, although teachers may be willing to integrate IK into their teaching, learners' dismissive attitudes can be a significant deterrent, potentially discouraging teachers from integrating IK into their lessons.

Another challenge teachers encounter is a lack of adequate professional development and training on using IWBs for IK integration. Khansani and Rendani pointed out that while they have received basic training on operating IWB, they have not been trained to use them specifically for IK integration. Coupled with this issue is that some teachers could not attend the workshops that GDE facilitated in the past. Nokuzola, one of the teachers, mentioned that due to workload, they could not make time to attend the limited training workshops that GDE facilitated on using IWBs as a tool for teaching and learning. Furthermore, Khensani also pointed out that *"we do not have proper training"*. In addition to teachers lack sufficient training, Xolani lamented that:

"Most teachers have minimal time, so they do not have enough time to attend the training because they have classes from 8 a.m until 4 p.m at noon."

This indicates that even though the GDE provided some workshops for teachers, some teachers were not able to attend due to time constraints, and those who attended did not benefit much, as the training took place after teaching when teachers were fatigued. Still, on training, teachers indicated that they have never received training on integrating IK using IWBs; they have only been trained on using IWBs. This means that teachers are unprepared to meaningfully and effectively use IWBs for IK integration.

Rendani further voiced that frequent power outages and poor internet connectivity in her school disrupted her use of IWBs when teaching. She mentioned that *"when load shedding strikes, that is it for us"*. Teachers also lamented the lack of teaching and learning materials that have IK-related content. Devika and Layla highlighted the lack of pre-existing materials such as textbooks, artifacts, and teaching aids. Teachers also further raised the issue of time constraints owing to the workload and teach-to-test pressure. Teachers said the following:

Devika: We cannot integrate IK because we are getting through the heavily assessed syllabus in the tests.

Themba: Our SMT is more concerned about us finishing the syllabus and making sure learners pass the assessments.

From the responses, teachers are not supported on IK and IWB integration. However, they are under pressure to finish the syllabus and ensure learning performs well in the assessments. This results in

teachers not integrating IK, which is often not assessed in Life Sciences. In addition, the time factor also comes in, as teachers need to focus more on teaching than searching for IK and IK-related resources.

The observed lesson also laid bare the challenges teachers encounter when using IWBs for IK integration in Life Sciences classrooms. Most of them showed a lack of digital skills to use IWBs, which indicates lacking professional development and training. For example, Layla only showed an image of an African lady brewing traditional African beer, while other teachers only mentioned this example for learners. Learners were not further engaged, and other multimedia elements of the IWB, such as simulations, videos, and audio recordings from IK-holders, were not explored. In addition, all the teachers used one example when teaching the topic of cellular respiration: traditional beer. This indicated that teachers lack examples of IK that they can integrate when teaching Life Sciences. In addition, this further confirms that teachers do not have guidelines from CAPS documents and textbooks at their disposal. As a result, teachers tend to rely on traditional teaching methods when integrating IK using IWBs.

4.2. Life Sciences teachers' needs in using IWBs to integrate IK

From the challenges teachers mentioned and experienced, it is clear that teachers need support from stakeholders such as GDE, DBE, SMT, and IK-holders to be proficient in using IWBs to integrate IK meaningfully. When asked about the support they needed, these are the teachers' responses:

Nokuzola: Schools should invite IK-Holders to share examples of IK that can be integrated into different topics.

Hunter: DBE should make more examples of IK available for teachers through CAPS documents and textbooks.

Rendani: We require more reliable school infrastructure with stable electricity and internet connectivity.

Themba: We need more collaborative opportunities as teachers to share best practices and strategies for using IWBs for IK integration.

Xolani also raised a most pressing need in line with the challenges raised by teachers: professional development and training from DBE and GDE are crucial. This support will enable teachers to be competent and confident in using IWBs effectively for IK integration. To sum up, teachers need support from various stakeholders such as colleagues, IK-Holders, SMT, DBE, and GDE. As mentioned by Themba, teachers need to create Professional Learning Communities (PLCs) for teachers to share best practices and examples of IK amenable for integration in different Life Sciences topics.

5. Discussion

The study's findings showed that most teachers encounter numerous challenges when using IWBs for IK integration. As such, these teachers need support from various stakeholders to mitigate and encounter these challenges for meaningful and effective Life Sciences teaching and learning. Teachers revealed they cannot access the necessary resources to help them integrate IK, such as textbooks, artifacts, and examples of IK. This aligns with a sentiment shared by de Beer and Whitlock (2009) that DBE has failed to provide teachers with clear guidelines to integrate IK. Also, Sitsha (2023) reported that teachers lack professional training on using appropriate teaching strategies when using technology to integrate IK. As a result, teachers often use traditional methods, such as sharing only one or two examples of IK (Cronje et al., 2015). This was also witnessed in this study, as teachers only used one example, IK, brewing traditional beer, by mentioning it or showing a static image. This indicated that teachers lack the knowledge of pedagogical content to integrate IK meaningfully.

Different scholars (e.g., Mokoena et al., 2021) have reported that when IWBs were installed in schools, teachers did not receive sufficient training on how to use them for teaching effectively. This claim corroborates the findings of this study, as many teachers lamented the lack of proper training on using IWBs. In addition, teachers have not received holistic training on integrating both IK and IWB when teaching. The challenges raised indicate that an intervention is required through support from various stakeholders. Edson and Govender (2021) recommended that teachers collaborate with IK-Holders to gain access to different IK amenable for integration, owing to teachers' lack of awareness of IK (Mkhwebane, 2024).

6. Implications, recommendations, and conclusions

Important findings of this study indicate that teachers encounter numerous challenges when they attempt to harness IWBs for IK integration; thus, urgent support is needed. Without support such as professional development and training on using IWBs to integrate IK, Life Sciences learners will continue to have less interest in the subject and perform poorly. In addition, teachers will continue to avoid using

IWB for IK integration. In contrast, others integrate IK as an 'add-on' by mentioning a few examples and showing static images to learners. If left unaddressed, all these challenges will cause the decolonization of our education system project to fail, especially in the 4IR era, where technology takes center stage in the classrooms. This study's findings have implications for in-service and preservice teachers' training on using IWBs to integrate IK meaningfully. This study recommends that teachers take the initiative to learn from each other through PLCs, where they will share best practices for IK integrating using IWBs. IK-holders should also share IK examples amenable to integration in Life Sciences teaching. Lastly, DBE and GDE should make technical support personnel available to assist teachers with technical issues.

References

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. https://psycnet.apa.org/doi/10.1191/1478088706qp063oa

Cohen, L., Manion, L., & Morrison, K. (2017). *Research methods in education*. Routledge.

Creswell, J. W., & Creswell. J. D. (2018). *Research Design: Qualitative, quantitative and mixed methods approaches* (5th ed.). SAGE Publications.

Cronje, A., De Beer, J., & Ankiewicz, P. (2015). The effect of an intervention programme on how science teachers view the nature of indigenous knowledge. In *Proceedings of ISTE International conference on mathematics, science, and technology education* (pp. 588-596). UNISA.

da Silva, C., Amorim, J. P., & Pereira, F. (2023). The integration of indigenous knowledge in school: A systematic review, Compare. *A Journal of Comparative and International Education, 1*(0), 1-18.

de Beer, J. C., & Whitlock, E. (2009). Indigenous knowledge in the life sciences classroom: Put on your de Bono hats! *The American Biology Teachers, 71*(4), 209-216. https://doi.org/10.1662/005.071.0407

De Silva, C. R., Chigona, A., & Adendorff, S. A. (2016). Technology integration: Exploring interactive whiteboards as dialogical spaces in foundation phase classrooms. *The Turkish Online Journal of Educational Technology, 15*(3), 141-150.

Department of Basic Education. (2011). *Curriculum and Assessment Policy Statement: FET phase, Life sciences*. South African Government Gazette.

Edson, M., & Govender, N. (2021). Creating Indigenous Knowledge Spaces in Physics Learning Environments: Postcolonial views and insights from high school physics teachers. *Universal Journal of Educational Research, 9*(9), 1628-1640. http://dx.doi.org/10.13189/ujer.2021.090903

Mavuru, L. (2022). Reimagining indigenous knowledge in a multicultural science classroom. *International Journal of Inclusive Education*, 1-17. https://doi.org/10.1080/13603116.2022.2127498

Mayer, R. E. (2024). The past, present and future of the cognitive theory of multimedia learning. *Educational Psychology Reviews, 36*(8), 1-25. https://doi.org/10.1007/s10648-023-09842-1

Mkhwebane, L. N. (2024). Life sciences teachers' integration of indigenous knowledge: A vision for making science classrooms culturally responsive. *EURASIA Journal of Mathematics, Science and Technology Education, 20*(8), em2483. https://doi.org/10.29333/ejmste/14859

Mokoena, M. M., Simelane-Mnisi, S., & Mji, A. (2021). Challenges and solutions for teachers' use of interactive whiteboards in high schools. *Universal Journal of Education Research, 10*(1), 36-47.

Nwokocha, G., & Legg-Jack, D.W. (2024). Reimagining STEM education in South Africa: Leveraging indigenous knowledge systems through the M-Show model for curriculum enhancement. *Journal of Social Sciences Research and Review, 7*(2), 173-189.

Odora-Hoppers, C. A. (2015). Think Piece: cognitive justice and integration without duress. *International Journal of Development Education and Global Learning*, 7(2), 88-101.

Selepe, K., Ramsaroop, S., & Carolin, A. (2022). Incorporating indigenous knowledge in the teaching of weather and climate in primary schools in KwaZulu-Natal, South Africa. *Journal of Geography Education in Africa, 5*(1), 1-25. https://upjournals.up.ac.za/index.php/jogea/article/download/3953/3724

Sitsha, M. (2023). *Exploring the Integration of Indigenous Knowledge (IKS) into the teaching of Life sciences through Information and Communication Technologies* (Master's Dissertation, North-West University).

Slay, H., Sieborger, I., & Hodgkinson-Willians, C. (2008). The use of interactive whiteboards to support the creation, capturing, and sharing of knowledge in South Africa. *Learning to Live in Knowledge Society, 281*(1), 19-26. https://doi.org/10.1007/978-0-387-09729-9_3

Steenkamp, J., De Beer, J., & Petersen, N. (2019). The conundrum of integrating indigenous knowledge in science curriculum themes: A review of different viewpoints. In *Proceedings of the 10th ISTE conference on Mathematics, science and technology education* (pp. 21-25).

Visvanathan, S. (1997). *A carnival for science: Essays on science, technology, and development*. Oxford University Press.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

REDEFINING WORKPLACE LEARNING: SLASHING ERRORS BY USING AUGMENTED REALITY

Christian Ploder, Teresa Spiess, Michael Kohlegger, & Robin Schmid
MCiT at the MCI Internationale Hochschule GmbH (Austria)

Abstract

Integrating Augmented Reality (AR) in workplace training offers new opportunities to enhance learning efficiency and reduce errors. This study examines AR's impact on assembly performance through a field experiment with a partnering company, comparing HoloLens 2-guided instructions with traditional paper-based assembly plans. Two groups (n=20) assembled a prototype drive unit under controlled conditions. Results indicate that AR users required fewer assistances, but statistical significance was not confirmed ($p = 0.734$). Learning retention was assessed through a second assembly without assistance, showing a minor error reduction ($p = 0.754$, insignificant). However, AR significantly improved assembly speed, with users completing tasks 9.12 minutes faster ($p = 0.011$). While usability challenges exist, AR boosts motivation and holds strong potential for Industry 4.0. Future research should explore optimization, cost efficiency, and long-term effects.

Keywords: *Augmented Reality, workplace training, learning efficiency, error reduction, industry 4.0.*

1. Introduction

Companies must continue training and onboarding new employees, which is often time-consuming and costly. Advances in digitalization and improved access to AI systems are opening up new opportunities, mainly through virtual (VR) and augmented reality (AR). Since their market launch, these technologies have offered potential for production, remote support, and digital training.

This paper examines the implementation of AR technology in companies, particularly concerning the necessary expertise, costs, and hardware requirements. One focus is on the advantages and disadvantages of AR in training and education. The methodology analyses the extent to which the use of a HoloLens 2 contributes to reducing the error rate and increasing time efficiency in a given assembly line.

Company processes are becoming increasingly complex, making onboarding new employees more difficult and causing high costs and time expenditures. AR technology, such as the HoloLens, offers the opportunity to digitalize training and further education and make them more efficient. Implementing AR technology creates innovative learning methods through the visual support of work steps.

The first part of this paper deals with the basics of AR technology, its advantages and disadvantages, and its difference from VR. It also examines the potential that implementation offers companies. In the third part, a field experiment is conducted within our partner company to analyze the efficiency of the HoloLens in prototype assembly. The focus is on error reduction, learning behavior, and the technology's expandability. Finally, the potential of AR integration and the insights gained will be evaluated.

2. Basics of augmented reality – Advantages and disadvantages

Augmented Reality (AR) is a computer-assisted technology that overlays digital information onto the physical environment in real-time. This allows users to interact with virtual objects while maintaining a connection to their real-world surroundings (Deppe et al., 2022, p. 351). The concept was first introduced in the early 1990s (Thomas, Metzger & Niegemann, 2018, p. 15). Unlike Virtual Reality (VR), which immerses users in a completely artificial environment, AR enhances the existing reality with digital elements (Zobel et al., 2018, p. 31).

As AR technology evolves, its application across various industries continues to expand, making exploring its advantages and disadvantages essential. Some key benefits of AR technology include its support for training and education through 3D visualization, which enhances knowledge retention and engagement (Roopa, Prabha & Senthil, 2021, p. 3861). Additionally, AR devices such as smart glasses offer hands-free interaction, allowing users to operate them through voice commands and gestures, thereby reducing the need for traditional input devices (Kind et al., 2019, p. 65). Another significant benefit is real-time data integration, enabling immediate data visualization, particularly useful in industries like healthcare and manufacturing (Bellalouna et al., 2022, p. 314). Unlike VR, AR also minimizes the risk of motion sickness, as it does not require full immersion, reducing the likelihood of VR-induced nausea (Kind et al., 2019, p. 67).

Despite its numerous advantages, AR technology presents several challenges that must be carefully considered before implementation. One significant drawback is the high cost associated with AR, including expensive hardware like the HoloLens 2 (approximately €4,000) and additional costs for custom software development (Radu & Schneider, 2019, p. 10). Technological limitations also pose a challenge, such as inferior performance in low-light environments and the limited accuracy of GPS systems (Zender et al., p. 6). The complexity of implementing AR solutions further complicates adoption, as these applications often require multidisciplinary collaboration, increasing development efforts (Zender et al., p. 6). Data privacy and security concerns arise from using AR devices like smart glasses, which can collect and store real-time user data, raising questions about anonymity and security (Acharya, 2020).

To fully grasp AR's role in the digital landscape, it is important to distinguish it from virtual reality (VR). Here are some fundamental differences between these two technologies.AR and VR differ significantly in immersion, hardware requirements, and user interaction. While VR creates an entirely virtual environment that disconnects users from the real world, AR integrates digital elements into the existing environment (Wohlgenannt, Simons & Stieglitz, 2020, p. 456). Regarding hardware, VR requires headsets that block real-world vision, whereas AR typically uses transparent smart glasses (Zobel et al., 2018, p. 31). The purpose of user interaction also varies, with AR primarily enhancing real-world tasks, while VR is mainly used for simulations and gaming (Zobel et al., 2018, p. 31).

While both AR and VR offer immersive experiences, AR’s ability to integrate with real-world tasks makes it particularly valuable for industrial and educational applications. Its growing adoption underscores the need for further research into its long-term impact and technological advancements.

3. Methodology

The methodology analyses how AR technology influences the error rate and learning behavior in new processes and further training in companies. The focus is on comparing conventional learning methods and using HoloLens glasses. Specifically, the study examines whether employees work more efficiently with AR than analog assembly plans when assembling prototypes or non-series production parts.

Important metrics are the number of assists required, the error rate, and the processing time compared between test groups with and without HoloLens. The field experiment was conducted in cooperation with an Austrian company, which provided assembly kits, 3D models, and test personnel.

Two groups (A and B) were formed for the experiment, each with 10 test subjects. Group A assembled the drive unit kit using the HoloLens 2 without access to an analog assembly plan. Instead, they used only the displayed 3D models and digital instructions. Group B, on the other hand, worked with a classic assembly plan printed on paper.

Both groups carried out the assembly on two consecutive days: On the first day, group A worked with the HoloLens 2 and Group B with the assembly plan for training. On the second day, both groups assembled the drive unit without aid. This allowed conclusions to be drawn about the learning behavior and efficiency of the HoloLens 2 in training new work steps.

The experiment is based on an experimental design in which Group B serves as the control group, and Group A represents the manipulated variable. The aim is to investigate the effect of the HoloLens 2 on assembly efficiency. The example drive unit kit used consists of eight individual parts and eight work steps. Initial tests showed an average assembly time of around 20 minutes.

The kit was chosen for its ideal complexity: It requires precise work without errors but remains manageable even for less tech-savvy test subjects. Both groups worked at identical assembly stations with standardized tools, screw containers, and the eight individual parts of the drive unit (see Figure 1).

Figure 1. Test setup assembly site.

The sample consisted of employees of the cooperating company who represented potential drive unit fitters. During the selection process, care was taken to ensure a heterogeneous composition regarding technical affinity and age group. All participants had to have no prior knowledge of drive unit assembly, be considered trustworthy, and be available precisely 24 hours apart on both test days. Participation was also voluntary. A total of 20 test subjects were randomly allocated to the groups to generate 180 data sets for subsequent analysis.

Potential confounding variables were identified and controlled to minimize external influences. Distractions caused by the working environment were to be avoided as far as possible. Therefore, the experiment was conducted in a remote assembly section, and all employees were informed in advance to minimize distractions. Noise was also recognized as a potential disruptive factor, as it could impair the concentration of the participants. For this reason, the quietest possible area was chosen for the experiment.

Another critical aspect was the technical reliability of the HoloLens 2. As a failure of the glasses would have falsified the test conditions, the battery charge was checked every time the participants changed, and the glasses were recharged during short breaks. In addition, the HoloLens 2 software was extensively tested in advance to avoid technical problems during the experiment.

On the first day of the experiment, two test subjects - one from group A (with HoloLens 2) and one from group B (with an analog assembly plan) - were tested simultaneously every 30 minutes. After a brief introduction, the experiment began. Group A was given an additional two minutes to test the controls of the HoloLens 2, including the functions for rotating, scaling, and moving objects. The time measurement then started for both participants.

Each test person assembled the drive unit at an identical, independent assembly station. Any necessary assistance and errors were documented during the process. It was explained to all participants in advance that screws only need to be tightened hand-tight so that this is not categorized as a source of error. The assembly began with the fixing of the cover plate with an M38 pan-head screw, followed by the assembly of the cable clamp with two cylinder-head screws. The holding clamp was then bolted to the wheel holder in the next step with the wheel drive using six bolts. The participants then fitted four guide rollers to the wheel holder using four pan-head screws. The grease was then applied to the pre-assembled bearing plate and retaining plate. In the next step, the bearing plate, wheel holder, and retaining plate were screwed together with six pan-head screws before the wheel was finally mounted with four cheese-head screws.

Once all the steps had been completed, the timing was stopped. On the second day of the test, all participants assembled the drive unit again - this time without the support of the HoloLens 2 or the assembly plan. The aim was to compare the learning behavior of the groups and to analyze the extent to which the use of the HoloLens 2 led to a more efficient way of working. Not only was there a direct comparison between the groups surveyed but also the individual progress of each participant between the first day of the test with aids and the second day without support.

4. Results

The field experiment results were analyzed using SPSS (Statistical Package for the Social Sciences). A total of 180 data sets were collected from 20 randomly assigned test subjects, divided into two groups (A and B). The study aimed to determine whether AR technology improves error rates and learning behavior in new processes and training. The hypotheses were tested using statistical methods.

H1: Group A requires fewer assistances on the first test day than Group B

The number of assistants was analyzed to assess whether the HoloLens 2 facilitates independent work. Group B required 14 more assistances than Group A, with a mean difference of 1.4 assistances. However, the Fisher's Exact Test yielded a p-value of 0.734, exceeding the 5% significance threshold. Thus, no statistically significant difference was found, and the null hypothesis was retained.

H2: Group A demonstrates better learning behavior than Group B

To evaluate retention, errors on the second test day were analyzed. Group B made an average of 0.3 more errors than Group A. However, the Fisher's Exact Test produced a p-value of 0.754, indicating no statistically significant difference in learning performance. Therefore, the null hypothesis is maintained.

H3: Group B completes the assembly process faster than Group A

To assess efficiency, the average assembly time was compared. Group A (with HoloLens 2) had a mean assembly time of 33.17 minutes, making them 9.12 minutes faster than Group B. The standard deviation analysis showed that Group A was, on average, 5.05 minutes faster. A Mann-Whitney U-Test yielded a p-value of 0.011, indicating a statistically significant difference in assembly time. Thus, Group A with the HoloLens 2 was significantly faster.

H4: Generation Z completes the assembly process faster than other generations

The data was analyzed to determine generational differences in efficiency. More than 50% of the participants belonged to Generation Z. A Kruskal-Wallis Test produced a p-value of 0.836, indicating no significant speed difference between generations.

H5: Technical affinity influences assembly speed

Participants rated their technical affinity on a scale from "very low" to "very high." 30% rated themselves as "high," while another 30% identified as "low" in technical affinity. A Spearman's Rank Correlation Coefficient Test resulted in a p-value of 5.4%, slightly above the significance threshold. Thus, no statistically significant correlation was found between technical affinity and assembly speed.

H6: Learning styles influence the number of assistances required

Participants were categorized according to Kolb's Learning Style Model. The Accommodating group (learning through trial and error) required the fewest assistances, whereas Divergent learners required the most. However, a Kruskal-Wallis Test produced a p-value of 0.749, meaning no statistically significant relationship was found between learning style and assistance needs.

5. Conclusion

The field experiment conducted in this study investigated the implementation of AR technology in prototype assembly to determine its impact on error rates and learning behavior in corporate training and new processes. The results provided valuable insights into the advantages and challenges of AR-based training.

The findings indicate that participants using the HoloLens 2 required less assistance than those without AR support. This is likely because they could analyze each work step in detail from multiple angles using the 3D model. However, initial difficulties in object manipulation (rotating, moving, scaling) were observed and mitigated by a two-minute familiarization phase. Furthermore, accommodating learners (learning through experimentation) appeared to benefit the most from AR-based instructions, requiring fewer assistances during assembly.

Another noteworthy observation was the high motivation among HoloLens 2 users, suggesting that AR technology can positively impact engagement. However, the direct relationship between motivation and learning outcomes was not analyzed and remains an open research question.

Finally, a larger sample size could enhance the statistical validity of future studies. However, the potential of AR technology in Industry 4.0 is undeniable. A strong emphasis on user-friendly programming will be key to maximizing its efficiency, a sentiment echoed by positive feedback from participants who worked with the HoloLens 2.

References

Acharya, A. (2020). Pros and Cons of Augmented Reality. *Honest Pros and Cons*. Last update 09.06.2024. https://honestproscons.com/pros-and-cons-of-augmented-reality/

Bellalouna, F., Langebach, R., Stamer, V., & Zipperling, F. (2022). Use Cases für industrielle Anwendungen der Augmented Reality Technologie. *HMD Praxis der Wirtschaftsinformatik, 59*(1), 309-328. https://doi.org/10.1365/s40702-021-00824-x

Deppe, S., Brünninghaus, M., Voit, M., & Röcker, C. (2022). Anwendungsszenarien für AR in der Produktion: Use Cases und Technologielösungen. *HMD Praxis der Wirtschaftsinformatik, 59*(1), 351-366. https://doi.org/10.1365/s40702-022-00838-z

Kind, S., Ferdinand, J.-P., Jetzke, T., Richter, S., & Weide, S. (2019, April). *Virtual und Augmented Reality: Status quo, Herausforderungen und zukünftige Entwicklungen* (180). TAB. Last update 09.06.2024. http://www.tab-beim-bundestag.de/

Radu, I. & Schneider, B. (2019). What Can We Learn from Augmented Reality (AR)? In S. Brewster, G. Fitzpatrick, A. Cox, & V. Kostakos (Hrsg.), *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (S. 1-12). New York, NY, USA: ACM.

Roopa, D., Prabha, R., & Senthil, G. A. (2021). Revolutionizing education system with interactive augmented reality for quality education. *Materials Today: Proceedings, 46*, 3860-3863. https://doi.org/10.1016/j.matpr.2021.02.294

Thomas, O., Metzger, D., & Niegemann, H. (2018). *Digitalisierung in der Aus- und Weiterbildung. Virtual und Augmented Reality für Industrie 4.0* (1. Aufl.). Berlin: Springer Gabler.

Wohlgenannt, I., Simons, A., & Stieglitz, S. (2020). Virtual Reality. *Business & Information Systems Engineering, 62*(5), 455-461. https://doi.org/10.1007/s12599-020-00658-9

Zobel, B., Werning, S., Berkemeier, L. & Thomas, O. (2018). Augmented- und Virtual-Reality-Technologien zur Digitalisierung der Aus- und Weiterbildung – Überblick, Klassifikation und Vergleich. In O. Thomas, D. Metzger & H. Niegemann (Hrsg.), *Digitalisierung in der Aus- und Weiterbildung* (S. 20–34). Berlin, Heidelberg: Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-662-56551-3_2

SMARTPHONES AS ANALYTICAL TOOLS TO STUDY THE PHOTODEGRADATION OF FOOD DYES IN A LABORATORY SETTING

Inés Adam-Cervera[1,2], Roberto Sáez-Hernández[3], Paula García-Balaguer[4], Sergio Armenta[3], Ángel Morales-Rubio[3], & M. Luisa Cervera[3]
[1]Department of Physical Chemistry, University of Valencia (Spain)
[2]Institute of Material Science, University of Valencia (Spain)
[3]Department of Analytical Chemistry, University of Valencia (Spain)
[4]Department of Optics, Optometry and Vision Sciences, University of Valencia (Spain)

Abstract

The use of smartphones as analytical tools represents an innovative approach that expands the possibilities for measurement in the field of chemistry. Thanks to their high-resolution cameras and advanced sensors, these devices can perform functions similar to those of traditional equipment such as UV-Vis spectrophotometers. Furthermore, their portability, low cost, and ease of use make them an attractive alternative, allowing students to interact with emerging technologies and promoting hands-on learning while reducing dependence on expensive equipment. In this study, a method has been developed for students of the course "Advanced Sample Preparation Methods. Sustainability in the Laboratory," of the Master's program in Experimental Techniques in Chemistry at the University of Valencia. The activity has as its main objective to introduce the smartphone as an analytical tool to study and optimize, in a collaborative way, the photodegradation conditions of persistent organic pollutants in a continuous system. To this end, synthetic food dyes are used as models of contaminants and a photodegradation system based on a suspension of titanium dioxide (TiO_2) activated with ultraviolet light has been designed. The methodological approach of the practice allows students to reinforce and apply their knowledge in a real environment, learning to assemble and operate a continuous photodegradation system, analyse the efficiency of the process and compare analytical techniques such as UV-Vis spectrophotometry and colorimetric analysis with smartphones. In addition, the structure of the practice encourages collaborative work and critical evaluation of the results, promoting comprehensive training in sustainable chemical analysis techniques.

Keywords: *Laboratory module, photodegradation, smartphone, UV-Vis spectrophotometer.*

1. Introduction

In recent years, the use of mobile devices in chemistry teaching has gained prominence due to their accessibility, versatility and ability to enhance their learning experience (Wijtmans et al., 2014). In particular, the integration of smartphones as analytical tools in the laboratory represents a methodological innovation that allows students to interact with emerging technologies and develop skills in chemical analysis. Thanks to their advanced sensors and high-resolution cameras, mobile phones can be used to perform colorimetric measurements, offering a fast, simple and low-cost alternative to traditional instruments such as UV-Vis spectrophotometers (Shogah et al., 2023).

At the same time, pollution by persistent organic compounds constitutes a major environmental problem, since these pollutants accumulate in ecosystems and can represent risks to human health. One of the most effective and sustainable strategies for their elimination is photodegradation, a process that uses light as an energy source to degrade these compounds without generating toxic by-products (Chen et al., 2020; Saeed et al., 2022). However, teaching this technique in the academic field requires approaches that not only address the theoretical foundations, but also allow students to apply knowledge in a real experimental context.

Within this framework, the laboratory practice presented in this work has a double purpose: to introduce students to the study of photodegradation as a sustainable technique for the elimination of contaminants and, at the same time, to incorporate the use of the smartphone as an analytical tool in the laboratory. The possibility of comparing the data obtained through UV-Vis spectrophotometry with the results of colorimetric analysis performed with mobile devices reinforces the learning of experimental techniques and allows the precision of this technology to be evaluated.

In addition, the activity is designed to encourage collaborative learning, promoting teamwork in the design of experiments, data analysis and interpretation of results. This methodology promotes critical thinking, evidence-based decision making and the development of essential skills for the professional field (Vaillant & Manso, 2019).

Ultimately, this internship combines technological innovation, sustainability and collaborative work, offering a comprehensive training experience that not only strengthens the understanding of advanced analytical techniques, but also raises students' awareness of the importance of chemistry in solving environmental problems and its role in the scientific challenges of the future.

2. Objectives

The main objective of this practice is to integrate the use of the smartphone as an analytical tool in the collaborative study and optimization of the photodegradation conditions of persistent organic pollutants in a continuous system. Through this strategy, we seek to promote active learning, teamwork and the incorporation of new technologies in the laboratory.

To achieve this purpose, a series of specific objectives have been established, both conceptual and didactic:

Conceptual specific objectives

- Analyze the photodegradation process of persistent organic pollutants using non-toxic synthetic food dyes as a model.
- Design and assemble a continuous system for the photodegradation of organic compounds.
- Identify and select the key parameters that influence the efficiency of the continuous photodegradation process.
- Implement a circular photodegradation system that allows the reuse of the catalyst and minimizes the generation of waste.
- Apply rigorous analysis techniques using UV-Vis spectrophotometry to evaluate the degradation of the compounds studied.
- Introduce the use of smartphones as a fast, simple and low-cost alternative for the colorimetric analysis of samples.
- Interpret the results obtained and formulate consensual conclusions on the optimal conditions for the photodegradation of the compounds analyzed.

Specific educational objectives

- Explore and apply in a practical way a methodology widely used in the industry for the elimination of persistent organic pollutants, addressing a real environmental problem.
- Put into practice theoretical knowledge acquired throughout academic training in relation to the operation of continuous systems.
- Promote collaborative work in the selection and optimization of the parameters that affect the photodegradation process.
- Incorporate new technologies in laboratory practice to enhance student motivation and learning.
- Promote critical discussion and analysis of the results among the different work groups, favoring the collective construction of knowledge and the elaboration of well-founded conclusions.

3. Activity description

3.1. Educational context

This activity is carried out by a total of 25 students, within the framework of the subject “Advanced sample preparation methods. Sustainability in the laboratory”, of the Master in Experimental Techniques in Chemistry of the University of Valencia. The subject, of a practical nature, is aimed at teaching advanced methodologies for sample preparation, with a special focus on sustainability within the chemical laboratory. It consists of a teaching load of 2 ECTS credits (equivalent to 20 hours of laboratory practice), of which 4 hours are devoted to this activity. Specifically, the time distribution is established at 3 hours for the assembly, performance of the experiment and data acquisition, and 1 hour for the discussion of results and the completion of the satisfaction survey.

3.2. Activity

The experimental procedure begins with the assembly of a continuous photodegradation system, which students must assemble with the materials provided. This system consists of a Teflon tube wrapped around an ultraviolet (UV) lamp and connected to a peristaltic pump, through which a solution of a non-toxic synthetic food dye circulates together with a suspension of the TiO_2 photocatalyst. During this assembly, participants learn to design a continuous flow system and to work with a circular photodegradation process that allows the reuse of the catalyst and minimizes the generation of waste, thus applying key knowledge about sustainability in the laboratory (Lamiri et al., 1999).

Once the system is assembled, each pair of students performs the experiment under specific conditions of lamp wavelength, light exposure time or photocatalyst concentration. They then repeat the procedure three more times, modifying the light exposure time. This phase of the practice allows them to apply in a practical way the theoretical knowledge acquired on continuous systems and improve their capacity for critical analysis and problem solving, while developing skills to implement methodologies used in the industry in the elimination of contaminants

To evaluate the effectiveness of the photodegradation process, students analyze samples before and after treatment using two methods. First, they use a UV-Vis spectrophotometer, a reference device that allows quantifying the degradation of the dye by comparing spectral signals. In parallel, they take measurements using the camera on their smartphone, photographing the samples along with a color chart to analyze the RGB codes and calculate the concentration of the dye. This part of the practice introduces the smartphone as a fast and accessible alternative for colorimetric analysis, encouraging the use of new technologies in the laboratory and exploring its viability as an analytical tool.

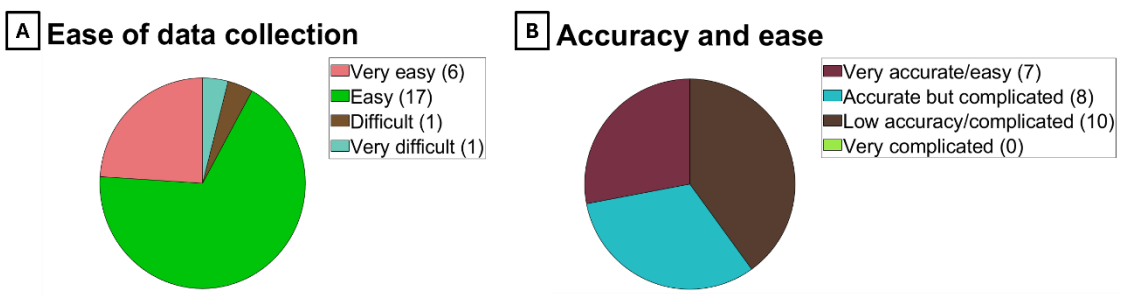
Once the experimental phase is over, all the pairs share their results in a discussion session so that they can collaboratively have an exhaustive study of the photodegradation conditions. Through this exchange, students analyse how the variation of the experimental parameters has influenced the efficiency of photodegradation and reach a consensus on the optimal conditions for the degradation of the dye studied. In addition, they compare the data obtained by spectrophotometry with those obtained through analysis with the smartphone, evaluating their reliability and usefulness as a measurement tool. This sharing promotes collaborative work and the development of critical analysis skills, allowing students to reflect on the precision and limitations of the methods used.

Finally, in order to assess the experience and the impact of the methodology used, students respond to a satisfaction survey. Through this evaluation, their perception of the use of the smartphone as an analysis tool, their understanding of the concepts addressed in the practice and the usefulness of the activity in their academic training are collected. The implementation of this methodology not only allows them to apply knowledge in a practical and realistic environment, but also encourages teamwork, critical thinking and the use of innovative technological tools in the field of analytical chemistry.

3.3. Results

Below are some of the results of the student satisfaction survey, which show that the use of smartphones during the practice was well received in terms of accessibility and ease of use. Most participants found it easy to collect color data using their mobile device (Figure 1A). However, when it came to centering the image and correctly photographing the sample (Figure 1B), some difficulties arose, suggesting that the precision of this method is not optimal. Additionally, although the methodology was considered somewhat intuitive, not all participants found it completely clear, indicating that it could benefit from better guidance or calibration to enhance the user experience

Figure 1. Results on the ease of data collection (A) and accuracy of the method used in the practice (B).

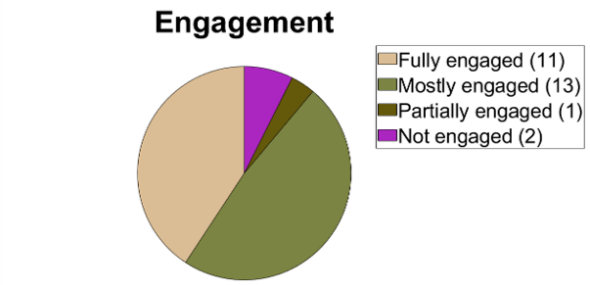


From the perspective of student engagement and interest, the activity was a success. Using smartphones was not only perceived as appealing and moderately innovative but also facilitated learning and helped students better understand theoretical concepts. During the practice, students were fully engaged

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

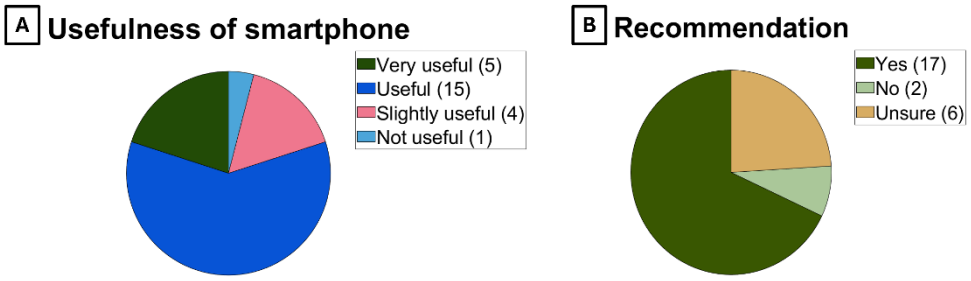
(Figure 2), suggesting that the use of technological tools can be a key factor in increasing motivation and participation in this type of activity.

Figure 2. Levels of student engagement and participation during experimental activity.



Regarding overall satisfaction, the results show that students consider smartphones a useful tool (Figure 3A) though not revolutionary. The comparison with other measurement methods did not reveal significant differences, as most participants rated this practice similarly to previous experiences. Despite this, they would recommend its implementation in future activities (Figure 3B), reinforcing the idea that this methodology is a valid complement to traditional methods.

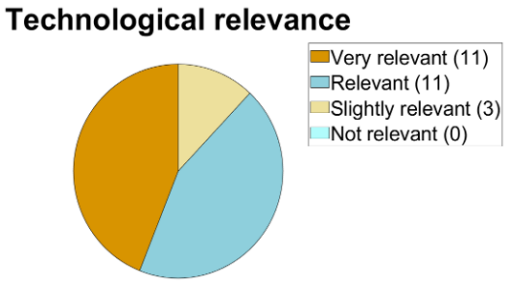
Figure 3. Student opinions on the usefulness of smartphones in practice (A) and their recommendation for future implementations (B).



On the other hand, the organization of time within the practice did not seem to pose a problem. Participants considered that the allocated time was adequate and that the different tasks within the practice were well balanced. Similarly, the level of difficulty was perceived as appropriate for the students' academic level, indicating that the activity was effectively designed without generating an excessive workload.

Finally, a key point to highlight is that most participants considered the use of smartphones to be very relevant to modern Analytical Chemistry (Figure 4). This supports the idea that integrating new technologies into chemistry education is not only feasible but can also provide significant benefits in terms of learning and motivation.

Figure 4. Perceived technological relevance of smartphone use in Analytical Chemistry.



4. Conclusions and future perspectives

The results obtained in this study show the positive impact of using smartphones in the analytical chemistry laboratory, highlighting their accessibility, ease of use and ability to encourage student participation. Furthermore, the comparison between the data obtained with the UV-Vis spectrophotometer and the RGB values captured by smartphones has allowed us to evaluate the reliability of this methodology and its potential in educational environments.

However, the study has also revealed challenges, particularly in relation to the accuracy and clarity of the instructions when capturing and processing images, suggesting that it would be advisable to improve key methodological aspects, such as calibration and standardization of the process, to optimize the accuracy and reproducibility of the results. In this regard, it has been proposed to develop an application that automates image processing and colorimetric analysis, reducing errors associated with manual adjustments.

Despite these challenges, the implementation of this technology has proven to be a valuable teaching resource, promoting active and motivating learning. Its integration into the laboratory not only favors the sustainability and accessibility of experimental practices but also contributes to the training of future professionals better prepared to face the challenges of modern analytical chemistry.

Acknowledgments

Authors thank the University of Valencia for an educational research project (UV-SFPIE_PIEC-3330106), and Inés Adam-Cervera thanks the University of Valencia for a predoctoral position “Atracció de Talent”.

References

Chen, D., Cheng, Y., Zhou, N., Chen, P., Wang, Y., Li, K., Huo, S., Cheng, P., Peng, P., Zhang, R., Wang, L., Liu, H., Liu, Y., & Ruan, R. (2020). Photocatalytic degradation of organic pollutants using TiO2-based photocatalysts: A review. *Journal of Cleaner Production, 268*, 121725.

Lamiri, A., Morales-Rubio, A., & de la Guardia, M. (1999). On-line photo-assisted catalytic degradation of carbofuran. *Ciencia, 7*(2), 157-162.

Saeed, M., Muneer, M., Haq, A. U., & Akram, N. (2022). Photocatalysis: an effective tool for photodegradation of dyes—a review. *Environmental Science Pollution Research, 29*, 293-311.

Shogah, Z. A. C., Bolshakov, D. S., & Amelin, V. G. (2023). Using Smartphones in Chemical Analysis. *Journal Of Analytical Chemistry*, *78*(4), *426.*

Vaillant, D., & Manso, J., A. (2019). *Orientaciones para la Formación Docente y el Trabajo en el aula: Aprendizaje Colaborativo*. Chile: SUMMA and “La Caixa” Foundation.

Wijtmans, M., van Rens, L., & van Muijlwijk-Koezen, J. E. (2014). Activating Students’ Interest and Participation in Lectures and Practical Courses Using Their Electronic Devices. *Journal Chemical Education, 91*, 1830.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

USE OF ART THERAPY WITH SPECIAL EDUCATIONAL NEEDS CHILDREN - RESEARCH ON THE ATTITUDES OF PSYCHOLOGISTS FROM THE MUNICIPALITY OF BLAGOEVGRAD

Sabina Eftimova, Teodora Genova, & Stefka Belyova
Department of Library Sciences,
University of Library Studies and Information Technologies ULSIT (Bulgaria)

Abstract

The study examines the use of art therapy as a therapeutic method for working with children with special educational needs (SEN) in the municipality of Blagoevgrad, focusing on the attitudes of psychologists towards this approach. Art therapy provides alternative forms of expression and emotional support that can be particularly effective for children with SEN for whom traditional methods of communication and therapy do not always produce the desired results. As part of the research, a survey was conducted with psychologists working with children with SEN in various educational and therapeutic institutions in the municipality. The aim is to analyze their attitudes, experiences and perceptions regarding the benefits and challenges of art therapy in the context of working with children with special educational needs. The results show that art therapy is accepted as a useful tool for stimulating the emotional and social development of children, but at the same time requires a broader understanding and additional qualification of specialists in the field. The report concludes with recommendations for the wider use of art therapy and the need for additional training and resources for psychologists working with children with SEN.

Keywords: *Art therapy, children with special educational needs, psychologists, Municipality of Blagoevgrad.*

1. Introduction

Children with special educational needs in Bulgaria face a number of difficulties associated with their adaptation to learning. The usual activities for other children sometimes present a painful experience (Mihaylova, 2017). In modern educational and psychotherapeutic practice, working with children with special educational needs (SEN) requires the use of diverse and innovative approaches that meet the individual needs and characteristics of each child. One of these approaches that is gaining more and more popularity is art therapy. Art therapy as a therapy method, which uses different forms of art - painting, sculpture, collages and others to help children express emotions, develop creativity and cope with difficulties related to socialization and emotional well-being.

In the context of children with SEN, art therapy offers an alternative channel for communication and emotional development, especially for those who experience difficulties with verbal expression. Despite the significant potential of this method, the attitudes and perceptions of professionals working with children with SEN, such as psychologists, play a crucial role in its successful implementation. This report aims to investigate the attitudes of psychologists in Blagoevgrad municipality towards the use of art therapy as an effective tool in their work with children with SEN.

The research will examine what place art therapy occupies in the practice of local psychologists, to what extent they consider it useful and suitable for children with specific educational needs, as well as what the main challenges and barriers to its implementation are.

2. Methodology

For the purposes of the study, two surveys were conducted using the Google Forms platform. The first survey was aimed at parents and addressed the topic: “Investigating Parents’ Perceptions of the Benefits and Challenges of Art Therapy for Children with Special Educational Needs (SEN)”. The second survey focused on psychology professionals who apply art therapy to children with SEN.

This report presents the results of the second survey, entitled “Investigating the Attitudes of Psychologists Using Art Therapy for Children with SEN”. The study involved 30 respondents – practicing

psychologists who apply art therapy methods in their work with children with special educational needs. The survey was conducted electronically, on a voluntary and anonymous basis, which ensures the credibility and free expression of the participants' opinions.

3. Results

To the first question, "How long have you been practicing as a psychologist?", the largest is the percentage of respondents who have 1-5 years of experience (30%), followed by the groups with 6-10 years and 16-20 years of experience (20% each). This shows that a large part of the participants are relatively new to the profession. The distribution of participants is across all possible categories of experience, indicating good performance at various stages of professional development.

When asked "Do you use art therapy in your practice?", 90% of respondents use art therapy in their practice and it is a technique that is popular among them. This may be due to the effectiveness of art therapy as a method of working with patients, especially in the context of psychotherapeutic or counseling practices. The remaining 10% of the respondents use art therapy partially or seldom.

"How do you rate the overall effectiveness of art therapy in working with children with SEN?", the analysis of the survey data shows that art therapy is a highly valued and effective technique when working with children with SEN. A closer look at the results shows the following:

1. Dominant Performance Rating (80%)

The highest percentage of respondents rated art therapy as very effective (rating 4.5). This shows considerable confidence in the therapeutic potential of this technique among specialists. Art therapy clearly figures prominently in their work, possibly being successful in promoting emotional expression, social skill development, and other aspects of the therapeutic process.

2. Average grade (16.7%)

The average rating (3) was given by 16.7% of the respondents. This may reflect the view that art therapy has its limitations in certain cases or with specific children, but is nevertheless a useful tool in practice. These professionals probably use it as an additional technique combined with other methods.

3. Little effective (3.3%)

The small percentage of respondents who rate art therapy as 2 indicates that there are known specialists who do not find it effective enough. This may be due to specific cases of children with SEN who do not respond well to this approach or perhaps to a lack of sufficient experience with the technique.

4. Absence of completely negative evaluations

The lack of respondents who rate art therapy as completely ineffective (rating 1) highlights that even among more skeptical professionals, it is not completely rejected.

The analysis of the data clearly shows that art therapy is perceived as a key and effective method for working with children with SEN, and the majority of specialists rate its role highly. Although there is some variation in evaluations, art therapy continues to be an important resource that is widely applied in practice.

"Which art therapy techniques turn out to be the most effective in your practice?" from the results obtained, it can be seen that the most popular and effective technique used is isotherapy with drawing, modeling with play dough and clay according to 70% of the respondents. Drawing and modeling with play dough and clay allow children to express their emotions and thoughts in a non-verbal way. In the context of art therapy, this type of expression is a powerful tool for self-regulation and emotional support, especially for children with SEN who may experience difficulties in communication.

Next comes music and dance therapy, which was rated as effective by 53.3% of participants. This therapeutic technique is also highly regarded and widely used. Music and dance stimulate motor activity, coordination and socialization while offering opportunities for emotional release and stress reduction. The technique can be used in group or individual therapy, helping to build relationships between children and their therapists.

Story therapy and bibliotherapy (36.7%) are relatively popular among specialists. These techniques use storytelling as a means of dealing with emotional and social challenges. By identifying with characters and situations in fairy tales, children can learn social norms as well as find solutions to their inner conflicts.

Art therapy with wool and other natural materials (33.3%) also has its application, but is less popular compared to other methods. The use of wool and natural materials stimulates children's senses and helps develop fine motor skills. This technique is especially useful for children who need tactile stimulation to focus and calm down.

Less used, but still indicated as effective techniques are sand therapy (23.3%) and theater (13.3%). The data highlight the diversity in professionals' preferences and the high level of trust in different art therapy methods. These results indicate that psychologists prefer techniques that provide flexibility and are easy to adapt to different therapeutic needs of children with SEN.

"Do you use bibliotherapy in your practice?", 40% of the surveyed psychologists actively use bibliotherapy in their practice. This shows that this method is widely accepted and considered effective for working with children with SEN. Bibliotherapy enables children to identify with characters and discover solutions to their own emotional and social problems through literary works. For these professionals, bibliotherapy is an important tool in helping children develop emotional intelligence and cope with stressful situations. The largest percentage of respondents (43.3%) indicated that they use bibliotherapy "somewhat". This may mean that although they are familiar with the methodology and apply it in some cases, they do not use it as a primary or regular tool. It is possible to integrate bibliotherapy in combination with other methods or to use it only in specific cases, as an additional approach to work with children. This indicates that the potential of bibliotherapy is recognized but may need greater implementation or resources for wider use. A small part of the respondents (16.7%) stated that they do not use bibliotherapy in their practice. This may be due to several factors, such as a lack of sufficient knowledge of this method, limited resources or a preference for other therapeutic approaches. Psychologists in this group may not see bibliotherapy as appropriate for their particular cases or may feel that other methods are more effective for the children they work with.

Bibliotherapy is a widely used and valuable method, with the majority of respondents (83.3%) applying it fully or partially. This shows positive attitudes towards the method and potential for its even wider implementation in practice with children with SEN.

The analysis of the answers shows a variety of difficulties that professionals face when working with children with SEN. Here are the key aspects that stand out:

1. Individuality of challenges: “There are always challenges, they are case-by-case.” This response emphasizes that each child with SEN is unique, and challenges vary according to their individual needs. Psychologists and therapists must adapt their methods, taking into account the specific characteristics of the child - be it communication difficulties, behavioral problems or motor skills.

2. Problems with concentration and attention: “Difficulty holding attention for a longer period” and “Keeping children's attention and engagement during art therapy”. One of the main challenges in art therapy is related to the difficulty of holding children's attention for a long enough time. Especially for children with autism, ADHD or other cognitive difficulties, the problem of concentration can be a significant obstacle. This requires therapists to constantly adapt materials and techniques to maintain children's interest.

3. Behavioral and communication difficulties: "Behavioral problems" and "Communication and behavioral difficulties". Children with SEN often have difficulties in social interaction and communication, which can make the art therapy process difficult. This can make the therapeutic process more difficult and require extra effort to create a safe and supportive environment.

4. Difficulties in motor and fine motor skills: “Fine motor skills are challenging for some children in drawing activities, etc.”. Children with SEN often have difficulty with fine motor skills, especially in activities involving drawing, modeling or other manual tasks. This can limit their ability to actively participate in some types of art therapy and necessitates the use of adapted materials or activities that stimulate fine motor development.

5. Initial predisposition and adaptation: "Children's predisposition to the various activities they are just being introduced to". Some children may resist new activities or have difficulty adapting to unfamiliar materials or work methods. This requires therapists to carefully plan and gradually introduce new techniques to reduce stress and stimulate children's participation.

6. Difficulties in expressing emotions: “Difficulty expressing emotions”. Art therapy is often used as a way to non-verbally express emotions, but for some children this can be challenging. Children with SEN may have difficulty understanding and expressing their emotions appropriately, making therapy more difficult and requiring additional effort on the part of the therapist.

7. Selection of materials and methods: “Selecting Appropriate Materials” and “Colors”. Selecting materials is an important aspect of art therapy. Therapists must carefully select materials so that they are appropriate for the child's abilities and needs.

8. Building Trust: "Building trust!" Working with children with SEN requires long-term trust building between the child and the therapist. The process can be lengthy and requires patience, especially for children with more severe disorders who need more time to become comfortable in the therapeutic environment.

9. Resistance from parents: “Resistance from parents.” In some cases, parents may show resistance or uncertainty about using art therapy. This requires therapists to work not only with children but also with parents to explain the benefits and reduce resistance.

General conclusions: concentration and attention are the most common challenges mentioned by specialists, who emphasize the need to adapt methods to keep children interested. Communication and behavioral difficulties are often a barrier to achieving effectiveness in therapy, which necessitates the

integration of additional strategies to deal with these problems. Motor skills and the expression of emotions also present a challenge that requires an individualized approach and appropriately selected techniques. Interaction with parents is also an important aspect to be addressed in order to reduce resistance and provide support for the therapeutic process. These challenges highlight the importance of flexibility and an individualized approach when applying art therapy to children with SEN.

The question "How do you think art therapy affects the social skills of children with SEN?" shows the majority of specialists (80%) rated the impact of art therapy on social skills as high or very high. Some of them give an average rating, which shows that some professionals see moderate effectiveness. The percentage of those who think that art therapy has low effectiveness in this area is very small (3.3%).

To the next question, "Do you notice improvements in the emotional state of children with SEN after art therapy sessions? Please give examples", analysis of observations on the effect of art therapy sessions on children with SEN shows the following main trends and improvements:

1. Improving the emotional state: children become calmer, more confident and in a better mood. Many of them manage to express their emotions more easily through creative processes such as drawing and modeling with clay. Children with autism show progress in expressing emotions through art, while children with ADHD show improvements in concentration and self-control.

2. Improving social interactions: after art therapy sessions, children often become more open to communication and freer self-expression. This leads to better social skills and interactions with their peers.

3. Strengthening self-esteem and confidence: art therapy stimulates children to feel significant and confident by providing them with an opportunity to express themselves and create. Participation in creative processes helps develop their emotional intelligence and creativity.

4. Development of cognitive and motor skills: activities stimulate mental development and improve fine motor skills, especially in children with mental retardation. They also develop teamwork skills.

5. Stimulating interest and attention: art therapy keeps children's attention and motivates them to actively participate in the process, leading to greater concentration and engagement.

The survey reveals the positive influence of art therapy on the social skills of children with SEN. Most respondents noticed that children became calmer, sociable and confident. Art therapy has improved children's concentration, emotional intelligence and self-esteem. Experts note that children express their feelings more easily and show progress in social relationships. These positive changes greatly aid their daily life and social interactions.

To the question "How do you think art therapy helps children express their feelings?" according to the respondents, art therapy helps children express their emotions and feelings in a creative and safe way, using art as a means of visual and symbolic expression. This approach is especially helpful for children who have difficulty sharing their feelings verbally. An important benefit of art therapy is that it provides a safe environment in which children can explore their emotions without fear of judgment. Through techniques such as drawing, modeling and other forms of creative expression, children can express inner feelings and experiences that would otherwise remain suppressed or misunderstood. Art therapy also develops children's motor skills while promoting discipline and focus, especially in children with SEN. According to the responses received, art therapy is a means of emotional balance and development, giving children new techniques of expression and opportunities to reveal and analyze hidden emotions through their works.

To the question " What additional resources or trainings do you think would be useful to improve your art therapy practice?" according to the respondents, a number of additional resources, trainings and approaches can be used that contribute to more effective expression of feelings and emotions in children. Here are the main aspects that would be helpful:

Additional materials and resources: access to a variety of art materials (didactic materials, puppets, models, natural materials) is essential. They provide children with various opportunities for creative expression. In addition, the need for greater financial resources for consumables was cited as an important factor in securing adequate materials.

Training and professional development: exchange of experience with colleagues, as well as participation in additional training and seminars, are key to improving practice. Training in specific art therapy techniques and methods for working with children with SEN would be particularly useful.

Practical experience and observations: direct observation of other professionals and exchange of experiences with colleagues, including those trained abroad, would also enrich art therapy practice. The inclusion of new techniques and methodologies, as well as meta-communication, can contribute to a better relationship with children.

Working with natural elements and relaxation: art therapy combined with nature activities and relaxation exercises can help to further calm and stimulate the creative process. Natural materials offer unique opportunities to connect with children's emotions.

Modern technologies: the use of software applications and digital tools for art therapy opens up new possibilities for working with children. Technology can complement traditional methods by providing new ways of expression and engagement.

Working with parents and the family: involving parents through training or workshops can create a better supportive environment for children.

Other techniques and methods: the inclusion of bibliotherapy, stories and picture books offers additional forms of emotional expression and expands the possibilities for interpretation of children's experiences.

In summary, improving art therapy practice requires a combination of access to additional materials, training in new techniques, sharing experiences with colleagues, and using modern technologies. This would lead to a more effective application of art therapy and better support for children in expressing their feelings and emotions.

"Would you recommend art therapy as a work approach to other professionals (educators, social workers, etc.) who work with children with SEN?", 90% of respondents would recommend art therapy, which confirms confidence in the approach to working with children with SEN. The reservations are minimal, and the absence of low ratings confirms the positive perception of art therapy among professionals.

"In your opinion, are art therapy techniques actively used by specialists in Bulgaria?", the results show a division among specialists in Bulgaria regarding the active use of art therapy techniques. According to the survey, 46.7% answered with "Definitely yes", indicating that almost half of the professionals actively apply art therapy in their work. On the other hand, 53.3% of professionals responded with "Definitely no", indicating that more than half do not actively use art therapy. This may be due to several factors: lack of training in art therapy methods, lack of resources, insufficient awareness of the benefits of art therapy or other priorities in their work.

4. Conclusion

“In art therapy children have the opportunity to express meaning, emotions and experiences through creating a tangible product. Psychomotor activities such as drawing, coloring, and working with clay/play dough involve all senses, including vision, touch and sound - depending on the materials being used. Art therapy promotes creativity, self-awareness, self-esteem, communication skills, and overall personality and psychomotor development” (Bojadjieva & Gradinarova, 2016).

According to the conducted study, experts believe that art therapy has significant potential to help children express their emotions and feelings, but its application in Bulgaria is uneven. Despite the recognized benefits and active use by almost half of the specialists (46.7%), the majority (53.3%) do not actively apply art therapy techniques.

This result highlights the need for additional training and resources, as well as greater funding for materials to facilitate the implementation of these methodologies. Specialists who apply art therapy note its positive effect on children, as it provides a safe environment for visual and symbolic expression of emotions, develops creativity and improves motor skills.

Modern technologies and digital tools for art therapy are highlighted as the main factors for improving the practice. Involving parents and enriching therapeutic techniques with different methodologies would also help the wider application of these approaches.

Acknowledgements

This paper is supported by the project entitled "Study of Attitudes towards the Therapeutic Potential of Reading in Atypical Situations for the Individual” financed by the National Science Fund of the Ministry of Education and Science of the Republic of Bulgaria with Contract № КП-06-Н45/2 from 30.11.2020, led by Chief Assist. Prof. S. Eftimova-Ilieva, PhD.

References

Bojadjieva, N. & Gradinarova V. (2016). Application of Art Therapeutic Approach in Educational Work with Children with Communication Disorders. In *Scientific Conference with International participation "Interdisciplinary Speech Therapy Practices"*, 2016, NBU, Sofia, pp. 101-108.

Mihaylova, I. (2017). Art Therapy Relevance in Children with Special Educational Needs. Model for Work with "Occupational Therapy" Students. *Neurology and Psychiatry, 1*, 25-35.

IMPACT OF ACTIVE METHODOLOGIES ON SUSTAINABILITY IN INITIAL TEACHER TRAINING: AN EDUCATIONAL INNOVATION

Mercedes Llorent-Vaquero, Juana Mª Ortega-Tudela, & Elena Mª Díaz-Pareja
Department of Pedagogy, University of Jaén (Spain)

Abstract

The training of committed and skilled professionals to face environmental, economic and social challenges is an unavoidable need in the current context. Education for Sustainable Development (ESD) is presented as a key pillar for transforming society, promoting essential skills such as systems thinking, anticipation, collaboration, critical thinking, strategic action and responsibility. In this sense, university students, as future graduates, play a central role in building a more sustainable world, so their training in this area is essential. An Innovation Project was carried out with the aim of analyzing how university students perceive the sustainability training they have received and its link with the use of active methodologies in their degrees. For this purpose, a quantitative study was carried out, with a descriptive and inferential design, in which 460 students of the Education degrees of the University of Jaén participated. This paper presents the final results obtained from a questionnaire developed specifically for this study, with Likert-type questions on a scale of 1 (strongly disagree) to 5 (strongly agree). The data were then analyzed using SPSS software. The study shows the positive impact of active methodologies on the development of knowledge, competences and satisfaction of university students in relation to the Sustainable Development Goals (SDGs) and sustainability. The innovation experience carried out highlights the beneficial effect of active methodologies in training on SDGs and sustainability together with a sense of satisfaction among students. In addition, the training has had an egalitarian impact as no gender or age differences were found.

Keywords: *Sustainability education, active methodologies, higher education, sustainable development, student perceptions.*

1. Introduction

The Sustainable Development Goals (SDGs) constitute a strategic framework promoted by the United Nations to address the major social, economic and environmental challenges of the 21st century. Their implementation in higher education is essential to train citizens capable of leading significant changes in society (UNESCO, 2021). Universities have a central role in promoting these goals, as they not only provide knowledge, but also develop competences that enable students to act ethically and responsibly in their professional fields (Sterling, 2023).

The incorporation of the SDGs into university curricula not only raises students' awareness, but also strengthens their critical and analytical capacity in the face of global problems. Mainstreaming sustainability in higher education requires a rethinking of teaching and learning methods, prioritizing innovative and participatory approaches that allow students to be actively involved in solving real problems (Barth et al., 2020).

The use of active methodologies in sustainability education has proven to be an effective strategy for the development of key competences such as systems thinking, problem solving and decision-making. Strategies such as project-based learning, service-learning and case studies connect theory with practice and enhance student engagement with environmental and social issues (Bessant et al., 2021).

Experiential learning is another approach that has gained prominence in sustainability education. Through practical activities, such as simulations, fieldwork and collaborations with external organizations, students can apply the concepts they learn in a real-life context, promoting greater understanding and engagement with the SDGs (Lange, 2019). In addition, participation in community initiatives and social impact projects reinforces the connection between academic knowledge and social reality, facilitating the internalization of sustainability values.

The role of teachers in the implementation of sustainability education is crucial. Teachers should not only transmit knowledge, but also act as facilitators of learning, promoting critical thinking and social

responsibility (Rieckmann, 2018). To this end, it is essential that educators receive specific training in active methodologies and innovative approaches that enable them to integrate sustainability into their pedagogical practices.

Teacher motivation and commitment also have a significant influence on students' attitudes towards the SDGs. Recent studies have shown that students feel more engaged with sustainability when they perceive that their teachers are committed to these values and use participatory methodologies that foster meaningful learning (Barth et al., 2020). It is therefore essential for universities to foster teachers' professional development in the field of sustainability by providing tools and resources that enable them to design more effective and transformative learning experiences (Martin et al., 2021).

2. Design & methods

In order to obtain the data, a quantitative research study was carried out, with a descriptive and inferential design, in which 460 students from the Education degrees of the University of Jaén participated. Data collection was carried out by means of a questionnaire developed specifically for this study, with Likert-type questions on a scale of 1 (strongly disagree) to 5 (strongly agree). Subsequently, the data were analyzed using SPSS software.

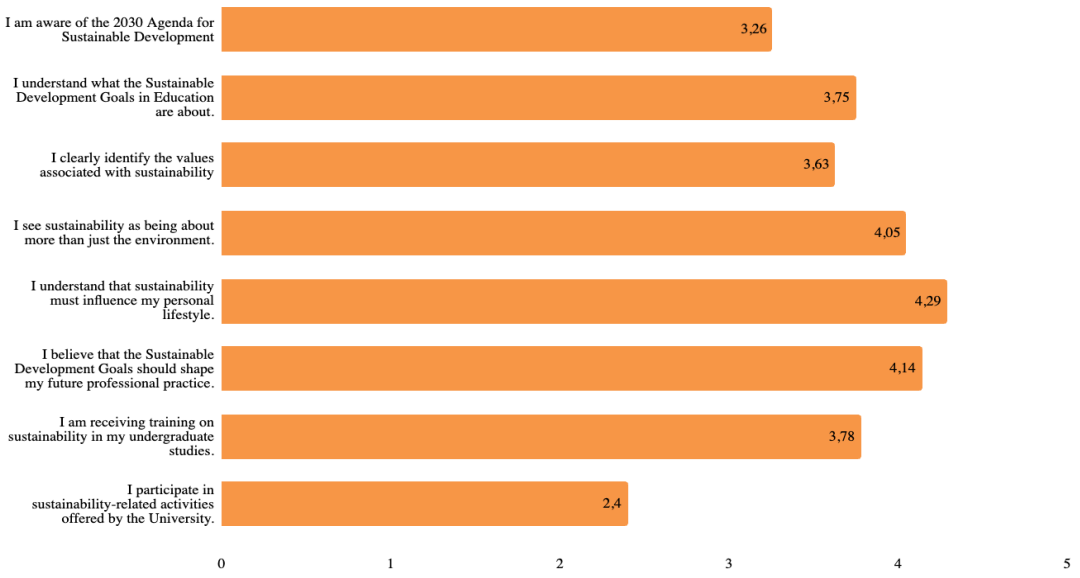
3. Results

The results are then grouped into three areas: knowledge about SDGs, the relationship between active methodologies and SDGs and sustainability, and overall satisfaction with both issues.

3.1. Knowledge on SDGs and sustainability

Figure 1 shows the results of the averages of the most relevant items in relation to the knowledge of the participating students about the SDGs. In this sense, they show a high level of knowledge about the SDGs and sustainability, highlighting their high awareness of the influence of their lifestyle on sustainability. Furthermore, according to the dispersion of the data, there is a high level of consensus on this last item (SD = 0.87). In contrast to this, it can be seen that although most of them are receiving training on sustainability in their university studies, they do not participate to a large extent in sustainability-related activities offered at the university.

Figure 1. Mean scores for the items on SDG and sustainability knowledge.



The results for most of the items vary significantly depending on the grade and year in which the students are enrolled. Table 1 shows the results, highlighting only those with significant differences. This is evidence of the impact of the innovation experiences carried out, since all of them were carried out in the first year of Pre-school Education. It should also be noted that there are no significant differences in relation to student age or gender, with the exception of the item ‘I am receiving training in sustainability in my undergraduate studies’ (p=0.027), although it does not show a significant linear pattern (p=0.673), and the likelihood ratio test does not support a clear relationship (p=0.239).

Table 1. Chi-square analysis results for SDG and sustainability knowledge vs. grade and year.

Analyzed Variables	χ^2	Df	p
Degree vs. I am aware of the 2030 Agenda for Sustainable Development	33.498	8	0.000
Degree vs. I understand what the Sustainable Development Goals in Education entail	90.741	8	0.000
Year vs. I understand what the Sustainable Development Goals in Education entail	26.352	8	0.001
Degree vs. I can clearly identify the values associated with sustainability	55.971	8	0.000
Year vs. I can clearly identify the values associated with sustainability	16.708	8	0.033
Degree vs. I believe that sustainability applies to various areas beyond the environment	18.070	8	0.021
Degree vs. I think the Sustainable Development Goals should guide my future professional practice	13.757	8	0.088
Year vs. I think the Sustainable Development Goals should guide my future professional practice	4.181	8	0.840
Degree vs. I am receiving training on sustainability in my undergraduate studies	89.293	8	0.000
Year vs. I am receiving training on sustainability in my undergraduate studies	29.436	8	0.000
Degree vs. I participate in sustainability-related activities offered by the University	17.878	8	0.022

In all the cases shown in table 1, the observed and expected counts reflect the highest proportion of students in the highest values (4 and 5) in Infant Education, standing out from the students in Primary Education and Social Education. This fact shows the benefits of the innovation project carried out, especially in terms of developing knowledge about the SDGs and sustainability.

3.2. Active methodologies, SDGs and sustainability

The active methodologies most frequently used by the teachers who teach the participants are those based on cooperative learning and self-learning and research, both obtaining an average of 4.22 and a SD of 0.74 and 0.78 respectively (scale 1-5). Other frequently used methodologies are those related to play-based learning (3.97), social awareness (3.91) and critical thinking and communication (3.88).

In terms of the relationship between active methodologies and the achievement of the SDGs, the analysis focused on SDG 4 which seeks to 'ensure inclusive and equitable quality education and promote lifelong learning opportunities for all'. In this sense, participants consider that achieving this goal is facilitated through active methodologies, obtaining values higher than 4 in all items (1-5). Specifically, they highlight their relationship with educational quality, autonomous learning and creativity. However, the integration of ICT, the roles of both the teacher as facilitator and the students as active learners, and the connection between theory and practice could be improved. It should be noted that in all items the dispersion of the data is low, reaching standard deviations ranging between 0.6 and 0.8, so the students' opinion is quite uniform.

Regarding the connection between active methodologies and sustainability competences, students also affirm that these competences are enhanced through them, obtaining values above 4 in all the items of the scale (1-5). Furthermore, the dispersion of the data is low for all items, with standard deviations varying between 0.6 and 0.8, indicating that students have similar opinions. To a greater extent, participants note how active methodologies favor problem-solving skills, the understanding of our norms and values, and the promotion of reflection, respect and tolerance. However, aspects related to more complex global knowledge or the connection to current problems are not so clearly appreciated.

In order to refine the contrast analysis, two variables were created for each of the dimensions presented in this sub-section (active methodologies and SDGs; active methodologies and sustainability). Using the Mann Whitney U and Kruskal Wallis H test statistics, possible relationships between these dependent variables and the gender (0.260, 0.169), age (0.613, 0.192), year (0.918, 0.857) or grade (0.414, 0.624) of the student body were ruled out.

3.3. Overall satisfaction

In general, students are satisfied with the use of active methodologies used in their degree studies to address sustainability, obtaining a mean value of 4.09 (SD=0.87). However, it appreciates with a lower value (3.93) the training received on sustainable development in the university framework.

More specifically, with regard to the teaching staff, they affirm that they are teachers who promote equity and inclusion (4.24) and the involvement of students in the community in order to transform it (4.21), considering to a lesser extent the role they observe in the teaching staff as agents of social change for the creation of a sustainable world (3.9).

It should also be noted that there are some significant differences in overall satisfaction depending on the course and grade in which the participants are enrolled. Table 2 shows the summary of the contrasting

results that showed significant differences. Given the ordinal and nominal characteristics of the variables, the Chi-square statistic was used for the analysis.

Table 2. Results of the Chi-square analysis for overall satisfaction vs. identification data.

Analyzed Variables	χ^2	Df	p	Interpretation
Degree vs. Satisfaction with SD training	55.866	8	0.000	The observed and expected counts show that Early Childhood Education students have the highest proportion in the highest values.
Year vs. Satisfaction with SD training	27.141	8	0.001	The observed and expected counts indicate the most significant difference in a higher concentration of Early Childhood Education students at value 4, while other degrees have lower values.
Degree vs. Satisfaction with the use of active methodologies for sustainability	24.666	8	0.002	The observed and expected counts show that the most significant difference is found in Social Education students, who report lower satisfaction compared to Early Childhood and Primary Education students.

According to table 2, the results show a higher satisfaction among the students who have participated in the innovation project, especially in terms of the training received in Sustainable Development.

4. Conclusions

Students perceive a clear relationship between achieving SDG 4 and the use of active methodologies, highlighting cooperative learning and self-learning in particular. However, aspects such as the integration of ICT, the connection between theory and practice—especially when applied to current issues—and a deeper focus on global aspects need improvement when using these methodologies.

Regarding their training, students are satisfied with the use of active methodologies for sustainability but slightly less so with the training received in sustainable development. In this regard, the innovation experience has led Early Childhood Education students to be more satisfied with their training. It is also important to note that although most students receive sustainability-related education, participation in sustainability activities within the university remains low.

Overall, the innovation project has had a positive impact on Early Childhood Education students, increasing their knowledge, satisfaction, and competencies related to the SDGs and sustainability. However, it is essential to, on the one hand, encourage greater participation in university sustainability activities by expanding the availability of workshops, activities, and seminars related to sustainability or by creating academic incentives to motivate students. On the other hand, strengthening the connection between theory, practice, and current sustainability issues is crucial. This could be achieved through activities or projects that link sustainability to practical cases and local problems or by promoting collaboration with external associations to apply knowledge to real-world contexts.

References

Barth, M., Godemann, J., Rieckmann, M., & Stoltenberg, U. (2020). Developing key competencies for sustainable development in higher education. *International Journal of Sustainability in Higher Education, 21*(3), 492-505. https://doi.org/10.1108/14676370710823582

Bessant, S., Robinson, Z., & Ormerod, M. (2021). *Active learning in sustainability education: A guide for university educators.* Palgrave Macmillan. http://hdl.handle.net/10396/20681

Lange, E. A. (2019). Transformative learning for sustainability. In W. Leal Filho (Ed.), *Encyclopedia of sustainability in higher education* (pp. 1954-1966). Springer.

Martín, M. L., Díaz, E., & García, C. (2021). Puesta en Práctica de ODS en Educación Superior a través de la competencia "Sensibilidad hacia temas Medioambientales y Sociales". In M. L. Sein-Echaluce, A. Fidalgo, & F. J. García (Eds.), *Innovaciones docentes en tiempos de pandemia. VI Congreso Internacional sobre Aprendizaje, Innovación y Cooperación (CINAIC 2021)* (pp. 48-52). Universidad de Zaragoza. https://doi.org/10.26754/CINAIC.2021.0010

Rieckmann, M. (2018). *Learning to transform the world: Key competencies in education for sustainable development.* UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000261802

Sterling, S. (2023). *Sustainable education: Re-visioning learning and change.* Green Books.

YOUNG WOMEN BELONG IN MAKERSPACES: DEVELOPING AND DETECTING YOUNG WOMEN'S AGENCY IN MAKING

Ken Rafanan[1], Elise Levin-Güracar[1], Nuria Jaumot-Pascual[1], Teresa Lara-Meloy[1], Harriette Stevens[2], & Jennifer Knudsen[1]
[1]TERC, Inc. (USA)
[2]Mathematics Education Group (USA)

Abstract

While many makerspaces are created by and cater to middle-aged males, our research has found that when supported, young women manifest their agency engaging in a multitude of making disciplines including those traditionally thought of as masculine fields such as woodworking and metalworking. Design principles, activities, findings and research tools from a program developed under an out-of-school maker project, AAMASE, are shared. The principles, activities and tools were developed to strengthen and support the agency of young African American women in a community-based makerspace in the mid-Atlantic region of the United States. The project focused on agency by co-designing making experiences with minoritized secondary-school youth and centering their experiences. Making projects ranged from one-day builds such as making resin art pieces, to longer entrepreneurship-focused projects such as designing a student locker organizer product. Principles for supporting and strengthening youth's agency in making are shared and expanded upon. The paper also briefly describes the researchers' use of the object-elicitation technique to investigate the makers' processes, identity, and development of agency. Finally, the paper presents data and analysis of young women's reflections on their experiences in the program.

Keywords: *Making, STEM, youth development, agency, design principles.*

1. Introduction

African American Young Women in Making to Engage in STEM and Entrepreneurship (AAMASE) was an NSF ITEST Developing and Testing Innovations project aimed at serving 13–18-year-old young women in Greensboro, North Carolina, USA. The project was a collaboration between TERC, a STEM education research and development organization, and the Forge Greensboro, a nonprofit community makerspace. Through participatory design research, we engaged youth in making and entrepreneurship activities emphasizing STEM disciplinary practices to amplify their agency while building their engagement and skills in STEM and their awareness of STEM career pathways. Participants learned how to design, build, and pitch a product with guidance from designers, makers, and entrepreneurs.

The research included interviews with partners, mentors, and facilitators, activity recordings, and interviews with the youth. The research insights shared below are based on data from four groups that participated in the program for 8-10 weeks each. Each group had about 10 middle and high school age young women who were mostly African American, but also included white, Hawaiian Native, and Latina young women. Three participant cohorts were recruited through out-of-school learning organizations that had existing youth-serving programs and one cohort was recruited from a private school. This paper focuses on youth agency and experience throughout the program, integrating data from object elicitation interviews and observations.

2. Theoretical framework and literature review

This work is framed by a values-based theory of change centered around agency. Theory of change (Weiss, 1995) is a theory of how and why an initiative works. It makes clear what assumptions are being made in an intervention, and the desired outcomes. A values-based theory of change starts with a value or values for learning and engagement (Wardrip, Evancho, & McNamara, 2018).

For this project, we propose a definition of agency as follows: a person's or group's ability, inclination, and sensitivity to conceptualize and pursue the making of an object (physical, psychological, and/or social) to address a need or desire given a set of appropriate physical and/or social resources. This working definition allows the scaling of our unit of analysis between individual and group as appropriate as well as recognizing the salient resource features of an environment. In their review of the agency literature, Cavazzoni et al. (2022) defined agency loosely as "people's ability to exert control over one's life and [to] pursue goals" (p. 1126) and found that studies used agency along two main conceptual pathways: 1) how an individual engages in agentic actions across their social environments; and 2) how an individual engages in agentic action in a more constrained realm of action. Our working definition of agency is aligned with the more constrained perspective as we aim to support and develop agency in participants in making and STEAM-focused learning environments.

Due to structural racism, women, women of color, and African American women in particular have been kept at the margins of STEM for far too long. African American women tend to be marginalized in school STEM (Brickhouse, 2001), and their experiences of micro-aggressions and other racist practices affect their proclivity to engage in STEM (Grossman & Porche 2014). Too often, their agency is diminished. Contrastingly, when their science experiences can match their aspirations—either in or out of school—they engage and blossom in STEM (Tan, et al., 2013; King & Pringle, 2019). This marginalization has impacted our STEM workforce. An NSF report found that less than 5 percent of science and engineering occupations are occupied by African Americans, while they made up 12 percent of the total workforce (NSF, 2017).

The AAMASE program aimed to better support young women's agency in a STEM learning environment. Makerspaces' fusion of craft and high tech holds great promise for enabling makers to see the need for STEM and to engage in STEM-related work. Often, though, white, cis-gendered males (Bang, 2015) are over-represented in makerspaces and can perpetuate barriers to improved agency. In response, researchers and practitioners have sought ways to center non-dominant youth in the community of makers to support learning. Further, entrepreneurship, an area where marginalized groups have faced systemic barriers, provides motivation for making and a pathway to STEM careers (Howard, Smith, & Nwaigwe, 2020). AAMASE offered a combination of engagement in making and entrepreneurship, focused on the strengths of young women of color (from middle grades to early high-school) to draw them towards the center of a making/entrepreneurial community, the Forge: a makerspace with both low- and high-tech tools focused on the process of making, community, and incubation of businesses.

2.1. Makerspaces as STEM learning environments

AAMASE situates its approach to making as a community-centered, culturally embedded practice. Making and design projects bring together tools and communities to provide both motivation and a context for developing STEM practices (Gravel et al., 2018; Martin, 2015) that are aligned with the Next Generation Science Standards (NGSS) (NGSS, 2013). In fact, programs like AAMASE can support improved agency that results in new visions of STEM that invite broader participation (Calabrese-Barton, Tan, & Greenberg, 2017).

2.2. Young African American women as makers and entrepreneurs

Creating more equitable environments for making and learning requires "learning designers to consider who a maker is (and who can be a maker); what a maker does; for whom a maker makes … [and] who a maker can become in, and through, the act of making" (Castek et al., 2019). Importantly, design principles for fostering more agentic making environments call for incorporating STEM practices as a meaningful part of the making activity (Vossoughi, Escudé, Kong, & Hooper, 2014). AAMASE centered young women's making interests and experiences to subvert the inequities often found in making culture and actualized culturally sustaining pedagogy by amplifying participants' voices (Champion et al., 2020).

2.3. Engaging Young African American women through participatory design research

Too often, minoritized youth are the objects of STEM programs, without having much influence on their design. For example, the design principles in Kennedy and Odell's (2014) overview of high-quality STEM programs leave youth out of the stakeholders included in the design of such programs. Ignoring youth results in missed opportunities for helping minoritized youth learn STEM practices in a way that influences their views of their STEM futures (Tan et al., 2013). *Participatory design research* (PDR) offers an alternative: "Participatory design [PD] is an essential design strategy for creating artifacts and experiences that reflect the voices of the population being designed for and with" (Coenraad et al., 2019). Three main factors contributed to the program reflecting the youths' STEM and making-related interests: 1) youth were told at the beginning of the program that it was a research project and that their voices were essential for the field to learn from their experiences; 2) the AAMASE program staff and design researchers asked the participants (a majority of whom were young women of color) what they wanted to create and

learn and then observed participants' engagement throughout up through reflections on completed build cycles; and 3) perhaps most critically, when youth asked for different resources or learnings, program facilitators worked diligently to provide the experience that the youth were seeking.

3. Research design and methods

A major element of data collection was object elicitation (Levin-Güracar et al., 2024), wherein the interviewee brings an object that they made in the program with them into the interview to spark a conversation about their experiences and what they learned. Since the objects were created by the youth, they embody their knowledge, skills, and attitudes and make interviews easier by shifting the focus from the interviewer-interviewee dyad to the object. This type of interview elicits richer information than regular interviews because images and objects facilitate recalling processes and memories in more detail (Harper, 2002). For this project, a protocol was developed to contribute to the understanding of participants' development in the project's three foci (i.e., STEM, making, entrepreneurship). The protocol started the conversation around how they approached the design and making process, with follow-up prompts about process, design, idea gathering, and prototyping.

4. Elements of agency

Cavazzoni and colleagues write, "There is still little agreement on how this construct [of agency] should be understood and defined. ... Indeed, no current consensus or standardized methodology exists to assess agency" (2022). Given the lack of consensus, we propose for AAMASE the following five criteria for assessing agency: 1) Self-efficacy - is there evidence that participants perceive that their effort influences their success; 2) Personalization - do the products/processes that participants create/articulate show attempts to make them more relevant or useful to specific people in participants' lives; 3) Connection - do the products/processes that participants create/articulate show connections to notions of self or others; 4) Planfulness - do the products/processes that participants create/articulate show evidence that they were pursued based on some plan or design; and 5) Iteration - do the products/processes that participants create/articulate show evidence that they were improved upon.

5. Supporting agency through AAMASE

Each session of AAMASE, youth were introduced to a different making discipline such as resin, pottery, laser cutting, plasma cutting, 3D printing, sewing, and electronics. These disciplines were chosen in community with the participants. For the final three sessions, youth were presented with a selection of 12 design challenges to solve a problem for a facilitator-created youth persona. Youth had full agency in selecting which challenge they wanted to take on, as well as choice in how they wanted to address the design challenge with access to multiple making disciplines, materials and making mentors around the Forge. Entrepreneurship was integrated throughout; participants developed their brand concept; they learned about business concepts (e.g., costs, labor, and marketing); and some youth showcased their project and their business ideas in a Shark Tank-style final project presentation.

Given our working definition of agency, in addition to organizing the project to support an agency-supportive environment more generally, the specific learning activities and pedagogy in AAMASE aimed to support the five criteria of self-efficacy, personalization, connection, planfulness, and iteration. A single making activity might incorporate support for all five of the criteria or just a subset, but no activity should fail to support multiple.

For example, one of the projects engaged participants in a resin art project. Youth worked with a mentor to experience the fundamentals of resin art as well as some of its chemistry. Youth were provided with coaster molds and various materials that could be used inside of the resin (flowers, glitter, etc.).

One youth, Ciera, decided to use a photocard of a K-pop star, a non-standard decoration that she happened to have with her, into her resin coaster pour. In her object elicitation interview with a researcher, Ciera explained that using the photocard brought herself into the project:

> *It kind of gave it a little bit more meaning because, even though it's like a piece of cardboard, you know, with two random people who probably will never know me, it makes brings me joy, ... making this whole piece that I know that no one else in the world could basically remake because of how different epoxy is, it kind of makes it all a little bit more, ... gives a little bit more worth to me.*

Ciera clearly connects the resin project to personalization, adding her favorite artist's photo directly into her resin pour. The nature of the project made this possible. While the product (coaster) was the same for all students, it was open as to how they decorated and made the final product their own. Ciera also commented on the project's opportunity for creativity and making something unique:

> *It's awesome ... I like this project a lot because it has a lot of like creativity and uniqueness with it. You know, you could all be given the exact same materials and everyone could create something completely different. I like [it] because you can express your individuality, and you can basically bring yourself into your piece. And then your piece is an extension of you*.

Ciera's project further demonstrates the connection aspect of agency, connecting her project to an interest that she shares with peers. Ciera also demonstrates self-efficacy; she is proud of what she created and was able to use the materials to make something personal. Other youth shared similar experiences about AAMASE providing space to explore their creativity. One said:

> *While I'm here at the Forge, I want to dive into my own creativity. I haven't been able to connect as well to my creative side, and I feel like if I can, then I can get to know myself better, plus the more you create the more creative you are then the more pieces of yourself that you get to make, and that can make others happy; it can make you happy.*

To support youth in experiencing their "creative side", projects must support youth's agency and support them in engaging in ways that connect to themselves. This youth is talking about making pieces of herself, clearly understanding the importance of personalization in the making process.

6. Conclusion

To better support young women's agency in makerspaces, programs should be organized to center around the participants' learning interests and focusing the learning activities on their experience instead of on a set curriculum with specified goal products. The structure of AAMASE making activities supported Ciera's and other participants' agency most frequently through the support of *self-efficacy*, *personalization*, and *connection*. Due to time constraints, *planfulness* and *iteration* were supported less often. The AAMASE participants reported and displayed high engagement and enjoyment. Experiences like Ciera's and those of her peers are key to engaging young women in STEM-rich learning experiences and ultimately broadening STEM opportunities for all.

Acknowledgments

The authors extend our gratitude to the participants of the AAMASE program for their enthusiasm for the program and their willingness to participate in our research. The authors also thank The Forge for being such patient partners in this endeavor. This material is based upon work supported by the National Science Foundation ITEST Program (award #2148543). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

References

Bang, M. (2015). Culture, learning, and development and the natural world: The influences of situative perspectives. *Educational Psychologist, 50*(3), 220-233.

Brickhouse, N. W. (2001). Embodying Science: A Feminist Perspective on Learning. *Journal of Research in Science Teaching, 38*(3), 282-295.

Calabrese Barton, A., Tan, E., & Greenberg, D. (2017). The makerspace movement: Sites of possibilities for equitable opportunities to engage underrepresented youth in STEM. *Teachers College Record, 119*(7), 1-44.

Castek, J., Schira Hagerman, M., & Woodard, R. (2019). *Principles for equity-centered design of STEAM learning-through-making*. University of Arizona, Tucson, AZ.

Cavazzoni, F., Fiorini, A., & Veronese, G. (2022). How Do We Assess How Agentic We Are? A Literature Review of Existing Instruments to Evaluate and Measure Individuals' Agency. *Social Indicators Research, 159*, 1125-1153. https://doi.org/10.1007/s11205-021-02791-8

Champion, D. N., Tucker-Raymond, E., Millner, A., Gravel, B., Wright, C. G., Likely, R., ... & Dandridge, T. M. (2020). (Designing for) learning computational STEM and arts integration in culturally sustaining learning ecologies. *Information and Learning Sciences*, *121*(9/10), 785-804.

Coenraad, M., Palmer, J., Franklin, D., & Weintrop, D. (2019, June). Enacting identities: Participatory design as a context for youth to reflect, project, and apply their emerging identities. *Proceedings of the 18th ACM International Conference on Interaction Design and Children* (pp. 185-196).

Gravel, B., Tucker-Raymond, E., Kohberger, K., & Browne, K. (2018) Navigating worlds of information: Literacy practices of experienced makers. *International Journal of Technology and Design Education, 28*(4), 921-938.

Grossman, J. M., & Porche, M. V. (2014). Perceived Gender and Racial/Ethnic Barriers to STEM Success. *Urban Education*, *49*(6), 698-727.

Harper, D. (2002). Talking about pictures: A case for photo elicitation. *Visual studies*, *17*(1), 13-26.

Howard, T., Smith, N., & Nwaigwe, U. (2020). *Banks and the Black Community: What Can Major Commercial and Retail Banking Institutions Do to Better Support Black Entrepreneurs and Businesses in the U.S.?* Center for Policy Analysis and Research.

Kennedy, T. J., & Odell, M. R. L. (2014). Engaging students in STEM education. *Science Education International*, *25*(3), 246-258.

King, N. S., & Pringle, R. M. (2019). Black girls speak STEM: Counterstories of informal and formal learning experiences. *Journal of Research in Science Teaching*, *56*, 539-569.

Levin-Güracar, E., Jaumot-Pascual, N., Rafanan, K., Lara-Meloy, T., Eways, J., & Mitchell, I. (2024, September 28-October 1). Object Elicitation Interviews: Engaging Youth in Conversations About Their STEM Learning Through Making [Conference presentation]. *ASTC Annual Conference*, Chicago, IL, United States.

Martin, L. (2015). The Promise of the Maker Movement for Education. *Journal of Pre-College Engineering Education Research (J-PEER)*, *5*(1), Article 4.

National Science Foundation, National Center for Science and Engineering Statistics. (2017). Women, Minorities, and Persons with Disabilities in Science and Engineering: 2017 (*Special Report NSF 17-310*). Arlington, VA.

NGSS Lead States. (2013). *Next generation science standards: For states, by states*. Washington, DC: The National Academy Press.

Tan, E., Calabrese Barton, A., Kang, H., & O'Neill, T. (2013). Desiring a career in STEM-related fields: How middle school girls articulate and negotiate identities-in-practice in science. *Journal of Research in Science Teaching*, *50*(10), 1143-1179.

Vossoughi, S., Escudé, M., Kong, F., & Hooper, P. (2013, October). Tinkering, learning & equity in the after-school setting. In *Annual FabLearn conference*. Palo Alto, CA: Stanford University.

Wardrip, P., Evancho, J., & McNamara, A. (2018). Identifying what matters. *Phi Delta Kappan*, *99*(6), 60-63.

Weiss, C. (1995). Nothing as Practical as Good Theory: Exploring Theory-Based Evaluation for Comprehensive Community Initiatives for Children and Families. In J. Connell, A. Kubisch, L. Schorr, & C. Weiss (Eds.), *New Approaches to Evaluating Community Initiatives*. Washington, DC: Aspen Institute.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

THE EVOLUTION OF FOREIGN LANGUAGE LEARNING IN HIGHER EDUCATION: A RISKY APPROACH

Véronique Delplancq[1], Ana Maria Costa[1], José Pereira[1], Justine Anne S. Céline Martin[2], Ricardo Casañ-Pitarch[3], Romain Gillain[4], & Susana Fidalgo[1]

[1]*Instituto Politécnico de Viseu, CI&DEI (Portugal)*
[2]*Universidad de Castilla-La Mancha (Spain)*
[3]*Universitat Politècnica de València (Spain)*
[4]*Instituto Politécnico de Leiria, CI&DEI (Portugal)*

Abstract

The introduction of active pedagogies into teaching practices is creating renewed motivation and energy for teachers and students alike. These varied pedagogies, marked by a few trends, represent, particularly in higher education (HE), a tremendous opportunity to modernise content and make the learning environment livelier and more open. However, it should be acknowledged that many difficulties have arisen, and many challenges need to be overcome. It is not only a question of selecting suitable active teaching methods, but it is also vital to define strategies that are appropriate to the target audience, the time available, and the skills being pursued to be flexible and responsive enough to reorient learners very quickly, even during class time, and to create activities that are motivating and effective in terms of learning. The impact on assessment is evident. Digital tools play a major role in this new paradigm, but they can also lead to problems in the students' work if they do not identify with the target digital tools. Learning foreign languages (FL) is becoming more communicative and interactive. In this sense, online platforms, mobile applications, and multimedia resources offer tremendous opportunities to develop multiple skills and diversify knowledge influenced by social and professional demands. This research shows the results of studies carried out in recent years with students of the Media Studies degree at the Higher School of Education of the Polytechnic Institute of Viseu (Portugal) in FL courses. We will introduce the active teaching methods used, discuss the pedagogical devices, lesson plans and choices made regarding the digital tools used, and list the difficulties encountered by the teachers and the major challenges they had to tackle in order to guarantee and maintain the students' motivation and commitment throughout the course. Keeping these ideas in mind, the assessment of skills and knowledge also needs to evolve to better guarantee the fulfilment of the learning objectives. In conclusion, the risks created by this deep and extremely rapid evolution are inherent to the extraordinary opportunities to rethink FL learning and test new activities characterised by promoting creativity at the HE level. The key factor lies in the adaptability of all the participants involved in the process, the willingness to move ahead, away from the comfort zone of traditional approaches and to innovate in a reasonable and effective way.

Keywords: *Active pedagogies, foreign languages, higher education, challenges, opportunities.*

1. Introduction

Applying pedagogical activation strategies wisely and setting up motivating and practical activities in the teaching-learning of foreign languages (FL) with specific objectives in higher education (HE) is not an obvious or simple task for the various actors in the process. Concentrating on the student, his/her characteristics, motivations, interests, and the specific institutional and professional aspects of the course, the teacher needs to possess knowledge about various parameters and management tools that are not always easy to apply. The teacher's role in this new paradigm of learning has evolved enormously, and the difficulties he or she must face to carry out his or her mission successfully are manifold (Børte, Nesje, & Lillejord, 2020).

Understanding the different variables, knowing how to take advantage of them and interconnecting them in a way that is effective both for the learning environment and for the objectives pursued in terms of developing skills and acquiring knowledge is often a real obstacle for the FL teacher. Digital tools help to introduce dynamic activities as part of active teaching strategies, but they are not always a guarantee of success - quite the contrary. Poorly chosen, poorly supervised and poorly used, they can represent a drop in

motivation, a risk for the fulfilment of the objectives envisaged in terms of learning and a lack of interest on the part of learners (Delplancq, Costa, Pereira, Gillain, & Fidalgo, 2024).

Several experiments have been carried out in recent years at the Higher School of Education (ESEV) of the Polytechnic Institute of Viseu (Portugal) in FL classes (English and French) with students from various non-language-oriented degrees. All these projects aim to renew learning practices to better motivate learners, update approaches and activities with current digital methods and tools and meet the demands of the 21st century in societal and professional terms. Many observations were made, leading to improvements in the teaching methods used and the identification of weaknesses in their implementation, particularly in interaction throughout the learning process and assessment.

After a brief description of the experimental route and context, the article looks into the work of the teachers at various stages of the learning process: choice and introduction of active teaching methods, development of preferred strategies, design and proposal of activities specific to the target groups, options for digital tools and development and application of the assessment model defined jointly with the learners. It highlights the benefits of the choices made, their weaknesses, the challenges met, and the difficulties encountered in preparing and implementing the experimental system.

2. Background to the implementation of active teaching methods

The ongoing implementation of active pedagogies at ESEV began at the start of the 2018-19 academic year, a need accelerated by the global health crisis. Undergraduate courses last three years. The first experiments involved students attending the undergraduate Media Studies course (2nd year). The study plan of this course comprises three years (180 ECTS), which includes one compulsory FL curricular unit (English and French; 4 ECTS each) and three which are optional (4 ECTS). The study plan of the said course also includes curricular units within the fields of photography, digital art, or technologies. This course intends to train media professionals (journalism, audio-visual production and direction and communication consultancy and develops research in these areas). The average number of learners in the experimental group was 20. The rooms available have only a desk computer and a projector. Wi-Fi is available throughout the school.

The work was refined and then extended to other professional degree courses, such as Advertising and Public Relations or Sport and Physical Activity taught at the same institution, with the same FL teachers.

The findings of an initial project (Lopes et al., 2018) reinforced the conviction that FLs were vital for the labour market, both at the time of recruitment and during integration and career progression. The benefits are clear for both employees and companies. For teachers, this implies an ever-closer approximation to the realities of the labour market and society in general in the form of lively and motivating learning with up-to-date teaching methods, strategies, activities, tasks and tools. The first thing to consider is which teaching methods best suit the learning conditions and target audiences.

First step: choosing active teaching methods

The first question which arises when considering the choice of active teaching methods is the target audience's specific characteristics. The generational, cognitive, and socio-economic characteristics of the target audience, their educational background, professional experience, level of knowledge in the subject in question, and cross-disciplinary skills need to be described. The face-to-face learning environment must be assessed. Students should also be allowed to reorientate their choices throughout the course to make learning more responsible and motivating. Lastly, the teaching methods adopted should enable the development of the intended skills and the acquisition of knowledge, which should be monitored and assessed in a coherent manner (Harrington et al., 2021).

Collaborative and cooperative work in small, linguistically heterogeneous groups in rooms that were large enough and flexible enough to accommodate it was immediately valued. Given the needs of the students and the academic profile of HE, project-based learning and research were also essential. Flipped classroom strategies were used to leave room for the development of communication in all its forms. The work was carried out in M-learning using the usual mobile electronic devices: mobile phones, tablets and notebooks. Brainstorming sessions, debates, and discussions shared during the classes based on the work carried out within the projects were chosen to strengthen the interaction between the various actors in the process and encourage spontaneous discourse.

Peer assessment has emerged as an important step in highlighting the relationship between the strategies adopted and assessment and valuing the student as an active partner in learning. Finally, the use of electronic platforms and gamification are currently active teaching methods that are virtually indispensable in the process of revitalising and modernising learning practices.

Digital tools are a powerful ally of active teaching methods. But they still need to be chosen and mastered.

Second step: choosing digital tools

The Internet offers us a vast choice of digital tools, some of which are quite similar and some of which are more or less user-friendly, secure and natural. Constantly evolving, not least because of the growing influence of ever more powerful AI, these tools can quickly become paying tools, in whole or in part, for a more sophisticated version whose benefits in terms of functionality are not necessarily vital to the objectives pursued in the classroom. The other criteria used to select these tools are the originality of the productions and their compatibility with the level of learning, ease of access and use (for both teachers and students), the size of the mobile application, the functionality modules and the packs of elements. Safety conditions must also be taken into account during installation and use.

Digital tools whose primary objective is not learning can be useful for implementing activities and updating presentations. For example, the Korsakow system6 is a documentary and narrative production software that enables teachers and students to present the results of their research and project work in a dynamic and engaging way (Lopes et al., 2023). Social networks also play a significant role in the publication of products produced by students in collaborative and cooperative terms (Delplancq, Costa Lopes, Pereira, & Fidalgo, 2023).

The Moodle platform enables remote contact to be maintained with students, including those who cannot attend classes regularly. It can also be used to share documents or information, for archiving, to record assignments, etc. Real-time collaboration in the preparation of documents from multiple devices has been put in place thanks to Google Docs.

Canva, Gamma-app and Animaker can create dynamic presentations, tag clouds, mood boards and mind maps. Genially helps you create original interactive tools like computer graphics and escape games. Adobe Photoshop retouches, processes and customises images for original creations. Google Maps Street View is a geoportal that brings a wealth of resources to FL learning through its encounters with external reality and the originality of the resulting activities (for example, preparing a guided tour for a specific audience in a given time). Immersive experiences, such as virtual visits to remarkable sites, with exploitation activities at the end, are other pathways that have been explored. Questions were put to ChatGPT in order to enrich the proposed answers.

In terms of assessment, the students chose Kahoot or Quizizz to assess their colleagues at the end of the activities through fun quiz-type activities. The learners also used Mentimeter for evaluation in the form of surveys. Puzzel.org and Wordize were used to create word games to reinforce and evaluate what had been learnt.

Many other platforms, such as those for generating texts or answers to specific questions were tested but were ultimately not chosen in line with the reasons given above, following dialogue with the students to elicit feedback throughout the development of the work plan.

Third step: defining and implementing the work plan with the students

The key concepts in defining the work plan are differentiated and diversified learning, equity, efficiency, individualisation, personalisation, collaboration, active and innovative student-centred methodologies, creativity, hard and soft skills acquisition, and multidisciplinarity. The work plan is systematically presented to the students at the beginning of the semester, justified and negotiated with them to encourage enthusiasm, awakening motivation and calling on everyone to take responsibility as dynamic actors. Adaptability and flexibility are seen as essential characteristics of the work plan.

The first stage, therefore, consists of a conversation with the learners focusing on their expectations regarding FL learning, their opinions on motivating and empowering them with the FL skills likely to assist (and be an asset for) them in their forthcoming jobs, their desire to work with digital tools and their knowledge of the subject. This icebreaker phase is essential if students are to identify with the process, feel that they are working as a team and appreciate the importance of FL learning at this level of education. Working together to define KPIs is another vital initial activity in this consensual and responsible pathway approach. Finally, the students must also specify all the skills to be developed. The groups are created and each elects a spokesperson to gather the team's opinions and proposals.

The teaching unit must be presented in detail (objectives, methodologies, strategies, content, etc.) and with complete transparency, especially about the proposed assessment model, which all must adopt. The continuous assessment parameter must be valued in this context of accountability for learning and its results. Group and individual assessment elements must be consistent with and linked to the methods adopted. Self-assessment and peer assessment are introduced. Language levels (Common European Framework of Reference for Languages) must be assessed at the beginning and end of the course, and this has been done using original tests developed by the teachers based on TOEFL, DALF and DELF. The

results are presented to and discussed with the students and should serve as a guide for the proposed activities.

The following sessions use active teaching strategies continuously, sometimes intersecting but alternating to avoid monotony and encourage renewed creativity. The activities are diversified for the same reasons. They consist of tasks that mobilise cross-disciplinary skills specific to the students' subjects (e.g. reports and interviews for the media studies degree, virtual guided tours for those in advertising and public relations, training plans for those in sport, escape room, quizzes, word games, etc.).

Monitoring is one of the keys to success. Regular updates and sharing of difficulties, successes, doubts, and improvements to be made to the various components of the process (including the games created, from the point of view of the teachers and students) are important assets in collaborative learning. Learners need to feel supported, learn to adopt positive attitudes and be able to obtain clear answers to their proposals and doubts. The SWOT analysis format is an interesting one to use in this approach. The evolution of KPIs should also be assessed, and a comparative analysis of student learning results will help with reflection and improvement.

3. Discussion

In the case of the experiments carried out with vocational bachelor degree students at ESEV, the implementation of active teaching methods, in particular, assisted by digital tools, has very clearly led to a renewal of practices and a repositioning of the roles of both teachers and students. The appropriateness of learning and the entire teaching-learning process are being questioned. Teachers are working on new strategies, but students are also developing new techniques to make their work easier, such as installing automatic translation functions on electronic devices.

Regarding preparation, the teachers have had to take various spontaneous training courses, mainly distance learning (MOOCs, tutorials, etc.), on active teaching methods, digital tools, using and applying digital platforms, etc. The aforementioned investment in time becomes even more time-consuming due to the preparation of activities specific to the target audience and the creation of material, particularly online material. Supporting work outside contact hours also means being more available and having flexible working hours.

A precise analysis of the workspace, the materials available, the characteristics of the target audience in terms of generational interests, knowledge, academic and professional expectations, the time available in and out of the classroom, and the skills to be developed is essential before embarking on the design of the teaching system. The work plan is open-ended and must ensure the student's active participation in the various stages, including their own decisions on how the work plan unfolds. The teachers present work proposals, accounting for each of the components therein included. As the students must give their opinions and interact to complete and improve the proposed plan, they very quickly feel like they are part of a team guided by the teachers. Flexibility does not mean losing sight of the objectives of the curriculum unit.

Flipped classroom strategies were used to enable learners to continue learning outside the classroom and to prepare material for face-to-face lessons, mainly focused on developing communication in all its forms. Peer evaluation helped to strengthen critical thinking and to highlight the relationship between the strategies adopted and ~~the~~ evaluation. Experiments in self-evaluation and hetero evaluation with a view to constructive criticism need to be worked on with the class to learn to develop positive attitudes and effective, objective and ethical communication.

Introducing active teaching strategies, particularly playful activities, means not losing sight of the teaching objectives and avoiding falling into the trap of the wow effect. These strategies also imply regularly reminding students of the rules, varying the strategies, activities and materials used and produced, and monitoring them regularly. Gamification is a great success, but it also requires reflexive thought, work and monitoring. In this context, particular attention must be paid to the assessment model. Discussed and negotiated with the students, their assessment must also be flexible enough to adapt to changes, student activities and their relevant suggestions.

4. Conclusion

Active teaching strategies aided by digital tools play a significant role in motivating teachers and students when applied in a reasoned and highly monitored way. The most significant benefit is to better address the identified needs of students, who feel more motivated and more committed to the process of sharing the responsibilities and expectations of the various actors involved. Every effort must be made to ensure that all learners, without exception, feel at ease with these teaching methods and derive maximum benefit from them in terms of varied and up-to-date learning without falling into the trap of over-facilitating.

The activities devised must be creative, original, varied, consistent with the objectives, and arouse the interest of the learners while guaranteeing the development of skills and the acquisition of knowledge. The investment in time and energy for teachers is considerable, as they are in a process where relationships with learners are very different from those of traditional models, and timetables are flexible.

Among the obstacles that need to be overcome, the extreme variability and rapid evolution of digital tools require constant attention. Assessing the effectiveness of learning in terms of knowledge acquired and skills developed is a real challenge. One of the problems is understanding whether these gains are sustainable. In addition to these aspects, future research needs to assess the acceptance, functionality, and usability of the technologies used by teachers and students and the real impact of digital tools.

Acknowledgement

This work is funded by National Funds through the FCT - Foundation for Science and Technology, I.P., within the scope of the project Refª UIDB/05507/2020 and DOI identifier https://doi.org/10.54499/UIDB/05507/2020.
Furthermore, we thank the Centre for Studies in Education and Innovation (Ci&DEI), the Polytechnic of Leiria and the Polytechnic of Viseu for their support.

References

Børte, K., Nesje, K., & Lillejord, S. (2020). Barriers to student active learning in higher education. *Teaching in Higher Education*, *28*(3), 597-615. https://doi.org/10.1080/13562517.2020.1839746

Delplancq, V., Costa, A. M., Pereira, J., Gillain, R., & Fidalgo, S. (2024). Using Digital Tools to Innovate in Higher Education: From Icebreakers to Various Skills Development. In K. Prager & N. Bilge (Eds.), *Digital Literacy at the Intersection of Equity, Inclusion, and Technology* (pp. 198-223). Hershey: IGI Global. https://doi.org/10.4018/979-8-3693-2591-9.ch009

Delplancq, V., Costa Lopes, A. M., Pereira, J., & Fidalgo, S. (2023). Active foreign language learning practices in higher education: the perspectives of the actors. In *Education Applications & Developments VIII*, 208-217.

Harrington, C., & 50 College Students (2021). *Keeping Us Engaged: Student Perspectives (and Research-Based Strategies) on What Works and Why*. New York: Routledge. https://doi.org/10.4324/9781003445531

Lopes, A. C., Costa, C. A., Coutinho, E., Oliveira, I., Pereira, J., Gillain, R., Amante, S., Fidalgo, S., Relvas, S. & Delplancq, V. (2023). Looking into foreign languages and multimodal creativity as a tool for pedagogical innovation in higher education: the JASM Project–open window onto the world. In *New approaches to the investigation of language teaching and literature* (pp. 141-153). Hershey: IGI Global. https://doi.org/10.4018/978-1-6684-6020-7.ch008

Lopes, A. C., Oliveira, A., Amante, F., Oliveira, I., Abrantes, J., Pato, M. J., Amaral, O., Relvas, S., Fidalgo, S., & Delplancq, V. (2018). Foreign languages and employability: a complex relationship. Case study in the region of Viseu (Portugal). In *EDULEARN18 Proceedings*, 614-618. IATED. https://doi.org/10.21125/edulearn.2018.0246

LEARNING AMONG OLDER ADULTS: THE POTENTIAL OF PEER TUTORING

Cristina Vidal-Marti
MIDE, Universitat de Barcelona/ Lecturer (Spain)

Abstract

Peer tutoring is a cooperative learning method based on linking people with similar characteristics or situations who help each other in order to learn. Cooperative learning is understood as an inclusive educational methodology that turns difference and heterogeneity into a positive element of learning. It consists of organising the group into small working groups or stable pairs over time, where all participants become active agents in their learning process and take responsibility for both their own process and that of their peers. The classroom becomes a meaningful learning space that favours the integration of knowledge and the development of competences that are not strictly instructional. The benefits of peer tutoring are manifold, although Topping (2000) highlights two: the bonding that is established between the participants and the continuous interaction over time that facilitates a relationship, knowledge and mutual help. However, this method is rarely applied in the older adult population. For this reason, this paper presents an educational experience where peer tutoring was implemented in older adults to promote memory knowledge and optimise their training process. The design and implementation of the educational project is explained, providing the data collected from the evaluation process, in order to identify the benefits of peer tutoring. The participants were twenty-nine older adults from the city of Barcelona, three of whom were tutors. The sample was selected using inclusion and exclusion criteria. The twenty-six participants were distributed in three groups. The three tutors had no previous teaching experience. The data collection instruments were different for each agent. Being, in the case of the students, a survey and a discussion group. For the tutors, a participant observation and a survey. The results establish that peer mentoring in older adults has benefits. In per regarding the mentees, it favours a greater knowledge and, consequently, a greater perception of memory functioning. Per concerning the tutors, a greater feeling of help and social usefulness. The overall evaluation of the experience was positive; 9.08 for the tutors and 9.53 for the tutees. In conclusion, peer tutoring is a good learning method for older adults.

Keywords: *Peer mentoring, learning, benefits, mentoring, mentoree, mentored.*

1. Introduction

Memory is a cognitive domain of concern for the older adult population. Cognitive training programs aimed at the older adult population, without pathology and from an educational and preventive perspective, are oriented to work on metamemory and to provide strategies and techniques that favour learning and cognitive work (Calatayud et al., 2018; Pérez et al., 2015). A significant percentage of older adults participate in these programs with the aim of optimizing this domain and consequently improving their cognitive health (Sánchez & Fernández, 2021).

The increase of older people, the concern about memory as the person ages and the increase in demands from that social group to participate in memory training programs raised the need for innovative changes to respond to such demands. In turn, the needs were reinforced by social policies aimed at the empowerment of this group and the need to place the elderly person at the centre of the intervention (Vidal-Marti, 2020; 2023).

This scenario led to the creation of an intervention project, within the framework of a memory training program, with the aim of responding to these needs and promoting the active role of the elderly (Vidal-Marti, 2012; 2022). A project was designed and implemented in which the older adult had a greater role and helped other people, to train and promote memory training.

Peer tutoring was chosen because it is a collaborative learning method, in which members help each other in their learning process in order to acquire the established competencies (Fernández-Barros et al., 2023). Peer tutoring is understood as a cooperative learning method in which there are two differentiated roles; the tutor and the tutored (Topping, 2000; Topping & Ehly, 1998).

In this experience, the same age typology was used, in which the tutor is an older adult person and the tutored as well. Before starting the experience, the tutors participated in training and, later, with the support of a professional, they designed the educational intervention: objectives, contents, activities (individual, group and reinforcement) and evaluation criteria (criteria and instruments).

2. Design

The design of this study is descriptive, qualitative and cross-sectional.

3. Objectives

The objectives of this study were twofold. The first focused on describing the design and implementation of peer tutoring for older adults and the second on the benefits of the experience.

4. Methods

4.1. Participants

The initial sample consisted of 32 participants, 3 of whom were excluded because they did not complete the project. The sample was selected using inclusion and exclusion criteria. The inclusion criteria were three: being over 60 years of age, having participated in a memory training project taught by a professional, and explicit willingness to participate.

The exclusion criteria were two: having a cognitive impairment and having a disease that would disable the person to participate in the experience. Each participant underwent a neuropsychological assessment and an in-depth interview to identify possible exclusion criteria.

The sociodemographic characteristics of the 29 participants were that 75.86% were women and 24.14% men. The mean age was 74.7 years, ranging from 62 to 77 years. There were twenty-six participants, distributed in three groups: one of eight and two of nine, and three tutors. The participants, who assumed the role of tutor, were two women and one man, two with a high school education and one with a university education. The three tutors had no previous teaching experience.

4.2. Data collection

There were two data collection techniques: a survey and a discussion group. The first was instrumented by means of a questionnaire.

The questionnaire was structured in two distinct parts. The first focused on the overall assessment of the experience and the second, more specific, consisted of eight closed questions.

Using a Likert-type scale, the participants were asked to respond to these questions, establishing a value of 1 to not at all in agreement and 10 totally in agreement.

The eight items surveyed by means of closed questions were: content, methodology, organization, facilities, duration, schedule, number of sessions and materials. The questionnaire was administered to the students during the last session of the project and to the tutors at the end of their work.

The focus group was made up of ten tutees, two tutors and one professional from the organization. All participated on a voluntary basis. It was constituted following the premises of Krueger (1991). It lasted about two hours and focused on learning about the benefits at the educational level in greater detail.

4.3. Procedure

The project was presented to potential candidates, who were older adults who had previously attended a memory training program taught by a professional. Following the presentation, the selection of the potential tutors and mentees began. First, the tutors were selected and, later on, the mentees.

At the same time as the selection of the tutors, the training of them was carried out. It consisted of a training based on three blocks: peer tutoring, group dynamization and memory training.

Once the training was completed, working sessions were established to design the planning in a consensual manner. In turn, two follow-up meetings were established for the tutors while the project was being implemented; however, only one was held and it dealt with anecdotal issues.

Data collection and processing was carried out taking into consideration all ethical aspects.

5. Discussion

One objective of this work was to make visible the experience of peer tutoring in older adults in a non-academic context, in order to further reinforce the active participation of the participants and facilitate their memory training.

Few experiences of implementation of peer tutoring in older adults were found in the literature review. The references found focus their subject matter on learning technological tools in a recurrent manner (Freddolino et al., 2010; Pihlainen et al., 2021; Woodward et al., 2013). The only common criterion identified in the papers was age; however, comparison on the basis of this variable made little sense and did not provide any complementary data.

Based on the experience, commenting that both the tutees and the tutors valued its implementation positively. The experience was positively evaluated by the two agents who participated. The scores obtained were higher than 7 out of 10 in both roles and in all items, with the exception of organizational issues, in which tutors and mentees differed.

A second objective was to learn about the benefits of peer tutoring. Four aspects were identified, with two tutors and mentees agreeing.

The first was the sharing of experiences, experiences and concerns about memory. Both tutors and mentees commented that this benefit was present throughout the project. Tutors expressed that sharing helped them to understand the discomfort of memory loss; and mentees to understand that cognitive changes are part of the cognitive aging process. They added that having moments to share throughout the project contributed to increase the perception of receiving support and consequently favoured greater peer support in their learning process. This process of approaching the other person, and not focusing on oneself, was highlighted as a positive element. This issue is relevant in the ageing process to reinforce generativity and the sense of one's own existence.

A second benefit is that the experience facilitated the learning process (Duran, 2006; Margüello et al., 2024). In this work, the data obtained do not allow for a clear positioning, although in the focus group tutors and tutees clearly stated that peer tutoring had helped to acquire concepts and knowledge for memory training. Therefore, although no reliable data are available, there is a perception that the method facilitated the learning process.

A benefit expressed only by the tutors was the attention to diversity. The tutors affirmed that the methodology helped the learning process, because in both individual and group activities, the cultural, learning and motivational differences among the students were visualized. The group work favoured mutual help among the students and, consequently, reinforced the achievement and encouraged the learning process as a group. Different research supports this same benefit (Heredia & Duran, 2013, Molina et al., 2019).

A benefit identified by the mentees is that peer tutoring provided positive effects different from other learning methods. The favourable climate of communication, a greater perception of help, accompaniment and interest in sharing would explain that people of different ages helped each other to train their memory. Peer tutoring allowed those being tutored to have a tutor as a reference person, who was close, interacted as an equal, guided and made the learning process possible, both for those who had difficulties and those who did not.

6. Conclusions

This work shows that peer tutoring is a good method for promoting educational experiences in older adults. The good assessment of the tutors and the tutees and the benefits provided by peer tutoring allow us to affirm that this method is optimal to facilitate memory training and to be applied in this age group.

However, the author of this paper is aware of possible limitations. In future experiences it will be important to expand the instruments to collect information that will make it possible to know the degree of learning with greater precision. In the questionnaire as well as in the discussion group, both the tutors and the students affirmed that the experience had facilitated learning. However, these statements could not be contrasted with data extracted from the techniques and call into question their suitability.

In short, peer tutoring in older adults is a good educational method to favour memory training.

References

Calatayud, E., Plo, F., & Muro, C. (2018). Analysis of the effect of a program of cognitive stimulation in elderly people with normal aging in primary care: Randomized clinical trial. *Atención Primaria, 52*(1), 38-46.

Duran, D. (2006). Tutoría entre iguales: La diversidad en positivo. *Aula de innovación educativa, 153-154*, 7-10.

Fernández-Barros, A., Duran, D., & Viladot, L. (2023). Peer tutoring in music education: A literature review. *International Journal of Music Education, 41*(1), 129-140.

Freddolino, P. P., Lee, V. W., Law, C. K., & Ho, C. (2010). To Help and to Learn: An Exploratory Study of Peer Tutors Teaching Older Adults about Technology. *Journal of Technology in Human Services, 28*(4), 217-239.

Heredia, J., & Duran, D. (2013). Aprendizaje cooperativo en educación física para atender a la diversidad: inclusión de alumnado con rasgos autistas. *Revista nacional e internacional de educación inclusiva educativa, 6*(3), 25-40.

Krueger, R. A. (1991). *El grupo de discusión: guía práctica para la investigación aplicada*. Pirámide.

Margüello, O. I., Rodríguez, I. R., & Bengotxea, J. I. I. (2024). La tutoría entre iguales en la orientación universitaria. El caso del programa BAT en los grados en pedagogía y educación social de la universidad del país vasco. *Revista Española de Orientación y Psicopedagogía, 35*(3), 86-104.

Molina Díaz, M., Benet Gil, A., & Doménech Vidal, A. (2019). La tutoría entre iguales: un elemento clave en las aulas interculturales inclusivas. *Revista complutense de educación, 30*(1), 277-292.

Pérez, A., Roqué, M., Domènech, S., Monteserín, R., Soriano, N., Blancafort, X., ... & López, M. J. (2015). Efficacy of memory training in healthy community-dwelling older people: study protocol for a randomized controlled trial. *BMC geriatrics, 15*(1), 1-8.

Pihlainen, K., Korjonen-Kuusipuro, K., & Kärnä, E. (2021). Perceived benefits from non-formal digital training sessions in later life: Views of older adult learners, peer tutors, and teachers. *International Journal of Lifelong Education, 40*(2), 155-169.

Sánchez Gómez, C., & Fernández Rodríguez, E. J. (2021). The effectiveness of a training programme in everyday cognition in healthy older adults: a randomised controlled trial. *BMC geriatrics, 21*(1), 1-13.

Topping, K. (2000). *Tutoring. Educational Practices Series, 5*. UNESCO. https://eduq.info/xmlui/bitstream/handle/11515/17945/125454e.pdf?sequence=1

Topping, K., Buchs, C., Duran, D., & Van Keer, H. (2017). *Effective peer learning: From principles to practical implementation*. Routledge.

Topping, K., & Ehly, S. (1998). *Peer-assisted learning*. Routledge.

Vidal-Martí, C. (2012). *Si entrenem, recordem*. Claret

Vidal-Marti, C. (2020). Aprendizaje cooperativo en los programas de entrenamiento de memoria multifactorial para personas mayores. *Tendencias Pedagógicas, 36*, 154-163.

Vidal-Martí, C. (2022*). Envejecimiento activo y empoderamiento*. Horsori.

Vidal-Marti, C. (2023). Evaluation of a training programme to train older adults as facilitators in a memory training project: using Kirpatrick's model. *Quality in Ageing and Older Adults, 24*(1/2), 65-78.

Woodward, A. T., Freddolino, P. P., Wishart, D. J., Bakk, L., Kobayashi, R. I. E., Tupper, C., ... & Blaschke-Thompson, C. M. (2013). Outcomes from a peer tutor model for teaching technology to older adults. *Ageing & Society, 33*(8), 1315-1338.

CLARITY, SPECIFICITY, AND CONTEXT (CSC): ENGINEERING EFFECTIVE PROMPTS FOR GENERATIVE AI IN HIGHER EDUCATION

Laura Zizka
Learning, EHL Hospitality Business School HES-SO University of Applied Sciences and Arts Western Switzerland (Switzerland)

Abstract

Since 2022, there has been a revolution in Higher Education Institutions (HEIs) called Generative Artificial Intelligence, or Gen AI. Gen AI is based on algorithms that are created to help it learn patterns from large sets of data to produce new content. While other technology, such as the personal computer or the Internet, has been introduced into HEIs, Gen AI has led to heated academic debates and opposed positions regarding its place in HEIs and its use by students and faculty members. For example, some argue that Gen AI has become more trustworthy and reliable, while others critique Gen AI's inability to do critical thinking or complex analytical tasks. ChatGPT and other technologies have been labeled 'disruptive innovations' that could revolutionize academia. Of the many examples of Gen AI, one of the most prevalent is ChatGPT. This study will investigate one of the lesser-researched areas in the research thus far, i.e., prompt engineering. Previous research has defined *prompt engineering* as the strategic means of producing the ideal prompt that will help the user to achieve a specific goal. Gen AI functions by giving a detailed response according to instructions in a prompt. No prompt means no output. Nonetheless, there are best practices to consider when drafting the prompts. According to the literature, effective prompts are based on clarity, specificity, and context. Thus, we drafted ten versions of the same prompt, and ChatGPT drafted ten to gauge if both sets of prompts were equally effective. A content analysis was conducted to evaluate the effectiveness of the prompts. The prompts were also assessed using a rubric based on three criteria – clarity, specificity, and context. All twenty prompts were compared to create a ranking of prompt efficacy. We found that several of our prompts ranked higher than those created by ChatGPT. From the results, our prompt ranked first with a perfect score of 30, although the scores for all prompts were quite close. To conclude, we will share best practices for using prompt engineering in HEIs and tips for writing better prompts.

Keywords: *Prompt engineering, Generative Artificial Intelligence, ChatGPT, Higher Education Institutions (HEIs), academic writing.*

1. Introduction

The history of using technology as a learning tool has followed stages from Web 1.0 (PC Internet) through Web 2.0 (mobile Internet stage) and continuing to Web 3.0 (metaverse and future form of Web) (Wang et al., 2023). In the early stages (before 2010), it was not that popular, but in the development stage, from mid-2010 to 2022, AI algorithms emerged and began to grow rapidly (Wang et al., 2023). In 2022, the technology reached a new high, *flourishing* stage. The use of this technology at each stage has become prevalent in Higher Education Institutions (HEIs). Generative Artificial Intelligence, or Gen AI, is one of the most debated technologies. Gen AI is based on algorithms that are created to help it learn patterns from large sets of data to produce new content (Wang et al., 2023). Open AI was established in 2015 to develop public tools such as ChatGPT; in simple terms, ChatGPT is a highly sophisticated chatbot based on Large Language Models (LLMs) that can answer almost any text-based request as they are based on an exceptional amount of data to train them (Lund et al., 2023). Gen AI functions by giving a detailed response according to instructions in a prompt (Wu et al., 2023).

According to the literature, *prompt engineering* is defined as 'crafting optimal prompt to achieve a specific goal with a generative model" (Amatriain, 2024, p. 3). Effective prompts could include instructions, in-context examples, descriptions of features in the dataset, and questions to encourage fair, unbiased prompts (Li et al., 2024). Heinig (2024) suggested that the most effective prompts are based on clarity (i.e., concise, brief, and easy to understand), specificity (i.e., clear and detailed), and context (i.e., based on relevant background information). Amatriain (2024) suggested that credibility can be

evaluated by prompting LLM to produce multiple answers to the same question. Thus, this study will investigate one of the lesser-researched areas in the research thus far, i.e., prompt engineering through the lens of clarity, specificity, and context (CSC).

2. Methods

To analyze the clarity, specificity, and context of effective prompts, we began by drafting ten versions of the same prompt. We then tasked the paid version of ChatGPT to draft ten prompts to gauge if both sets of prompts were equally effective. A content analysis was conducted to evaluate the prompts' effectiveness and gauge if both the human and the Gen AI-produced prompts were equally effective. Gen AI was then used to create a ranking of prompt efficacy separately and then combined.

Table 1 shows the ten prompts from the researcher and ChatGPT. To save space, only the sentence that differs appears on the table. The full prompt read:

Write a 500-word response to the following position: "This paper argues that hoteliers promote the human-touch, thus, robots cannot replace humans." The response must include 5 academic journal articles used in-text and on a reference list in APA 7th edition format.

Table 1. Ten prompts from the Researcher and ten from ChatGTP.

Researcher ten original versions	ChatGPT ten versions
1." This paper posits that humans cannot be replaced by robots in the hospitality industry, thus, hoteliers should invest more in promoting the human touch. "	1b " This study argues that robots are unable to replicate the human element in the hospitality sector, suggesting that hotels should prioritize investments in enhancing human interactions."
2." This paper argues that humans cannot be replaced by robots in the hospitality industry, thus hoteliers should invest more in people. "	2b " The paper contends that robots lack the capability to replace humans in the hospitality industry, and thus, hoteliers should focus on fostering personalized guest experiences."
3." This paper argues that robots cannot replace humans in the hospitality industry, thus hoteliers should focus on its employees. "	3b. " This analysis proposes that automation cannot fully substitute the human presence in the hospitality field, urging hotel operators to invest in strengthening the personal touch of their services."
4." This paper states that the hospitality industry is people-centric; hence, robots cannot replace humans. "	4b. " This research suggests that robots fall short of replacing human staff in hospitality, advocating for increased investment by hoteliers in elevating the quality of human engagement ."
5." This paper posits that the hospitality industry is human-centric; thus, humans cannot be replaced by robots. "	5b. " The paper asserts that robots cannot replace the unique human skills vital to the hospitality industry, recommending that hotels prioritize efforts to enhance interpersonal customer service."
6." This paper postulates that robots cannot currently replace humans in the hospitality industry as the industry is based on human contact."	6b. " This study maintains that the hospitality industry cannot rely solely on robots to meet guest expectations, and advises hoteliers to invest in human-centric service improvements."
7." This paper posits that human contact is essential in the hospitality industry; thus, robots cannot replace humans ."	7b. " The research argues that while technology can assist, it cannot replace the nuanced human interactions critical to hospitality, prompting hoteliers to focus on promoting the human touch."
8." This paper posits that human contact is essential in the hospitality industry; thus, humans cannot be replaced by robots. "	8b. " The paper posits that robots lack the empathy and adaptability necessary to replace humans in hospitality, urging hotel management to emphasize investments in human-driven service experiences."
9." This paper argues that hoteliers should invest more money in its people because robots cannot replace humans."	9b. " This analysis suggests that the hospitality industry should not view robots as a complete replacement for human staff, and instead, should allocate resources to nurturing the human aspect of guest service."
10." This paper argues that hoteliers promote the human-touch, thus, robots cannot replace humans."	10b. " This paper contends that robots cannot replicate the human warmth essential in hospitality, leading to the conclusion that hoteliers should focus their investments on promoting personal interactions with guests."

Source: OpenAI, 2025.

From Table 1, the length of the examples is the most flagrant and immediate observation. The Researcher's ten prompts resulted in 198 words total compared to 290 words for the ChatGPT output. The Gen AI output added superfluous and overly complicated word constructions that did not contribute to *better* prompts. When asked whose prompts were more effective overall, ChatGPT confirmed that the Researcher's prompts were better. ChatGPT admitted that the variations it provided were too verbose: *My variations use more complex phrasing, such as "This analysis proposes" or "The research argues." While this may seem more academic, it can also introduce ambiguity and make the argument less direct. In academic writing, clarity often outweighs complexity, especially when discussing industry-specific topics* (OpenAI, 2025).

.

3. Findings / discussion

The Researcher tasked ChatGPT with the creation of a rubric to rank the outputs*: Create a rubric to evaluate all twenty prompts that focuses on the following three criteria: Clarity, Specificity, and Context. Grade each of the prompts on those three criteria and rank them.*

Rubric for Evaluating Prompts
ChatGPT*: I will create a rubric based on the following three criteria: Clarity, Specificity, and Context. Each criterion will be scored on a scale from 0 to 10, making the total score out of 30 for each prompt.*

Table 2. Rubric for evaluating prompts.

Clarity	Specificity	Context
Definition: Measures how clearly the prompt conveys its main argument. A clear prompt has a straightforward thesis and avoids vague or complex language.	Definition: Evaluates the level of detail and precision in the prompt. A specific prompt clearly defines its terms and offers a precise recommendation or action.	Definition: Assesses how well the prompt addresses the unique characteristics of the hospitality industry, including the importance of human touch and the role of automation.
Scoring: □9-10 points: Thesis is crystal clear, concise, and easily understandable. □7-8 points: Mostly clear, but may include minor wording issues or slight ambiguity. □5-6 points: Somewhat clear, but has noticeable issues with vague language or complex phrasing. □0-4 points: Confusing or unclear thesis; difficult to discern the main argument.	Scoring: 9-10 points: Provides a well-defined argument with specific recommendations or detailed language. 7-8 points: Generally specific, but may lack detailed action points or use slightly vague language. 5-6 points: Lacks precision or uses generic language without specific recommendations. 0-4 points: Very vague, with broad statements that lack any detail or actionable insight.	Scoring: □9-10 points: Strongly aligned with the specific context of hospitality, addressing industry-specific issues effectively. □7-8 points: Good contextual relevance, but could more deeply integrate industry-specific aspects. □5-6 points: Shows some understanding of the context but may be too general or lack specific industry focus. □0-4 points: Weak or no connection to the hospitality context; could apply to any industry without significant modification.

Source: OpenAI, 2025.

Table 2 shows the specific criteria created by ChatGPT to evaluate the prompts. ChatGPT's definition of *clarity* focuses on 'straightforward, direct language,' which mirrors Heinig's (2024) criteria of 'concise, brief, and easy to understand.' *Specificity* for ChatGPT includes 'detail' and 'precision,' which concurs with Heinig's 'clear and detailed criteria (2024). Finally, ChatGPT's definition confirms Heinig's (2024) proposition of providing relevant background. In fact, ChatGPT elaborates on the industry and links strongly to the prompt when mentioning the human touch. Thus, ChatGPT can create criteria similar to a human for the definition. However, the point allocation for scoring is a bit fuzzy. What would differentiate a seven from an eight if the criteria were applied? To mitigate that issue, a human faculty member could rework the scoring to be more user-friendly for their grading.

The Researcher then requested ChatGPT to assess all twenty prompts using this rubric.
The ranking of the 20 prompts goes as follows:

Table 3. Grading of the 20 prompts (together).

Grading of All 20 Prompts

Prompt	Clarity (0-10)	Specificity (0-10)	Context (0-10)	Total Score (0-30)
Your Variation 1	10	10	10	**30**
My Variation 1	10	9	10	**29**
Your Variation 5	9	9	10	**28**
My Variation 5	9	9	9	**27**
Your Variation 7	9	8	10	**27**
My Variation 3	8	9	9	**26**
My Variation 7	8	8	9	**25**
Your Variation 2	8	7	9	**24**
My Variation 10	8	8	8	**24**
Your Variation 8	8	7	8	**23**
My Variation 2	7	7	9	**23**
Your Variation 3	8	6	8	**22**
My Variation 4	7	7	8	**22**
Your Variation 6	6	7	7	**20**
My Variation 9	6	6	8	**20**
Your Variation 10	5	6	7	**18**
My Variation 8	6	5	7	**18**
Your Variation 4	5	5	7	**17**
Your Variation 9	5	5	6	**16**
My Variation 6	5	4	6	**15**

Key: Your variation= Researcher My variation: ChatGPT
Source: OpenAI, 2025

While it was not necessarily expected, the versions from the Researcher and ChatGPT both had five examples in the top ten. Nonetheless, the Researcher's versions would, overall, score more points. When asked to explain this phenomena, ChatGPT responded that the Research versions were clear and direct, consistent and focused, and relevant to the industry (OpenAI, 2025). ChatGPT's more detailed response was the following:

1. Clarity and Directness:

- Your variations use clear, simple, and direct language. For instance, "This paper posits that humans cannot be replaced by robots in the hospitality industry" is straightforward and easy to understand.
- The focus on terms like "human contact," "people-centric," and "human touch" provides a strong emphasis on the core values of the hospitality industry without ambiguity.

2. Consistency and Focus:

- Your variations are consistent in their emphasis on the central theme: the irreplaceable value of human employees in hospitality. There is less deviation from this main point, making the argument cohesive.
- Many of your prompts explicitly highlight the industry's reliance on human interactions and the need for investment in the human element (e.g., "invest more in promoting the human touch"). This consistency would likely be appreciated by graders for maintaining a clear, focused argument throughout.

3. Relevance to the Industry:

- Your prompts use industry-specific language effectively, such as "people-centric," "human contact," and "human touch." These phrases directly address the unique characteristics of the hospitality industry, demonstrating an understanding of what differentiates it from other sectors.
- The focus on investment in people and the human element aligns well with industry trends, making your variations more relevant and applicable to real-world contexts.

Source: OpenAI, 2025.

ChatGPT further elaborated on why its scores would be lower, citing complex phrasing which could lead to greater ambiguity, less consistency in actionable recommendations that could weaken them, and a lack of logical flow which reduces the effect of the prompts (OpenAI, 2025).

Further, when asked, ChatGPT provided a critique of each of the 20 prompts as seen on Table 4.

Table 4. Comments on the 20 prompts.

Final Comprehensive Ranking of All 20 Variations

Rank	Prompt	Score	Reason for Ranking
1	Your Variation 1	10/10	Clear thesis, strong recommendation, direct language, and industry relevance.
2	My Variation 1	9.5/10	Well-articulated argument, slightly less direct than the top prompt.
3	Your Variation 5	9/10	Emphasizes the human-centric nature of the industry effectively.
4	My Variation 5	8.5/10	Focuses on unique human skills and provides a clear call to action.
5	Your Variation 7	8/10	Highlights the essential role of human contact; straightforward and relevant.
6	My Variation 3	7.5/10	Solid argument, but slightly wordy. Good actionable recommendation.
7	My Variation 7	7.5/10	Balanced approach, acknowledging technology's role while emphasizing human interactions.
8	Your Variation 2	7/10	Simple and direct, but slightly vague in the recommendation ("invest more in people").
9	My Variation 10	7/10	Strong focus on personal interactions but could be clearer in language.
10	Your Variation 8	6.5/10	Similar to Your Variation 7 but slightly redundant in phrasing.
11	My Variation 2	6.5/10	Argument is clear but lacks specificity in the recommendation.
12	Your Variation 3	6.5/10	Clear argument but could benefit from more specific language about employee focus.
13	My Variation 4	6/10	Emphasizes quality of engagement but is slightly vague in the call to action.
14	Your Variation 6	6/10	Weakened by the use of "currently," implying robots might replace humans in the future.
15	My Variation 9	5.5/10	Redundant language and vague recommendation. Lacks a strong, direct stance.
16	Your Variation 10	5/10	Weak logical flow and unclear connection between hoteliers promoting the human touch and robots' inability to replace humans.
17	Your Variation 4	5/10	Simplistic argument, lacking depth and actionable insight.
18	My Variation 8	5/10	Argument is vague, lacking strong evidence or specific recommendations.
19	Your Variation 9	4.5/10	The language is vague and does not clearly specify how hoteliers should invest in people.
20	My Variation 6	4/10	Lacks assertiveness and depth, focusing too much on general service improvements without specific recommendations.

Source: OpenAI, 2025.

ChatGPT's comments on its reasons for ranking merit further analysis and reflection. With an equal number of highly ranked prompts from the Researcher and ChatGPT, it was necessary to try to gauge why one prompt was 'better' than another. While the Researcher's prompts were criticized for language, weak flow, and simplicity, ChatGPT's versions had weaker arguments, call to action, and recommendations.

4. Conclusions / limitations / future studies

Based on the results of this study, a writer may wonder why ChatGPT would not provide 'perfect' examples each time; in fact, the question remains: why did ChatGPT not provide better examples than a human? One response derives from the method in which Gen AI produces output: For example, ChatGPT uses a simple information processing method, i.e., it predicts the next possible word in a sentence (Wu et al., 2023). There is no magical, technology-writing genius behind the screen. The technology does not think; it does not reflect; it does not try to help one writer over another. Thus, some writing output from GenAI may produce harmful or biased content (Tiulkanov, 2023) because the technology cannot think (Li et al., 2024). In fact, output may not be truthful because it cannot care if it is truthful or not and is not predictable about how or when it lies (Tiulkanov, 2023). Moving forward, to create more effective prompts, users may choose to focus on Heinig's (2024) three criteria: Clarity, Specificity, and Context.

This study was limited in its depth. Twenty prompts may not be sufficient to draw profound conclusions. Nonetheless, this gave a first glimpse into the efficacy of prompt engineering. Thus, a future study could elaborate on this initial study by drafting hundreds of examples by one or several researchers. The ranking was done uniquely by ChatGPT. A further study could include the Researcher and ChatGPT both ranking the prompts to compare their responses. Finally, ChatGPT was the only Gen AI used in this study. While it is free and easily accessible to all (which is why it was chosen), many other Gen AI could have been used. A study could be conducted using several Gen AI and comparing how they differ in their output and results.

Acknowledgments

Funding: This project has been funded by HES-SO under the reference: Projet prioritaire PP3 CCN- Guichet permanent- 'AI-generated text in Higher Education Institutions (HEIs): Are all responses equal?

References

Amatriain, X. (2024). Prompt design and engineering: Introduction and advanced methods. *arXiv:2401.14423*. https://doi.org/10.48550/arXiv.2401.14423

Heinig, I. (2024). *How to write the best AI prompts (+examples, do's and don'ts).* Retrieved January 8, 2025, from: https://sendbird.com/blog/ai-prompts

Li, Y., Zhang, L., & Zhang, Y. (2024). Fairness of ChatGPT. *arXiv:2305.18569*. https://doi.org/10.48550/arXiv.2305.18569

Lund, B. D., Wang, T., Mannuru, N. R., Nie, B., Shimary, S., & Wang, Z. (2023). ChatGPT and a new academic reality: Artificial intelligence-written research papers and the ethics of the large language models in scholarly publishing. *Journal of Association for Information Science and Technology*, *74*(5). https://doi.org/10.1002/asi.24750

OpenAI. (2025). *ChatGPT (October 25 version)* [Large language model]. https://chatgpt.com/c/671b78f0-d744-800e-8692-b44fbaa78911

Tiulkanov, A. (2023, January 8). Is it high time to take ChatGPT offline? *AI, Data & Digital Policy*. Retrieved from https://www.linkedin.com/pulse/high-time-take-chatgpt-offline-aleksandr-tiulkanov

Wang, Y., Pan, Y., Yan, M., Su, Z., & Luan, T. H. (2023). A survey on ChatGPT: AI-generated contents, challenges, and solutions. *IEEE Open Journal of the Computer Society*, *4*, 280-302. doi: 10.1109/OJCS.2023.3300321

Wu, T., He, S., Liu, J., Sun, S., Liu, K., & Han, Q.-L. (2023). A brief overview of ChatGPT: The history, status quo and potential future development. *Journal of Automatica Sinaca*, *10*(5), 1122-1136. doi: 10.1109/JAS.2023.123618

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

ARTIFICIAL INTELLIGENCE IN PHYSICS LEARNING: PERCEPTION AND APPLICATION

Joan-Josep Suñol
GID Physics, Department of Physics, University of Girona (Spain)

Abstract

In terms of learning/teaching innovation, one of the topics generating the most analysis and discussion is the application of artificial intelligence, AI. Both, in learning and assessment processes. This work analyses the application of artificial intelligence in the learning process of Physics in Engineering studies (first-year students). Complementary, surveys have been carried out among students on the perception and degree of knowledge of AI. In general, they are more favorable to its application in learning and self-assessment processes than in professor assessment. A significant percentage of students are concerned about its future impact on the labor market. The practical application of AI has been carried out in the teamwork activities and, the generation of learning material. Concerning the perception of the AI risks, the survey statistical analysis shows that: i) provide insufficiently verified information, ii) provides incorrect or incomplete bibliography or iii) AI is not prepared for scientific or technological tasks/activities (even in paid versions of AI). In the generation of learning material, it has been found that AI easily provides incorrect material and that, if the student interacting is not an expert, the self-assessment material generated can be counterproductive. Some examples are shown. The system is evolving, and intelligent tutoring systems will end up being generated. In addition, as professors, we must be aware that current students are AI users, but in a few years, first-year students will already be AI natives.

Keywords: *Artificial Intelligence, physics, higher education, teamwork.*

1. Introduction and objectives

Generative artificial intelligence (AI) has developed greatly in recent years, including in the field of education. One of the aspects to be analyzed is the perception of its users. In the set of perception studies, there is a bias towards those that focus on the positive aspects (Baidoo-Anu & Ansah, 2023). This fact is common in the research work on teaching/learning methodologies. Most of them are carried out by researchers who apply them and there is likely a tendency towards a positive assessment. Moreover, they tend to focus on students (Strzelecki, 2023). The most frequently highlighted positive issues are the reduction of the time needed to perform tasks and the easy accessibility of AI. More in-depth studies are needed to ascertain the perception of other aspects such as critical thinking (Darwin et al., 2023). There are expected benefits of AI in fostering the learning environment (more tailored, efficient, and analytical) (Nagy et al., 2024).

The involvement of the teaching staff and the center in learning through AI has to facilitate its correct use by the students. Some studies stress the need for academic institutions to facilitate the application of AI and mitigate associated problems, to reinforce positive experiences (Tlili et al., 2023). To this end, it is necessary to provide training tools for both teachers and students. It is also necessary to analyze the ethical issues of the educational field. There are risks such as the bias or the privacy remarked by professors and institutions. It is also mandatory financial support for specific AI applications. Nevertheless, most current studies are based on the experiences of a small group of teachers.

The students commonly use ChatGPT. It is known, that this application has problems: non-accurate answers to complex questions, wrong references, numerical mistakes (mathematics, information), and not up-to-date information (Kalyan, 2024). As a consequence, in this study, other applications such as Gemini or Perplexity are also recommended.

The main objectives of this study are to monitor the use of AI in academic work performed by first-year undergraduate engineering students, to increase their critical view of AI-generated material, and to survey students' perceptions of AI potential risks.

2. Methodology

The methodology used is as follows:

(a) Perception survey on possible positive or negative aspects of artificial intelligence. Statistical treatment of the data.
(b) b) Design teamwork activity related to the subject in which AI is used to generate text, images, questions, and problems.
(c) c) Activity management: Intermediate interactions with the professor to detect errors or mistakes in the generated material.
(d) d) Delivery of the work at the end of the activity. Including some reflective paragraphs on the use of IA. It is necessary to verify the evolution of the students' perceptions.

Finally, the analysis of the set of results will facilitate the introduction of improvements in the learning activity in its methodology and application in subsequent years.

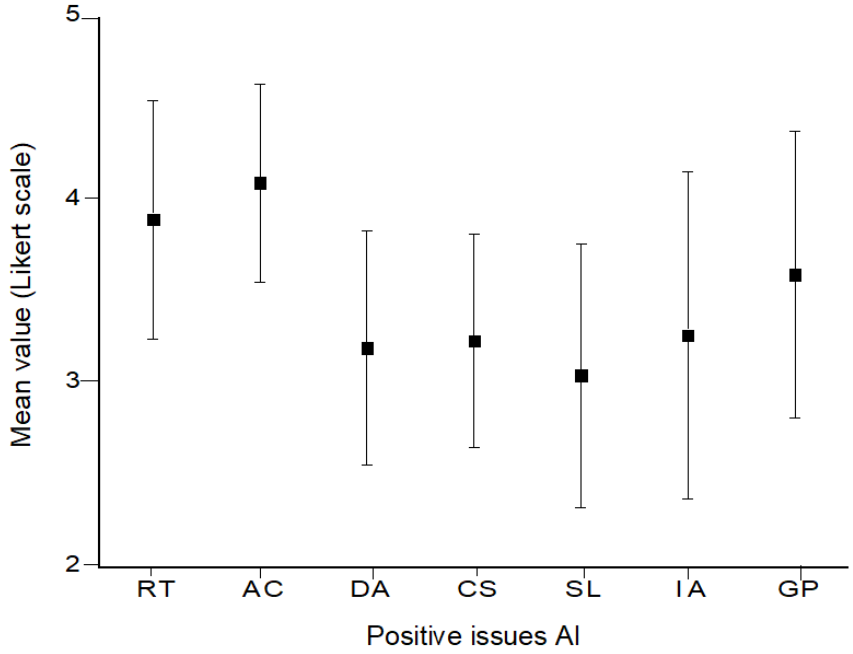
In the intermediate interaction with the students, the professor should consider that the learning environment and the learner's previous experiences influence the learning environment (Segaran et al., 2021). AI learning is often performed online, without interactions. It can be a problem for some students generating anger or anxiety (Hoferichter et al., 2022). In this study, the selected option is a teamwork activity to facilitate the interaction between peers.

3. Results and discussion

3.1. Perception study

A survey (Likert scale) was conducted at the beginning of the academic semester to ascertain the students' perceptions. A statistical study was carried out with the collected responses. Positive issues are reduction of task time (RT), easy accessibility (AC), Increased degree of autonomy (DA), complementary source of contrast in learning (CS), increased self-learning (SL), improvement assessment (IA), and general perception (GP). The best scores are those of the reduction of task time and easy accessibility. A similar result has been found in a previous study (Suñol et al., 2024).

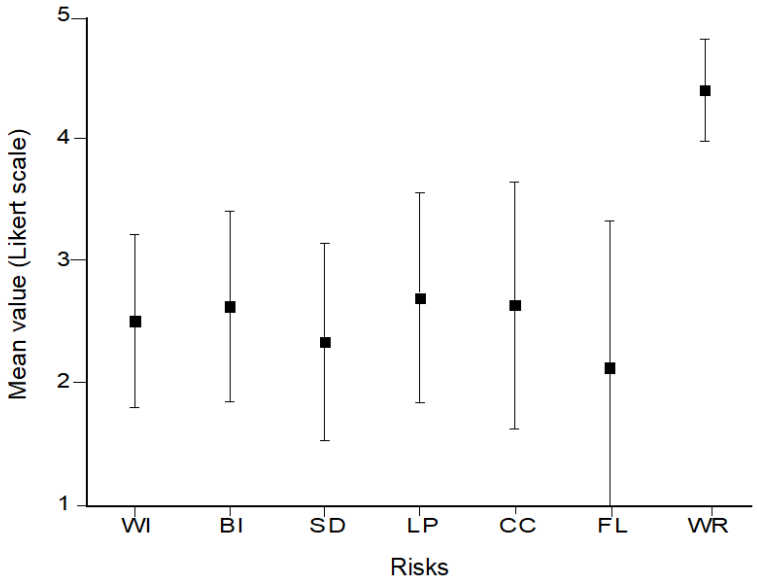
Figure 1. Perception survey: Positive issues evaluation of the positive issues of AI in learning tasks-activities.



With respect to the general perception of AI, it is positive (mean score 3.6).

The risks taken into account in the survey are wrong information (WI), biased information (BI), socio-economic discrimination (SD), loss of privacy (LP), decreased critical capacity (CC), false learning (FL), and human work replacement (WR). Other issues not considered in this study are the lack of personalization, the potential for echo chambers, and the non-deep understanding and learning. The last question is not linked to learning, but it has been included because students often remark in the open comments at the end of the survey. These open comments help the professor to understand the learner's feelings about AI and influence further modifications in the activity and/or the survey.

Figure 2. Perception survey: Negative issues evaluation of the positive issues of AI in learning tasks-activities.



Regarding the other risks of AI use, students do not perceive them significantly before performing the activity. Generally, professors and students have similar views on the potential benefits and risks of the academic use of AI (Marshik, 2024). Nevertheless, the professors are more sensitive to these risks. However, just as the students refer to future work problems, the professors point out other aspects such as the difficulty of applying AI in evaluation processes. AI was not well-accepted as a complete substitute for teacher grading (Alsalem, 2024). Other issues remarked by the academic staff are the increase in academic disparities and the decrease in professor authority (Jang, 2024).

3.2. AI material critical revision

In the intermediate interactions with each teamwork, the professor should check the questions problems, images, and references. Based on personal experience, a quick review can detect the most common errors. A random check can also be done. Errors are usually found when generating complex problems. This is the time to provoke a critical view of the material they have generated in the students. Most students tend to consider that everything the AI provides them is correct. One of the techniques suggested to students is providing an example problem to the AI. In this way, errors are minimized although they do not disappear.

Some examples of Perplexity AI correct application.

"Which of the following statements is a direct consequence of the second law of thermodynamics?

a) It is impossible to built a perpetual motion machine of the first kind.

b) It is impossible to build a perpetual motion machine of the second kind.

c) Energy is conserved in all thermodynamic processes.

d) Absolute temperature is always positive.

Correct answer: b) It is impossible to build a perpetual motion machine of the second kind."

"Generate one problem similar to this one and provide the solution.

A radiator with an exterior surface of 1.5 m^2 is painted with aluminum paint (emissivitat=0.55). (a) What is the heat flux through the radiator derived from radiation when the temperature of the radiator is 50ºC? (b) What is the heat flux absorbed if the room walls are below 22ºC? (c) What is the net heat flux from the radiator?

Problem 1: Solar Heating of a Black Roof

Problem: A flat black roof with an area of 100 square meters absorbs 80% of the Sun's radiation. If the solar intensity is 1000 W/m², calculate:

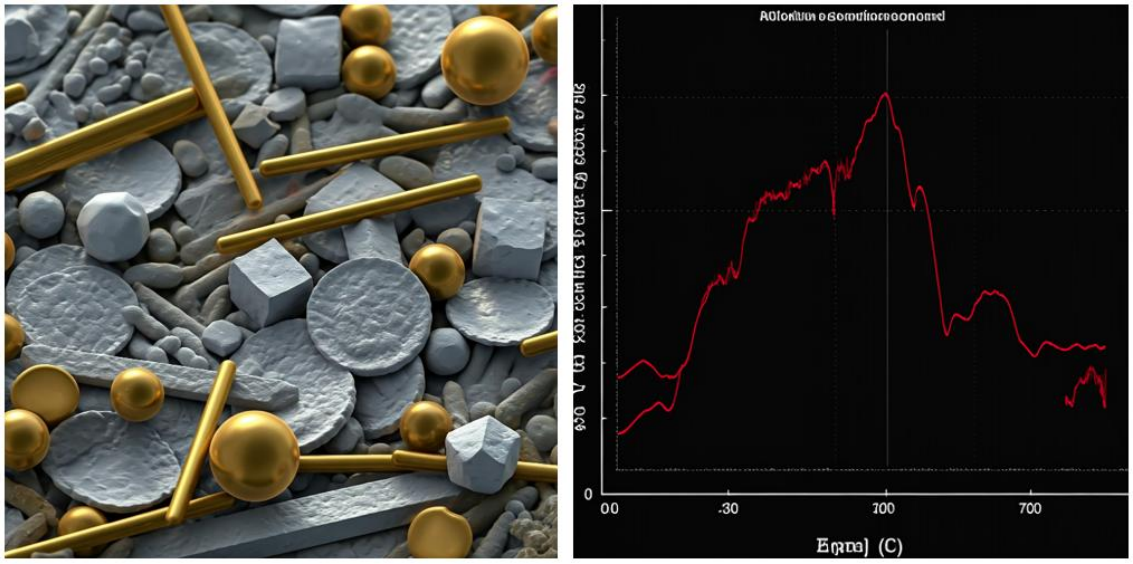
(a) The rate at which the roof absorbs solar energy. (b) The temperature increase of 1000 kg of water stored in a tank under the roof if all the absorbed energy is transferred to the water over 6 hours. Assume the specific heat capacity of water is 4186 J/kg°C.

Solution: (a) Rate of energy absorption = Solar intensity Area Absorption factor = 1000 W/m² 100 m² 0.8 = 80,000 W

(b) Energy absorbed in 6 hours = 80,000 W 6 3600 s = 1.728 x 10^{11} J Temperature increase = Energy absorbed / (Mass Specific heat capacity) = 1.728 x 10^{11} J / (1000 kg 4186 J/kg°C) ≈ 41.3°C."

In Figure 3, two wrong generative IA images are shown. Obviously, the left images do not correspond to nanoparticles and the right image is not a calorimetry scan.

Figure 3. Generated nanoparticles image (left) and generated calorimetry scan of a crystallization process (right). Gemini.



Regarding the generation of text, this is usually of a general and informative nature. In addition, if the request is complex, for example, searching for articles that discuss several topics, the probability of an incorrect response increases.

"Write two paragraphs about magnetic refrigeration of data centers from scientific articles

Magnetic refrigeration is emerging as a promising technology for cooling data centers, offering a more energy-efficient and environmentally friendly alternative to traditional cooling methods. This innovative approach leverages the magnetocaloric effect, where certain materials undergo temperature changes when exposed to varying magnetic fields. In magnetic refrigeration systems, materials like gadolinium are subjected to alternating magnetic fields, causing them to heat up when magnetized and cool down when demagnetized. This cyclical process can be harnessed to create a continuous cooling effect without the need for harmful chemical refrigerants, significantly reducing the environmental impact of data center cooling operations." Perplexity.

AI provides two references, only one is a scientific article (linked to magnetic refrigeration, not to data centers). Thus, also correct references should be checked.

3.3. Final remark

The final perception of the students is included as a section of the final deliverable. It is noted that the visualization of AI as a danger to their professional future has been reduced. In the other risks, increased interest is detected in the generation of erroneous, incomplete, or unverified information. Concerning the general assessment, it remains positive (as all the AI potentialities remarked in this study).

4. Conclusions

In this work, the use of AI platforms by first-year university students to generate text, questions, problems, and images and to find references (in a teamwork activity) has been promoted. Their initial perception has been collected in a survey which shows that students initially do not give excessive importance to the risks of AI in learning processes. They focus on its accessibility and the reduction of work time.

The interaction with the professor allows students to be aware of errors in the material generated by AI and increases their critical vision regarding this. However, the overall assessment of the use of AI in learning processes continues to be positive after the teamwork activity. Likewise, the need to train AI is evident. If the query is provided with a model, the probability of the problem, question, or image being wrong decreases.

Acknowledgments

The author acknowledges the financial support of the University of Girona and the support of the Institute of Educational Sciences of the University of Girona.

References

Alsalem, M. S. (2024). EFL teachers' perceptions of the use of an AI grading tool (CoGrader) in English writing assessment at Saudi universities: an Activity Theory Perspective. *Cogent Education*, *11*(1). https://doi.org/10.1080/2331186X.2024.2430865

Baidoo-Anu, D., & Ansah, L. O. (2023). Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. *Journal of AI*, *7*(1), 52-62. https://doi.org/10.61969/jai.1337500

Darwin, Rusdin, D., Mukminatien, N., Suryati, N., Laksmi, E. D., & Marzuki. (2023). Critical thinking in the AI era: An exploration of EFL students' perceptions, benefits, and limitations. *Cogent Education*, *11*(1). https://doi.org/10.1080/2331186X.2023.2290342

Hoferichter, F., Kulakow, S., & Raufelder, D. (2022). How teacher and classmate support relate to students' stress and academic achievement. *Frontiers of Psychology, 13*, 1-13. https://doi.org/10.3389/fpsyg.2022.992497

Jang, H., & Choi, H. (2024) A Double-Edged Sword: Physics Educators' Perspectives on Utilizing ChatGPT and Its Future in Classrooms. *Journal of Science Education and Technology*. https://doi.org/10.1007/s10956-024-10173-1

Kalyan, K. S. (2024). A survey of GPT-3 family large language models including ChatGPT and GPT-4. *Natural Language Processing Journal*, *6*, 100048. https://doi.org/10.1016/j.nlp.2023.100048

Marshik, T., McCracken, C., Kopp, B., & O'Marrah, M. (2024). Student and Instructor Perceptions and Uses of Artificial Intelligence in Higher Education. *Teaching of Psychology, 0*(0). https://doi.org/10.1177/00986283241299745

Nagy, A. S., Tumiwa, J. R., Arie, F. V., & Erdey, L. (2024). An exploratory study of artificial intelligence adoption in higher education. *Cogent Education*, *11*(1). https://doi.org/10.1080/2331186X.2024.2386892

Segaran, K., Mohamad Ali, A. Z., and Hoe, T. W. (2021). Does avatar design in educational games promote a positive emotional experience among learners? *E-learning Digital Media, 18*, 422-440. doi: 10.1177/2042753021994337

Strzelecki, A. (2023). Students' acceptance of ChatGPT in higher education: An extended unified theory of acceptance and use of technology. *Innovative Higher Education*, *49*(2), 223-245. https://doi.org/10.1007/s10755-023-09686-1

Suñol, J. J., Daza, J., Wederni, A. & Escoda, L. (2024). Artificial intelligence learning and assessment: perception of first-year university students. In *EDULEARN24 Proceedings*, 5814-5819.

Tlili, A., Shehata, B., Adarkwah, M. A., Bozkurt, A., Hickey, D. T., Huang, R., & Agyemang, B. (2023). What if the devil is my guardian angel: ChatGPT as a case study of using chatbots in education. *Smart Learning Environments*, *10*(1), 101186. https://doi.org/10.1186/s40561-023-00237-x

FOSTERING COMPUTATIONAL THINKING PRACTICES OF HIGH SCHOOL LEARNERS THROUGH CODING AND ROBOTICS WORKSHOP

Ayodele Abosede Ogegbo
Department of Science, Mathematics and Technology Education,
University of Johannesburg (South Africa)

Abstract

This study reports on high school learners' experiences in a coding and robotics workshop and how participation in the activities enhanced their computational thinking practices. Guided by the constructivist and social cognitive theory, an embedded mixed-method research design was utilized. Data was generated from lesson observations, field notes, and focus group discussions conducted. Participants were twenty-one Grade 10 and 11 female science learners from a rural community in a Northeastern province of South Africa. The qualitative responses were interpreted and analyzed using content analysis, and quantitative responses were analyzed using descriptive statistics. It was observed that learners developed a foundational understanding of robotic components such as input, processor, and output. This understanding helped foster their knowledge of abstraction, which is a key aspect of computational thinking. Additionally, learners acknowledged how working together enhanced their ability to break down the problem they were given collectively. They were also able to create a series of repetitive actions that helped in developing a logical sequence of instructions, which guided them in programming the problem. However, some learners expressed frustration with the engagement levels of their group members, which hindered their learning experience. Learners also expressed concern about the limited resources available in their schools, which can restrict the types of activities and learning experiences they can engage in, especially when teachers lack the necessary knowledge and expertise to embed coding and robotics activities into foundational subjects like physical sciences. The study recommends providing comprehensive training for educators in both robotics and effective teaching strategies. This training should equip educators with the skills to facilitate teamwork, pay attention to details, and promote active engagement among all participants.

Keywords: *Coding, computational thinking, female students, robotics, science education.*

1. Introduction

Computational thinking (CT) is a vital 21st-century educational skill, emphasizing algorithmic thinking and design applicable across subjects (Günbatar & Bakırcı, 2019). CT is a problem-solving method for computer execution and automation (Barr & Stephenson, 2011). It involves breaking down problems, identifying key concepts and patterns for efficient solution planning (Yadav et al., 2016). Developing CT skills, especially in STEM (Günbatar & Bakırcı, 2019), enhances problem-solving, creativity, adaptability, learning, and understanding. Schools globally integrate CT via unplugged and plugged activities (Angeli 2022; Umutlu, 2022), benefiting both students and teachers.

Like other countries, South Africa has recently introduced coding and robotics as an additional subject in the Grade R to 9 curriculum. The introduction of coding and robotics as a subject in the South African curriculum is essential for functioning effectively in a digital and information-driven society; it facilitates the application of digital ICT competencies and the transference of these competencies to address everyday challenges in the development of learners. Coding and robotics as a subject encompasses the various interconnected domains of Information Technology and Engineering, focusing on solving problems through the application of logical reasoning and computational thinking processes (DBE, 2024). Teaching and learning coding and robotics can also enhance learners' conceptual understanding of mathematics or physics. Despite the introduction of coding and robotics as a stand-alone subject in the South African curriculum, many schools across the country still lack the technological infrastructure and teacher expertise to effectively teach the subject (Tshidi & Dewa, 2024). These challenges could result in students not being able to engage with the subject practically, hindering their development of technical competencies like programming and computational thinking, which could significantly impact their ability to thrive in a technology-driven environment (Storte et al., 2019). One way to address this challenge is through the

continuous support provided by various higher education institutions and organizations. They equip learners and teachers across the country with the necessary skills by offering coding and robotics workshops. These workshops are considered effective in raising awareness and technology literacy among teachers and learners. Furthermore, they provide valuable hands-on experience and exposure to coding concepts while fostering the development of crucial computational thinking skills. Against this backdrop, this study is guided by the following research questions:

- How does participation in a coding and robotics workshop enhance the learners' computational thinking skills?
- What are high school learners' overall experiences in a coding and robotics workshop?

2. Theoretical framework

The constructivist learning theory and social cognitive theory are the underlying theoretical basis underpinning this study. The constructivist learning theory highlights that learners build knowledge through their experiences and reflections. This theory is often linked to methods like task-based learning, collaborative activities, and group projects, where learners engage in problem-solving and learn through teamwork and sharing ideas (Petraki & Herath, 2022). In the context of coding and robotics, this approach promotes understanding through active and iterative learning that allows learners to design algorithms, build models (solutions) to tackle challenges and apply their understanding to the science context.

The social cognitive theory introduced by Bandura (1986) examines how individuals develop or acquire new skills and behaviours. According to Bandura, people learn through personal experiences, by observing the actions of others, and through social support that fosters expectations, self-efficacy, and various reinforcements to facilitate behaviour change. In the context of coding and robotics, learners build their own models by observing and adhering to the facilitator's instructions as well as working together with other learners in groups, which allows them to explore and discover computational thinking concepts in a practical way. Learners will have to believe in their ability to plan, design, test and refine their algorithms or models.

3. Methodology

This research explored how secondary school learners enhanced their computational thinking abilities through a coding and robotics workshop. By employing an interpretive approach, the study utilized an embedded mixed-method research design in which qualitative and quantitative data are applied together (Behmanesh et al., 2022). This design effectively integrated a primary qualitative dataset with a secondary quantitative dataset, with both types of data gathered concurrently during the workshop. The study followed a cohort of 21 female secondary school students from a rural community in a Northern South African province. Participants were purposefully selected and willingly participated in the study. The Robotics Activity Attitudes Scale (RAAS) instrument (Cross et al., 2016) was adopted as the questionnaire used in this study and consisted of 41 closed-ended questions.

3.1. Context and participants

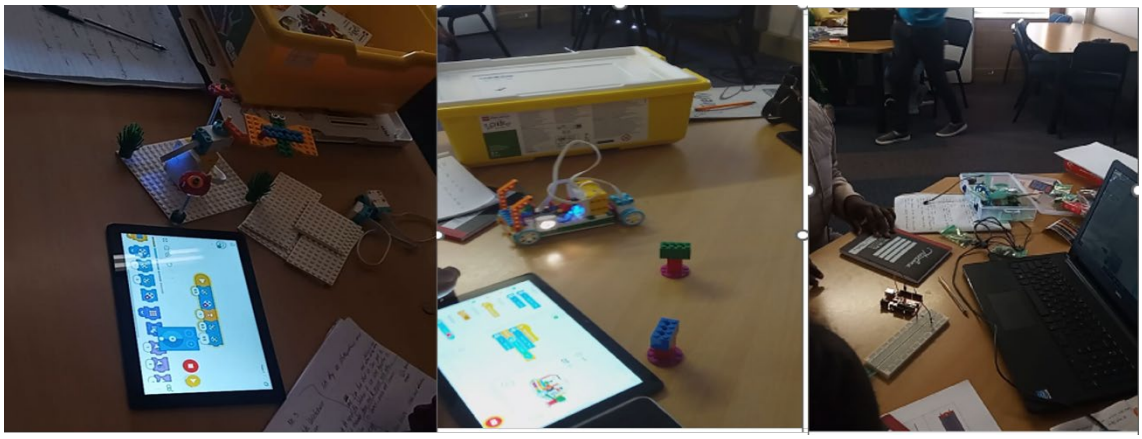
This study included twenty-two grade 10 and 11 female learners from a rural community in the Northernmost province of South Africa. The learners engaged in a one-week coding and robotics workshop hosted in collaboration with the Technolab unit at the University of Johannesburg. The workshop was aimed at building solid fundamentals that will help learners develop basic programming skills and other essential 21st-century skills. The one-week workshop integrated hands-on robotics and electronics projects with the development of computational thinking skills. Learners actively applied these skills by building robots using platforms like WeDo 2.0 and SPIKE Essential. One example was a project where students explored plant-pollinator interactions. They were tasked with creating and programming robot models of bees and flowers to simulate this relationship, culminating in presentations and documentation of their diverse creations. Project 2 required learners to think like engineers by designing, programming, and testing race cars. They explored the impact of various factors on speed and integrated sensors to gather data and further refine their designs for maximum velocity. The project explored during the workshop involved two core activities: (1) building a simple blinking LED circuit using an Arduino board and (2) developing a project utilizing an ultrasonic sensor with the Arduino platform. Towards the end of the workshop, learners engaged in a group activity that did not require any technology. In this unplugged activity, one member of each group was blindfolded. The other group members then provided verbal instructions to guide the blindfolded member through an obstacle course. This activity aimed to reinforce learners' understanding of fundamental programming concepts, such as providing clear and concise instructions and debugging errors

(when the instructions were unclear or inaccurate). The average age of learners who participated in this study was 16 years, with the youngest being 15 years and the oldest being 19 years

3.2. Data collection and analysis

Data was collected based on learners' work, participation in discussions, and self-reported survey responses. Students' problem-solving processes and computational thinking skills were analyzed through video recordings of their work on coding projects. Additionally, an observational schedule was employed to document students' interactions, behaviours, and problem-solving strategies during the workshop. Learners worked collaboratively in teams. All facilitators and learners were informed of the voluntary nature of their participation in the study and their right to withdraw at any time. Informed consent was obtained, ensuring that all participants agreed to participate in the research. For this paper, data was only analysed qualitatively using content analysis. The analysis was conducted with Atlas.ti, a qualitative data analysis software program. A pictorial representation of learners' activities is shown in Figure 1.

Figure 1. Sample of learners' activities during the workshop.



(a) (b) (c)

4. Findings

4.1. Learners' computational thinking outcomes from a coding and robotics workshop

The focus group discussions revealed that the coding and robotics workshop positively impacted learners' computational thinking abilities, particularly in problem-solving. Participants learned to approach problems creatively, explore multiple solutions, and understand that there isn't just one correct method. This fostered flexible thinking and encouraged them to consider various strategies, as exemplified by a participant's quote about "many ways of doing something" and the facilitator's instruction to visualize solutions.

Analysis of participants' responses and observation of activities also revealed that participating in the workshop also exposed learners to opportunities for engaging in decomposition and paying attention to detail. For instance, learners were observed practicing how to break down the given tasks into smaller, manageable parts (decomposition), which is crucial in computational thinking. Participant H mentioned:

> "When building the motor robot, we had to do a lot of calculations during the design specification stage by breaking down possible angles from which the robot might move. Another thing was that it was not easy to identify the components needed to build the robot. So my group had to do a lot of dissecting of ideas to understand how to go about the design".

This ability to carefully examine problems in bits allows learners to tackle challenges systematically. One significant skill that appears to be mentioned by almost all the participants during the reflection of their learning was the ability to pay attention to details. For instance, one of the learners mentioned, " I have learned that I have to pay attention to each and every detail to avoid big mistakes. I have learnt to think out of the box. I have learnt programming where I give instructions to a robot, and that will help in future when I give instruction at my workplace" – participant K. This statement was also emphasized by Participant A when she said that participating in the workshop has helped her learn how to follow instructions and pay attention. The workshop activities emphasized the importance of paying attention to details, especially in coding and robotics. This focus on detail is essential for debugging and ensuring that instructions are followed correctly, which is vital in programming. Based on learners' response to paying attention to details, the facilitator also emphasized the importance of these skills on learners'

academics. This was observed when he said: “When answering questions in class, particularly in subjects like mathematics and physical sciences, it is crucial to pay close attention to the details provided within the question. Word problems often require careful analysis to identify the key elements and relevant information needed to solve the problem effectively. This is a critical skill that needs to be developed to successfully tackle challenging questions”. Another learner reflected on the process of learning how to think systematically and logically, emphasizing planning, precision, and understanding the problem's requirements before attempting a solution.

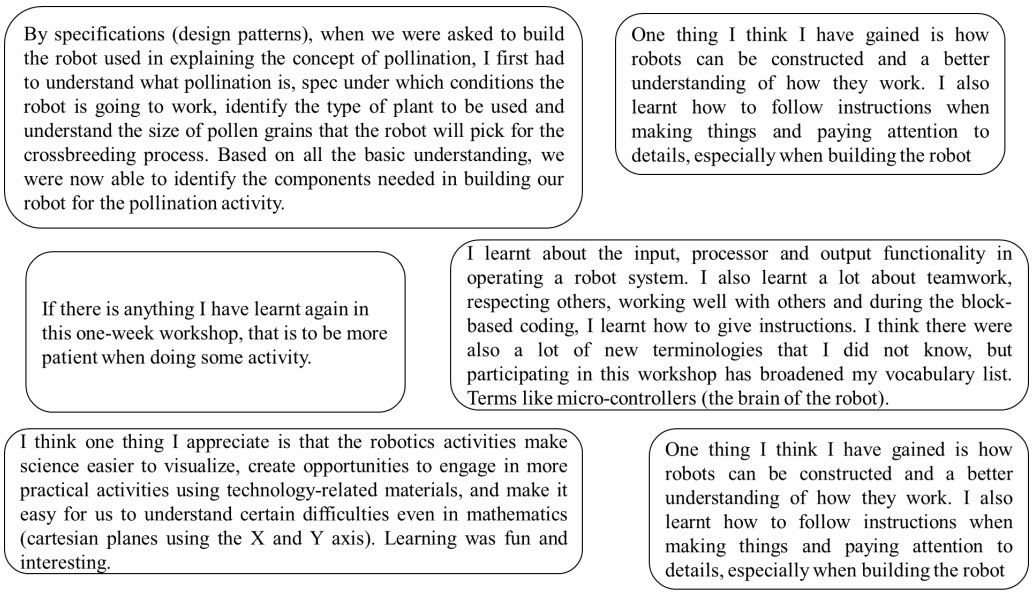
> During the unplugged activity, we were asked to program our partner as a robot. I had to try as much as possible to read the instructions on where I wanted my robot to go and how it would get there. So, I had to clearly select where I wanted the robot to go so that I would not build the wrong robot; if not, the robot would respond wrong. I think this has to do with my ability to understand the specifications of what I want before programming the robot so that the robot will respond correctly (Learner G).

This response demonstrates learner G’s growing awareness of computational thinking principles in relation to algorithm design, where the focus is on identifying the key details needed to focus on solving the problem without unnecessary distractions (abstraction) and devising clear, logical steps to achieve a specific goal. Findings of the study also showed that the workshop fostered collaboration among learners, which is important for developing computational thinking. They learned to communicate their ideas and solutions effectively, as observed during the discussions about their projects and problem-solving approaches. Most of the learners also noted this during their reflection. One participant noted the importance of teamwork, saying, "Teamwork, respecting others and working well with others

4.2. Learners' experiences in the coding and robotics workshop

Learner feedback on the coding and robotics workshop was largely positive, highlighting appreciation for its importance, high engagement with hands-on activities, and understanding of fundamental concepts like input-processing-output and the need for precision in coding and building. Participants connected robotics to real-world applications and saw its relevance to academics and future careers. However, some learners expressed frustration with group member engagement and concerns about limited school resources and teacher expertise in integrating coding and robotics into other subjects.

Figure 2. Learners experiences in the coding and robotics workshop.



5. Discussion, recommendations and conclusion

The results of the study reveal that the coding and robotics workshop provided a dynamic platform for high school learners to enhance their computational thinking skills. This agrees with existing research that demonstrates that hands-on activities effectively engage participants in problem-solving, decomposition of tasks, debugging, and logical reasoning, which are essential components of computational thinking (Yilmaz Ince & Koc, 2021). This current study also aligns with the perspectives of Mathebula et al. (2024) who assert that the structure of coding and robotics activities encourage learners to think creatively and explore multiple solutions to problems, fostering a mindset that values flexibility and innovation. Additionally, the emphasis on attention to detail and effective communication highlighted the

importance of collaboration in the learning process. As learners navigated the complexities of coding and robotics activities, they not only developed technical skills but also critical thinking abilities that are applicable across various academic disciplines. Participation in collaborative coding activities reinforced algorithmic thinking, enabling learners to approach problem-solving in a structured and logical way.

In conclusion, the coding and robotics workshop significantly contributed to the enhancement of learners' computational thinking skills. By engaging in practical, collaborative tasks, students were able to develop essential skills such as problem-solving, decomposition, and logical reasoning. This experience not only provided them with valuable technical skills but also fostered the development of crucial 21st-century skills necessary for success in a complex and technology-driven world. Based on the findings of this study, it is recommended that educators should receive ongoing training in coding and robotics to effectively facilitate workshops and incorporate these skills into their teaching practices. Furthermore, schools need to offer more workshops and extracurricular activities focused on coding and robotics to provide students with additional opportunities to develop their computational thinking skills. More importantly, future workshops should continue to emphasize teamwork and collaboration, as these skills are vital for success in both academic and professional environments.

References

Angeli, C. (2022). The effects of scaffolded programming scripts on pre-service teachers' computational thinking: Developing algorithmic thinking through programming robots. *International Journal of Child-Computer Interaction*, *31*, 100329.

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice-Hall.

Barr, V., & Stephenson, C. (2011). Bringing computational thinking to K-12: What is involved and what is the role of the computer science education community?. *ACM inroads, 2*(1), 48-54.

Behmanesh, F., Bakouei, F., Nikpour, M., & Parvaneh, M. (2022). Comparing the effects of traditional teaching and flipped classroom methods on Midwifery students' practical learning: the embedded mixed method. *Technology, Knowledge and Learning*, 1-10.

Cross, J., Hamner, E., Zito, L., Nourbakhshh, I., & Bernstein, D. (2016). Development of an assessment for measuring middle school student attitudes towards robotics activities. In *2016 IEEE Frontiers in Education Conference (FIE)* (pp. 1-8). IEEE.

Department of Basic Education, Republic of South Africa (2024). Coding and Robotics curriculum. Pretoria, South Africa. Available at https://www.education.gov.za/Curriculum/CurriculumAssessmentPolicyStatements(CAPS)/CAPS Foundation.aspx

Dong, W., Li, Y., Sun, L., & Liu, Y. (2024). Developing pre-service teachers' computational thinking: A systematic literature review. *International Journal of Technology and Design Education*, *34*(1), 191-227.

Günbatar, M. S., & Bakırcı, H. (2019). STEM teaching intention and computational thinking skills of pre-service teachers. *Education and information technologies*, *24*, 1615-1629.

Mathebula, S., Ramaila, S., & Mavuru, L. (2024). Utilizing Robotics to Foster Twenty-First Century Skills and Competencies in Grade 5 Natural Sciences Classrooms. *International Journal of Technology, Knowledge and Society*, *20*(2), 85.

Petraki, E., & Herath, D. (2022). Teaching and learning robotics: a pedagogical perspective. In *Foundations of Robotics: A Multidisciplinary Approach with Python and ROS* (pp. 43-62). Singapore: Springer Nature Singapore.

Storte, D., Webb, M., Bottino, R., Passey, D., Kalas, I., Bescherer, C., Smith, J.M., Angeli, C., Katz, Y., Rosvik, S., Brinda, T., Fluck, A., Magenheim, J., Anderson, B., & Fuschek, G. (2019). Coding, programming and the changing curriculum for computing in schools. A *Report of UNESCO/IFIP TC3 Meeting at OCCE, Linz, Austria*.

Tshidi, M., & Dewa, A. (2024). The promise and peril of Coding & Robotics education in South Africa: A scoping review of teacher preparation and generative artificial intelligence's potential for delivering equity. *Journal of Education (University of KwaZulu-Natal)*, (96), 140-164.

Umutlu, D. (2022). An exploratory study of pre-service teachers' computational thinking and programming skills. *Journal of Research on Technology in Education*, *54*(5), 754-768.

Yadav, A., Hong, H., & Stephenson, C. (2016). Computational thinking for all: Pedagogical approaches to embedding 21st-century problem-solving in K-12 classrooms. *TechTrends, 60*, 565-568.

Yilmaz Ince, E., & Koc, M. (2021). The consequences of robotics programming education on computational thinking skills: An intervention of the Young Engineer's Workshop (YEW). *Computer Applications in Engineering Education*, *29*(1), 191-208.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

SPECIAL EDUCATION TEACHERS AS AGENTS OF CHANGE: A NARRATIVE STUDY OF TEACHER AGENCY IN EMERGENCY SHELTER SCHOOLS

Michal Levy[1], Hagit Inbar-Furst[1], & Ruth Gottfried[2]
[1]Department of Special Education, David-Yellin Academic College (Israel)
[2]Department of Dance Movement Therapy, David-Yellin Academic College (Israel)

Abstract

This study explores the experiences of Special Education Teachers (SETs) as agents of change in Emergency Shelter On-Site Schools (ESOSs) through narrative inquiry. Twelve SETs from seven Israeli ESOSs shared 22 stories about their most meaningful experiences in this context. The analysis revealed three main findings: (a) positive changes in students and SETs were identified, emphasizing both academic progress and emotional wellbeing in students as well as positive changes in SETs perceptions and points of view regarding students; (b) two pathways to student success were observed—a slow, gradual process and pivotal turning points, and (c) three distinct profiles of teacher agency were revealed—Mastery-focused, Empowerment-focused, and Attachment-focused. These findings align with a trauma-informed educational approach and enhance the understanding of teacher agency in challenging contexts. Implications for pre- and in-service teacher training programs include cultivating effective teacher agency across all three profiles, recognizing different trajectories of student success, and developing a growth mindset in teachers.

Keywords: *Emergency shelters, narrative inquiry, special education teachers, teacher agency, trauma-informed education.*

1. Introduction

Teacher agency, defined as the "capacity to make choices, take principled action, and enact change" (Anderson, 2010, p. 541), is essential for impacting student learning (Molla & Nolan, 2020). In the context of trauma-informed education, teachers play a vital role in supporting children who have experienced one or more Adverse Childhood Experiences (ACE; Felitti et al., 2019). Trauma-informed teaching practices can significantly benefit students impacted by trauma, fostering strong teacher-student relationships and enhancing self-regulation skills (Brunzell et al., 2021). Nonetheless, the role of teachers as agents of change in Emergency Shelter On-site Schools (ESOSs) remains understudied.

ESOSs provide temporary educational support for children at-risk in crisis situations (Gottfried & Ben-Arieh, 2019). These unique environments present distinct challenges, including students' uncertain length of stay, varied academic levels, and complex emotional-behavioral needs (Hindt et al., 2019). Given these challenges, investigating teacher agency within ESOSs is crucial for understanding how Special Education Teachers (SETs) can effectively support positive changes in students in these specialized settings.

This study aims to explore SETs agency in ESOSs through the lens of narrative inquiry. By examining SETs' meaningful experiences, the study seeks to understand how they conceptualize and enact their roles as agents of change, foster positive changes in students, and manifest different profiles of teacher agency in trauma-informed educational settings.

2. Method

This study employed a narrative inquiry approach to analyze SETs experiences in ESOSs in Israel. The method was chosen as it provides deep insights into experiences through storytelling and meaning construction (Connelly & Clandinin, 2006). The analysis framework employed Lieblich et al.'s (1998) three-tiered method and included a holistic-content analysis, a categorical-form, and a categorical content analysis.

The research was conducted in Israeli ESOSs that provide short-term educational and therapeutic support for children in crisis, aged 5-15 years with an average stay of 5.9 months. Data collection was carried out through in-depth semi-structured interviews with 12 SETs. The study received ethical approval from both the Israel Ministry of Education and the researchers' Institutional Review Board.

3. Results

3.1. Positive changes in students and SETs

The Holistic Content Analysis revealed three interconnected dimensions of positive change in SETs meaningful stories. First, students demonstrated improved academic achievements, as evidenced by the quote "Suddenly, he started reading, and I said to him: 'Wow, you're reading fluently!' He continued reading with precision and I think we paved the way to his success," highlighting the development of new skills and abilities through persistent effort. Second, students showed enhanced emotional wellbeing, illustrated by their ability to overcome trauma and develop self-advocacy skills, as demonstrated by the quote: "She now receives occupational therapy, speech therapy, and remedial teaching – interventions that have contributed to her growth and emotional wellbeing."

Finally, SETs experienced transformative changes in their own perceptions and perspectives regarding students, as reflected by the quote "Over time, I understood that the student's actions are not a personal attack on me but a manifestation of their own hardships," indicating how teachers overcame initial biases to gain deeper understanding of their students' needs and finding profound meaning in witnessing their students' growth.

3.2. Pathways to student success

The Categorical-Form Analysis revealed two distinct pathways through which SETs facilitate student success in challenging educational environments. The first pathway characterizes success as an outcome of sustained effort and consistent support over time, exemplified by the quote "I want to emphasize that this transformation didn't occur within a month or two, but after a full year of persistence and effort," where teachers create nurturing environments through patient guidance and celebration of incremental progress.

The second pathway identifies success through transformative moments or pivotal breakthroughs in students' development, as illustrated by the quote "She whispered a single word to the care workers, which surprised and startled them. It was a significant breakthrough," highlighting how even a small interaction can mark a turning point for students who had previously refrained from communicating with staff.

3.3. Profiles of teacher agency

The Categorical Content Analysis revealed three distinct profiles of teacher agency in SETs meaningful stories. *The Mastery-focused profile* emphasizes differentiated instruction and adaptive teaching strategies, as illustrated by the quote "I adjusted my teaching to his unique needs, and gradually, the breakthroughs came," demonstrating teachers' commitment to personalizing learning experiences. *The Attachment-focused profile* prioritizes building secure emotional connections with students, exemplified by the quote: "I reassured her of my affection and care. It... encapsulated the depth of the emotional journey I had shared with this remarkable and resilient child," highlighting the importance of trust-building and emotional support. *The Empowerment-focused profile* concentrates on developing students' self-efficacy and confidence, as evidenced by the quote "I simply felt like I had gifted her with life... She has received this gift, this gift of seeing that she is capable, that she can do it, that she has conquered something", showing how teachers actively cultivated students' belief in their own abilities.

4. Discussion

This study revealed three key contributions to understanding SETs as agents of change in ESOSs. First, SETs primarily viewed their role through fostering student success in both academic achievements and emotional wellbeing, aligned with a trauma-informed educational approach (Brunzell et al., 2021) and showed a notable shift from initial biases to deeper understanding of student needs. Second, the study identified two distinct temporal pathways to building student success (slow/gradual process and pivotal turning points).

Third, three distinct profiles of teacher agency were identified: Mastery-focused (emphasizing differentiated instruction), Attachment-focused (prioritizing strong relationships), and Empowerment-focused (fostering student self-efficacy). These align with Tao et al.'s (2022) types of teacher support and implemented various guidelines for strengthening student self-efficacy (Bandura,

1997). While the study emphasized attachment and empowerment strategies in trauma-informed education (Brunzell et al., 2021), it found limited mention of self-regulatory skill development. Future research could explore SETs' role as attachment figures (García-Rodríguez et al., 2023), how teachers can facilitate vicarious experiences to build self-efficacy (Bandura, 1997), and how they develop self-regulatory skills in trauma-informed settings (Brunzell et al., 2021).

5. Practical implications

This study recommends that teacher training programs, both pre-service and in-service, focus on three key areas: (a) cultivating a growth mindset to view challenges as learning opportunities and commit to continuous student improvement (Themane & Thobejane, 2019), (b) recognizing and capitalizing on both gradual progress and pivotal turning points in student success through realistic goal-setting, progress monitoring, field-based experiences, and strategies for leveraging breakthroughs (Brunzell, 2021), and (c) developing effective teacher agency across Mastery, Empowerment, and Attachment-focused profiles by (c1) equipping educators with differentiated instruction and adaptive teaching (Tao et al., 2022), (c2) fostering student self-efficacy and autonomy (Bandura, 1997; Tao et al., 2022), and (c3) prioritizing strong teacher-student relationships through trauma-informed practices and social-emotional learning (Brunzell et al., 2021; Gyeltshen & Gyeltshen, 2022).

References

Anderson, L. (2010). Embedded, emboldened, and (net)working for change: Support-seeking and teach agency in urban, high-needs schools. *Harvard Education Review*, *80*(4), 541-572. https://doi.org/10.17763/haer.80.4.f2v8251444581105

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Freeman.

Brunzell, T., Waters, L., & Stokes, H. (2021). Trauma-informed teacher wellbeing: Teacher reflections within trauma-informed positive education. *Australian Journal of Teacher Education, 46*(5), 91-107. https://doi.org/10.14221/ajte.2021v46n5.6

Connelly, M. F., & Clandinin, J. D. (2006). Narrative inquiry. In J. Green, G. Camilli, & P. Elmore (Eds), *Handbook of complementary methods in education research* (3rd ed., pp. 447-487). Lawrence Erlbaum.

Felitti, V. J., Anda, R. F., Nordenberg, D., Williamson, D. F., Spitz, A. M., Edwards, V., Koss, M. P., & Marks, J. S. (2019). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: The Adverse Childhood Experiences (ACE) study. *American Journal of Preventive Medicine, 56*(6), 774-786. https://doi.org/10.1016/j.amepre.2019.04.001

García-Rodríguez, L., Redín, C. I., & Abaitua, C. R. (2023). Teacher-student attachment relationship, variables associated, and measurement: A systematic review. *Educational Research Review*, *38*. https://doi.org/10.1016/j.edurev.2022.100488

Gyeltshen, S., & Gyeltshen, N. (2022). The impact of supportive teacher-student relationships on academic performance. *Asian Journal of Advanced Research and Reports*, *16*(12), 15-34. https://doi.org/10.9734/ajarr/2022/v16i12446

Gottfried, R., & Ben-Arieh, A. (2019). The Israeli child protection system. In R. D. Krugman, J. Fluke, & L. Merkel-Holguin (Eds.), *National Systems of Child Protection. Child Maltreatment* (Vol. 8, pp. 139-171). Springer International Publishing. https://doi.org/10.1007/978-3-319-93348-1_8

Hindt, L. A., Bai, G. J., Huguenel, B. M., Fuller, A. K., & Leon, S. C. (2019). Impact of emergency shelter utilization and kinship involvement on children's behavioral outcomes. *Child Maltreatment*, *24*(1), 76-85. https://doi.org/10.1177/1077559518797198

Lieblich, A., Tuval-Mashiach, R., & Zilber, T. (1998). *Narrative research: Reading, analysis, and interpretation*. Applied Social Research Methods (vol. 47). Sage Publications, Inc. http://dx.doi.org/10.4135/9781412985253

Molla, T., & Nolan, A. (2020). Teacher agency and professional practice. *Teachers and Teaching*, *26*(1), 67-87. https://doi.org/10.1080/13540602.2020.1740196

Tao, Y., Meng, Y., Gao, Z., & Yang, X. (2022). Perceived teacher support, student engagement, and academic achievement: A meta-analysis. *Educational Psychology*, *42*, 401-420. https://doi.org/10.1080/01443410.2022.2033168

Themane, M., & Thobejane, H. R. (2019). Teachers as change agents in making teaching inclusive in some selected rural schools of Limpopo Province, South Africa: Implications for teacher education. *International Journal of Inclusive Education*, *23*(4), 369-383. https://doi.org/10.1080/13603116.2018.1434690

CRITICAL REFLECTIONS ON TRIALLING AN AI APPLICATION IN TEACHER EDUCATION ASSESSMENT IN THE TECHNOLOGICAL AGE

Tríona Stokes
Dr., Maynooth University Froebel Department of Primary and Early Childhood Education (Ireland)

Abstract

Since as early as the 1990s, the implications of AI on the traditional role of the teacher were foreseen (Garito, 1991). It has since been argued that effective facilitation of pupil learning in the technological age necessitates the exploration of innovative approaches in equipping pre-service teachers to this end (Tungera and Chigona, 2023). Thus, the researcher embarked on a pilot project to investigate student teachers' directed use of generative AI as part of a module assessment. The module in question focuses on academic reading writing and referencing, and thus behoves critical engagement with, and reflection on, AI tools as part of professional practice. Reflections are offered on the incorporation of an Artificial Intelligence (AI) software application in an Irish undergraduate Teacher Education programme from 2023-2025. As part of this research project, 85 Bachelor of Education students evaluated an AI application as a research tool for an academic essay submitted for assessment purposes in their first year of the programme. Students were subsequently invited to offer feedback on their experience of using AI for their review of literature. The same cohort were then invited as part of a mixed methods study to complete a follow-up survey, one academic year later, with the purpose of enabling reporting on the extent to which the initial experience of such AI application for assessment has informed further use thereof in the interim. A focus group was then convened using snowball sampling. To this end, further to an account of the AI implementation process and the associated research component, analysis of personal and professional learning are shared including student teachers' identification of the value of GenAI as an assistant, while demonstrating a sense of wariness of it, and concerns relating to reliability and environmental impacts. The findings are refracted against the OECD contention that the application of GenAI can be drawn upon 'to enhance and transform teaching and learning in the classroom', with teachers 'supported but not supplanted by AI' (Pons, 2023:7).

Keywords: *Artificial intelligence/AI, academic writing, teacher education.*

1. Introduction

Academic writing in higher education can no longer be separated from generative Artificial Intelligence (GenAI), as computing online serves prompts as part of its basic functionality. As universities grapple with the freight train-like speed of GenAI development in recent years, the field of Initial Teacher Education within higher education is no different. The implications for the particular skills and competencies required for academic writing in teacher education are the focus of this Irish study, in what has been described as the 'AI Era' (Davenport and Ronanki, 2018). The nature of the 5-credit university module discussed, focuses on communication, including academic writing and referencing conventions, as well as component aspects of digital literacy through the establishment of an e-portfolio.

The overarching aim of the research presented in this paper was to gain greater insight into Y2 student teachers' experiences of using generative AI assessment as a follow-up to a first year modular assessment completed in 2024 by the BEd cohort in Maynooth University Froebel Department of Primary and Early Childhood Education. In particular, the extent to which AI applications had been used by students in support of their academic studies from Year 1 to Year 2 of the BEd programme was sought. Further to an examination of the current backdrop against which the research took place in 2025, the Irish policy landscape is referenced as a segue into examining the study design and methodology.

2. Context of the study

By their nature, teacher education programmes encompass aspects of values education, didactics and moral reasoning, from across module components such as philosophy of education, theological studies, or foundations of religious education. In the teacher education context pertaining to this study, the second year of the Bachelor of Education programme at Maynooth University Froebel Department is also informed by the ethical values set out by the Irish Teaching Council's (2016) Code of Professional Conduct. The code, by which registered qualified teachers are bound, establishes the ethical foundation for the teaching profession in Ireland. Teachers' professional responsibilities are identified by six standards: values and relationships; integrity; conduct; practice; professional development; collegiality and collaboration. Artificial Intelligence will potentially hold implications for each of these six standards as the 'AI age' progresses in teachers' daily individual and collaborative planning, assessment and reporting practices, individually, and as part of a whole-school team. This clearly holds implications for in-service as well as pre-service teachers.

Teaching has been identified as one of the professions expected to be most impacted by GenAI (Pons, 2023). On entering the teaching profession, newly qualified teachers will need to be equipped with the digital knowledge, skill and values to negotiate AI use within their professional practice. Student-teachers need to become conversant in various AI applications to inform their future professional practice in engaging with different planning, assessment and reporting tools as part of their professional planning workload. One benefit of AI for classroom planning is likely to be its potential for timesaving measures for teachers, to short-circuit collating curricular links with teaching resources, for example. To this end, and on a very basic level, teachers may have fortnightly, weekly or even daily engagement with generative AI as standard. The OECD (Pons, 2023) discusses several potential benefits for GenAI and teaching including giving more regular and granular feedback, to tailoring personalised learning opportunities created based on assessment data collated on individual learners.

The hallmarks of the nature this or any AI engagement would require both knowledge and criticality in order to make sound professional educational judgments. This resonates with current educational research on the need for critical digital pedagogy in higher education (Williamson, 2022). Moreover, it speaks to the need for the teacher's role in effective facilitation of pupil learning in the exploration of innovative approaches in equipping pre-service teachers to this end (Tungera and Chigona, 2023). The children in the classroom, rather than 'end users' of technology, these 'digital natives' (Prensky, 2001) will need the guidance and support to engage consciously and judiciously with AI in turn. The OECD (Pons, 2023:5) advise of the skills that will be needed by teachers to prepare students for an unknown future, while acknowledging the impact of AI on the role of teachers and the very act of teaching and learning itself.

The Primary Curriculum Framework (2023) recognises the centrality of digital learning by virtue of naming one of its 7 competencies as 'being a digital learner' to be able to use a range of digital technology for creative outputs. This competency holds as its aim children's 'responsible, respectful, safe and ethical use of technology' (NCCA, 2023: 9). The teacher's role in facilitating digital learning must 'enable children to critically engage and contribute in a digitally connected and interdependent world' (2023: 9). In leading the learning in initial teacher education through these lenses, we can go some way to prepare the teachers of tomorrow to support children's digital learning journey.

3. Design and method

This paper features a small-scale mixed methods study which obtained institutional ethical approval at Maynooth University, Ireland. The overall purpose of the research is to inform the development and adaptation of the Year 1 BEd module discussed, to best serve its pedagogical outcomes. Following their required use of AI application, Elicit.com as a research tool in the formulation of a literature review for a Year 1 academic assignment, students were also required to evaluate the effectiveness of that tool for that purpose as part of that assignment brief.

The research design comprised an anonymous survey disseminated to all 85 students in the year group, followed by a focus group which could accommodate 5-8 students. Students had been invited to give individual feedback on their experience of using AI in assessment as part of their module evaluation in 2024. Over a year later, as BEd2 students in their second semester, students were then invited to partake in a survey to gain insight into the extent to which their use of the AI software in Year 1 had informed their use of generative AI in the intervening period from February 2024 to April 2025.

Microsoft Forms was used as the survey medium, an interface which student teachers would be familiar with owing to its widespread departmental use in module reviews. The survey was designed to take fewer than 10 minutes to complete, consisting of 3 multiple choice and 2 long answer questions presented

as requiring a response to proceed. Survey questions were designed to ascertain the extent to which AI had been used to support their studies, and to ascertain the types of applications used and the purpose for which they were accessed. The associated university policy categorizations for AI use were drawn upon to inform the phrasing of the questions regarding the purpose of student AI use. In so doing, it was envisaged that the commonality of language use from other university documents and nomenclature would support students in recognising the categories of AI use more readily. The categorisations of AI use are outlined in Table 1 below, which extend from using AI as a research assistant to source material for academic assignments, to full AI use throughout the process including Gen AI output.

Table 1. Categories of AI use in academic writing used in the survey.

Category of Gen AI use and example:
As a research assistant e.g., sourcing reading materials, but no Gen AI output, including paraphrased, in the final submission
Brainstorming e.g., topic aspects (no Gen AI output)
Creating structures e.g., outlines, but no Gen AI output including paraphrased, in the final submission
As an editing tool (to improve the clarity or quality of assessment but not used to create new content)
Full Gen AI use throughout the process including Gen AI output

At the briefing on the survey, further to the information sheet dissemination, students were facilitated in seeking clarifications regarding the purpose or use of the research. At the briefing the purpose of the methods was outlined as a survey followed by a focus group. Students who had 'something to say' about AI in any regard, were encouraged to come forward for the focus group by indicating their desire to do so by email to the researcher. A focus group was designed to explore specific aspects of student AI use which might better suits a focus group than a survey. The focus group questions tended to be more discursive questions in nature, for example, *How can generative AI develop skills for your future profession of teaching?* Due to the low numbers of participants present, the focus group readily followed the order of the questions set while students declared where they considered that they had already spoken to a question when it was posed. Both students spoke to each question to a greater or lesser extent, sometimes addressing question aspects ahead of their introduction.

4. Findings and discussion

There were 21 respondents from a cohort of 85, representing a response rate of 24.7%. The overall responses(n=21) are interpreted, beginning with an overview of the regularity with which this small cohort are using GenAI, followed by a reporting of its ability to help or assist and examples thereof, and a summary of issues raised in relation to wariness regarding GenAI use based on its reliability and environmental impact.

Survey responses to the question of how regularly students had used AI to support their studies in the past academic year yielded a mixed result. While only 3 students (14%) reported using AI 'regularly' since, 7 students (33%) reported using it 'rarely' while 1 had used it 'once' and 2 students had 'not used it at all'. 8 Students (37%) reported using generative AI 'several times' in the intervening period. The most popular application used was ChatGPT used by just over half of this small cohort (16 of 21 students or 52%), with www.Elicit.com next in popularity with 7 students (23%), followed closely by Grammarly (6 students or 19%). The fact that one third of the group reported using Elicit again since its required use, may indicate that their familiarity with its interface may have drawn them to use it again. However, only two respondents used Elicit alone, with others using one or two other applications in addition to Elicit. The reported use was lower than expected and raises the question of whether an element of underreporting may have factored in student responses.

Student reported varying use of generative AI in the intervening time period of 14 months. Almost a quarter of respondents (5 of 21) described it as 'helpful' or 'useful' and enabling students to 'work smarter not harder'. Two students reported a more open disposition to generative AI use since its required use as part of Year One Assessment, 'being less wary' of AI use since their use of Elicit as part of Year One assessment:

> '*I had never used AI before coursework last year. However, after using eleicit.com I saw how AI can be helpful in generating ideas rather than searching endlessly on Google and is easy to use and not scary and I am now more open to using it'.*

These responses indicate a benefit of having familiarity with an AI software and having experience of negotiating its interface. This affirms its use as part of a university module assessment, it can be argued. Further benefits mentioned in the focus group include how 'it will read out articles from Chat GPT– it spits

them out'. Its use to save time to find generic resources such as a sample of 'a boring story' for demonstration purposes in teaching was given as an example.

3 of 21 reported not having used AI at all, with two students declaring they did not like it, and one acknowledging a 'bias' towards it. Two more students said that it had not greatly influenced their use of AI without attributing a reason. Both focus group participants commented on GenAI as not being something to fear. One commented that 'there shouldn't be an overreliance [of students] on it', with the other cautioning against its 'lazy use' as an alternative to Google, where Google would suffice. This points to the focus group participants' observations of the ubiquitous use of GenAI, one that is commented on anecdotally by faculty members. Again, it invites the question of whether underreporting of GenAI use is likely.

An equal number of survey respondents, 4 of 21, cited 'brainstorming' as their reason for its use as students who referenced its use in sourcing reading material or 'researching' for academic work. One student referred to its application in 'generating ideas' for assessment, with another clarifying that it 'helped to brainstorm ideas for a topic but not used to academically write about the topic'. Another clarified, their use of it as a brainstorming tool 'rather than to generate a response as I feel it would not be authentic to do so'. This indicates a sense of savviness of approach amongst the student cohort. A sense of moral awareness of generative AI is also communicated in this response. Furthermore, one student cited the environmental impact in trying to 'avoid its use due to the high water usage', which was reiterated by a focus group member who noted, 'it does have an environmental impact'. A focus group respondent shared a moral concern of a different nature in stating that 'AI is taking jobs away from artists', due to its instant imaging functionality. Two students referred to the efficiency of AI in sourcing material, helping them 'work smarter not harder'. However, the same respondent cautioned in relation to the trustworthiness of GenAI:

> '*It has made me more familiar with the dangers of using AI because it can be inaccurate at times when providing information'.*

Another survey respondent noted the importance of 'checking their reliability before using them'. Overall, the responses gathered indicate a limited or what might be considered a conservative use of generative AI in academic writing practices, if an accurate portrayal of use. One respondent identified the use of AI as anxiety-inducing vis a vis academic demands regarding plagiarism:

> *'The popularity of Generative AI has caused me some anxiety in relation to my studies – the fear of being accused of plagiarism or misuse of AI has led me to avoid many research websites, online databases, etc. as I was unsure if they were AI or not'.*

This quote points to a sense of confusion for students regarding plagiarism and the potential for the misuse of AI, wittingly or unwittingly. A lack of clarity for students as to what might constitute a text generated by AI, as distinct from an original one of their own creations, is telling. In the focus group, both participants agreed that more input and guidance were needed at a university level, with suggestions that the library holds a role in this work. One student noted that 'each department should have its own stance on it', seeking a university policy interpretation at departmental level, which has been encouraged by university management. This raises the question of where the responsibility for education and training about ethical AI use lays, and how this ethical use of AI is even defined. Furthermore, it raises the question about addressing the varying levels of comfort and competency with digital literacy individual students have.

5. Conclusion and recommendations

The data presented demonstrates the reporting of a cautious approach to the use of generative AI by this small student teacher cohort, overall. While student use of particular AI software applications is clear, this is tempered by student concerns about how they use it. Brainstorming being cited as the main purpose for AI use, has been distinguished from the potential for use of AI in writing assignments. Concerns regarding the reliability of the data presented are also raised, with an acknowledgement of the need to 'check' the information presented. Critically, the need for education and guidance around ethical and judicious use of AI is sought. This puts the spotlight firmly on the nature and extent of digital literacy learning as part of initial teacher education.

The constitution of professional degrees and taught programmes in teacher education are defined by professional knowledge and practice or practicum, in addition to professional skills and competences, of which digital literacy skills are part. This raises the question of how digital, or more precisely, AI literacy might be defined. One such definition is that of Wang et al. (2022) which measures a person's AI literacy using a tool developed based on four components of awareness, use, evaluation and ethics. Wang et al. (2022:3) define AI literacy as:

> '*The ability to be aware of and comprehend AI technology in practical applications; to be able to apply and exploit AI technology tasks proficiently; and to be able to analyse, select and critically evaluate the data and information provided by AL, while fostering awareness of one own personal responsibilities and respect for reciprocal rights and obligations.'*

It is proposed that this definition be used as a starting point by this author to examine the potential for further opportunities to incorporate individual and collaborative exercises using and critiquing GenAI as part of the associated undergraduate module of the study, which holds professional communication as its focus. From this small study, it is clear that student teachers not only need opportunities to use GenAI with guidance, but also need to reflect and consider their experiences of same through facilitated dialogue. This may assist students to trust their instincts as they increase their experience and familiarity with different types of applications and help them to be more decisive in their continued critical use of GenAI as part of teaching and learning experiences. In so doing, we can better prepare them for the classrooms of tomorrow, which, by their time of graduation, are likely to reflect greatly developed practice in GenAI from where it is currently positioned.

The development of the student teacher's academic writing skill and proficiency in communication holds career as well as degree-wide ramifications, as discussed.

The potential for generative AI to save teachers time and repetition in generic tasks, to free up their time for more creative one merits closer examination. Guidelines and training for teachers to inform their use and choices in GenAI use is critical to the profession. Investment in training and education opportunities for teachers to learn about the potential for innovation through AI is clearly needed, from the pre-service to in-service stages in the continuum of practice.

References

Davenport, T. H., & Ronanki, R. (2018), Artificial Intelligence for the Real World. *Harvard Business Review, 96*(1) 108-116. Retrieved May 10, 2025 from https://www.bizjournals.com/boston/news/2018/01/09/hbr-artificial-intelligence-for-the-real-world.html

Elicit: The AI research Assistant. Retrieved March 1, 2025 from: https://elicit.com

Garito, M. A. (1991). Artificial intelligence in education: Evolution of the teaching learning relationship. *British Journal of Educational Technology, 22*(1), 41-47. Retrieved March 1, 2025, from https://doi.org/10.1111/j.1467-

National Council for Curriculum and Assessment (2023). *Primary Curriculum Framework for Primary and Special Schools*. Retrieved May 10, 2025, from 2023-Primary-Framework-ENG-screen.pdf

Pons, A. (2023). Generative AI in the Classroom: From hype to reality?, *Directorate for Education and Skills Education Policy Committee. EDU/EDPC* (2023), 11. Retrieved March 16, 2025, from http://one.oecd.org./document/EDU/EDPC(2023)11/en/pdf

Prensky, M. (2001). Digital Natives, Digital Immigrants, Part 1. *On the Horizon, 9*(5), 1-6. Retrieved May 15, 2025, from https://doi.org/10.1108/10748120110424816

Tunjera, N., & Chigona, A. (2023). Investigating Effective Ways to Use Artificial Intelligence in Teacher Education, *Proceedings on the 22nd European Conference on e-learning, 22*(1). Retrieved March, 16, 2025, from https://doi.org/10.34190/ecel.22.1.1625

Wang, B., Pei-Luen, P. R., & Yuan, T. (2022): Measuring user competence in using artificial intelligence: validity and reliability of artificial intelligence literacy scale. *Behaviour & Information Technology*, DOI: 10.1080/0144929X.2022.2072768

Williamson, B. (2022). The Automated University: Digital governance and algorithmic regulation in higher education. In B. Williamson, & R. Hogan (Eds.), *The Politics of Digital Education* (pp. 55-72). London: Routledge.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

LEVERAGING AI TOOLS IN FIRST-YEAR PROGRAMMING EDUCATION: A CASE STUDY ON STUDENT PERCEPTIONS AND LEARNING EXPERIENCES AT A PRIVATE HIGHER EDUCATION INSTITUTION

Denzyl Soobramoney Govender
IIE - Varsity College - Durban North (South Africa)

Abstract

This study explores the integration of AI-powered tools in programming education, using the Technology Acceptance Model (TAM) to analyse students' perceptions and experiences. Through thematic analysis of focus group discussions with eight participants, the research identifies key themes, including initial perceptions of AI, its role in enhancing understanding and structuring code, ease of use, and its impact on problem-solving skills. While AI tools were found to enhance learning efficiency and boost confidence, concerns regarding over-reliance and ethical implications were raised. The study underscores the importance of structured AI integration, fostering critical thinking, and implementing ethical guidelines to promote responsible use. The findings provide valuable insights for educators on balancing AI's potential with traditional teaching methods to enhance student learning. Recommendations for future research include exploring the long-term effects of AI on programming education and increasing awareness of its ethical considerations.

Keywords: *Artificial Intelligence (AI) in education, AI tools for learning, first-year programming students, programming education, AI-Assisted Learning.*

1. Introduction

The AI integration in South African higher education offers opportunities for personalised learning and data-driven decision-making but faces challenges like technological limitations, socio-economic disparities, and ethical concerns such as data privacy and algorithmic bias (Patel & Ragolane, 2024). Successful implementation requires collaboration between policymakers, educators, and technology providers. AI is reshaping education through adaptive learning systems and distance education, though infrastructure and expertise gaps remain (Funda & Piderit, 2024; Funda & Mbangeleli, 2024). In teacher and postgraduate education, AI enhances personalised learning, but ethical guidelines are crucial (Tarisayi, 2024; Goosen & Mugumo, 2024; Mbangeleli & Funda, 2024). In programming education, AI fosters problem-solving and interdisciplinary learning but requires oversight to prevent misuse (Brett et al., 2022; Saari et al., 2022). AI tools improve learning efficiency and engagement, especially for struggling students (Harry, 2023; Reunanen & Nieminen, 2024), with first-year students showing the most engagement (Lytvynova et al., 2024). This study explores first-year programming students' perceptions of AI tools, focusing on their impact on learning and ethical considerations (Rodriguez, 2012).

2. Literature review

The integration of AI in education, through technologies like chatbots and humanoid robots, enhances administrative efficiency and instructional quality (Chen et al., 2020). AI enables personalised learning, intelligent tutoring, and automated assessments, improving outcomes (Harry, 2023), but concerns around privacy, algorithmic bias, and ethics must be addressed.

AI supports learning through interactive tools and simulated environments, offering personalised feedback and responding to student needs (Fahimirad & Kotamjani, 2018). Adaptive learning systems and administrative tools provide data-driven, personalised experiences (Dhakal & Devkota, 2024). In engineering education, AI chatbots and image tools enhance concept understanding (Vidalis & Subramanian, 2023).

AI's role in hybrid teaching models improves engagement and instructional methods (Kshirsagar et al., 2022). Tools like intelligent tutoring systems streamline administration and enhance personalised education (Baichuan, 2024). While ChatGPT supports interactive learning, verifying AI-generated content

is crucial for academic integrity (Opara et al., 2023). AI tools such as MyEnglishLab and SuccessMaker prepare students for the evolving job market (Delgado et al., 2020).

In programming education, AI supports problem-solving and debugging but raises concerns about over-reliance and conceptual gaps (Liu & Li, 2024; Zviel-Girshin, 2024). AI-generated practice problems reduce anxiety and enhance comprehension (Reunanen & Nieminen, 2024). Tools like GitHub Copilot improve efficiency, but plagiarism concerns persist (Johanyák et al., 2023; Cotton et al., 2024).

AI integration in undergraduate curricula fosters programming and critical thinking (French et al., 2023), but ethical issues like plagiarism require clear policies (Madhu et al., 2023; Eke, 2023). Regulatory frameworks and ethical guidelines are essential for balancing AI's benefits with responsible use (Ihekweazu et al., 2024; Mubofu & Kitali, 2024). AI's impact on cognitive skills requires oversight to prevent over-reliance (Zhai et al., 2024).

Educators recognise AI's potential but emphasise academic integrity and independent problem-solving (Chavez et al., 2024). Ethical challenges like bias and job displacement highlight the need for critical engagement (Khatri & Karki, 2023). The Technology Acceptance Model (TAM) provides a useful framework for assessing AI adoption, with ease of use being key to engagement (Or, 2024). Ensuring AI tools are user-friendly and ethically deployed is crucial for the future of AI-driven education.

3. Methodology

This qualitative study explored first-year students' experiences with AI tools in programming education, using the Technology Acceptance Model (TAM) as the theoretical framework. TAM helped analyze students' perceptions of AI based on its perceived usefulness, ease of use, and external factors influencing adoption. Eight students from a private higher education institution, all experienced with AI tools like ChatGPT, Gemini AI, and NinjaTech AI, participated. Data was collected through a focus group discussion covering AI's impact on learning, debugging, problem-solving, and ethics. Thematic analysis was performed using ATLAS.ti to identify recurring patterns in responses. Ethical considerations ensured participant anonymity, voluntary participation, and the right to withdraw.

4. Findings

TAM was employed as the theoretical framework for this study to explore how students perceive and utilise AI tools in programming education. A thematic analysis was carried out on data gathered from focus group discussions, using ATLAS.ti to identify key themes.

Table 1. Themes.

Theme	Code	Description	Example Quotes
Initial Perceptions of AI in Programming	First Impressions of AI	Participants' initial reactions ranged from enthusiasm to caution.	*"AI tools are very helpful"* *"Somewhat helpful, but requires responsible use."*
	AI as a Disruptive Force	Some were excited by AI's capabilities, while others worried about its impact on traditional programming.	*"I was quite shocked at how much it could do and how scary it actually is that it can take over programmers' jobs."*
	Perceived Accessibility	AI tools were easily accessible, requiring only an internet connection.	*"It was very easy to use—just needed Wi-Fi."*
AI's Role in Understanding and Structuring Code	AI for Conceptual Learning	AI helped students grasp difficult programming concepts like inheritance, object-oriented programming, and syntax.	*"Helped me understand inheritance and how to extend classes."*
	AI for Code Structuring	AI assisted in layout, syntax understanding, and organising code efficiently.	*"Helped with structuring code and layout when I didn't know where to start."*
	AI for Debugging & Explanation	AI tools provided insights into debugging errors and explaining code structure.	*"It comments next to the code, telling me what it does."* *"ChatGPT explains why my lecturer did things a certain way.*
Ease of Use and Accessibility	Ease of Integration	AI was easy to incorporate into study routines.	*"It was simple to use; if one AI tool failed, I switched to another."*
	Technical Barriers	AI tools sometimes failed to respond, had internet dependency, or struggled with attachments.	*"Having a stable internet connection was a challenge."* *"Sometimes ChatGPT fails to respond."*
	Workarounds for AI Issues	Participants used alternative AI tools when one failed.	*"I tried other AI tools like Gemini when ChatGPT wasn't working."*
Impact on Learning and Problem-Solving Skills	Boost in Confidence & Efficiency	AI increased confidence and helped students complete tasks faster.	*"Definitely sped up my learning with excellent depth of explanation."* *"It was time-efficient and made my tasks quicker."*

	AI for Problem-Solving	AI enhanced problem-solving skills by breaking down complex tasks.	*"AI provided insight into extracting attributes and methods."*
	Reduced Critical Thinking	Some students worried about over-reliance, leading to weaker problem-solving skills.	*"AI does the problem-solving for you, making you think less."* *"Not to rely on AI all the time."*
	Industry Perspective	AI-generated code foundations reflect how developers work in real-world programming environments.	*"AIs create a good foundation of code for us developers to work on and improve."*
Challenges and Limitations of AI Use	Technical Issues	AI tools failed at times, giving errors, outdated responses, or struggling with document uploads.	*"ChatGPT sometimes provided outdated information."* *"Error messages when trying to analyse attachments."*
	Bias in AI Responses	AI sometimes gave biased or incomplete answers.	*"I noticed bias, so I asked AI to give me both sides of the argument."*
	Dependence on Internet & Software Availability	AI tools required consistent internet access and were unreliable at times.	*"Having a stable internet connection was necessary."*
Ethical Use and Responsible Learning	Avoiding Over-Reliance on AI	Some students acknowledged they initially depended too much on AI before adjusting their usage.	*"At first, I relied too much, but then I realised I needed to actually learn."*
	AI as a Learning Aid, Not a Replacement	AI should be used for guidance, not as a shortcut.	*"Highly recommend AI, but it can be abused."* *"It should help start building code, not replace effort."*
Attitudes Toward AI in Future Programming Courses	Widespread Support for AI Use	All participants recommended AI for programming students.	*"Yes, I would recommend it, but with limits."*
	Concerns About Overuse	A few participants warned against excessive AI reliance.	*"Do not overuse it, use it wisely."*
	Suggestions for Course Design	AI should be integrated into programming courses with guidelines.	*"If AI is used in programming courses, there should be clear limits and rules."*
Recommendations for AI Integration in Programming Courses	Structured AI Guidelines	AI should be used in moderation, especially for beginners.	*"AI should be a supplementary tool, not the main resource."*
	Workshops for Responsible Use	Students should receive AI training before using it in coursework.	*"I would recommend AI, but workshops should be held first to teach students how to use it effectively."*
Future of AI in Education and Industry	AI in Professional Environments	AI is widely used in industry for automation and efficiency.	*"In industry, AI is widely accepted and useful for business processes."*
	Developing AI Awareness in Students	Students should be taught when to use AI and when to rely on their own skills.	*"AI creates a foundation of code for developers, but they must refine it."*

5. Discussion

The study offers valuable insights into students' perceptions of AI tools in programming education. Participants found tools like ChatGPT, Gemini AI, and NinjaTech AI helpful for learning, debugging, and grasping complex concepts like inheritance and object-oriented programming, which aligns with research on AI's role in personalised learning and real-time feedback (Liu & Li, 2024; Zviel-Girshin, 2024). While AI tools improved comprehension and code structure, challenges emerged, such as concerns about over-reliance potentially weakening critical thinking and problem-solving skills (Zhai et al., 2024; Eke, 2023). Technical issues, including unreliable internet and occasional inaccuracies, were also noted (Delgado et al., 2020; Cotton et al., 2024). Ethical considerations were highlighted, with participants recognising the risks of AI misuse and emphasising the need for responsible use to prevent academic dishonesty (Madhu et al., 2023; Khatri & Karki, 2023).

5.1. Answer to research questions

Main Research Question: How do first-year programming students at a private higher education institution perceive and utilise AI tools to support their learning, and what factors influence the effective and ethical use of these tools?

Sub-questions:

1. How do first-year programming students perceive the usefulness of AI tools for learning programming concepts, specifically advanced inheritance?
2. What challenges do students encounter when using AI tools in their programming studies, and how do they address these challenges?
3. In what ways do AI tools impact students' problem-solving skills, confidence, and understanding of foundational programming concepts?
4. How do students' attitudes and experiences with AI tools influence their approach to learning programming effectively and ethically?

5. What are the factors that encourage or discourage responsible use of AI tools in programming education?

This study explores how first-year programming students at a private higher education institution perceive and utilise AI tools, such as ChatGPT and Gemini AI, to support their learning, particularly in advanced programming concepts. While students found AI tools helpful for learning and problem-solving, boosting confidence and efficiency (Liu & Li, 2024), concerns about over-reliance and reduced critical thinking emerged (Zhai et al., 2024). Ethical issues also arose, with students recognising the importance of responsible AI use and suggesting clearer guidelines (Madhu et al., 2023; Khatri & Karki, 2023). The research also investigates how students address challenges with AI, such as unreliable responses and over-reliance, and how these tools impact problem-solving skills, confidence, and understanding of core programming concepts. Students' perceptions of AI influence their learning approach, with those viewing AI as a supplement to traditional methods showing greater improvement. The study highlights factors that encourage or discourage responsible AI use, including AI literacy training, instructor feedback, and clear ethical guidelines (Chavez et al., 2024; Johanyák et al., 2023; Khatri & Karki, 2023). The findings underscore the need for ethical AI practices to maintain educational integrity.

6. Recommendations

Best practices for integrating AI into programming education include a gradual introduction of AI tools, particularly in beginner courses, with clear usage guidelines to complement traditional learning (Vidalis & Subramanian, 2023). Students should receive hands-on training to use AI responsibly for learning and debugging before applying it to assignments (Reunanen & Nieminen, 2024), while educators must select reliable, updated tools to avoid technical issues (Fahimirad & Kotamjani, 2018). To foster critical thinking, educators should encourage independent problem-solving, promote reflection on AI-generated solutions, and facilitate group discussions and peer reviews to enhance collaboration and reduce over-reliance on AI (Zhai et al., 2024; Kshirsagar et al., 2022; Mubofu & Kitali, 2024). Ethical guidelines are crucial, with clear boundaries on AI use to prevent plagiarism and over-reliance, along with workshops that promote responsible use and ethical awareness, including the potential biases in AI responses (Cotton et al., 2024; Madhu et al., 2023; Opara et al., 2023; Mubofu & Kitali, 2024).

7. Conclusion

This study examined student perceptions of AI tools in programming education, revealing that while students value AI for learning and problem-solving, they recognise the need to balance AI use with independent thinking. These findings align with previous research highlighting both the benefits and risks of AI. For educators, AI can be effective if integrated with clear guidelines, critical thinking encouragement, and ethical standards to ensure academic integrity. Future research should focus on AI's long-term impact on learning outcomes, the effectiveness of different tools, and how AI can support underrepresented groups in STEM.

References

Baichuan, Y. (2024). Research on Improving Teaching Efficiency and Quantifying Learning Plans in Innovative Education Practice. *Frontiers in Educational Research*, *7*(9).

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, *8*, 75264-75278.

Cotton, D. R., Cotton, P. A., & Shipway, J. R. (2024). Chatting and cheating: Ensuring academic integrity in the era of ChatGPT. *Innovations in education and teaching international*, *61*(2), 228-239.

Delgado, H. O. K., de Azevedo Fay, A., Sebastiany, M. J., & Silva, A. D. C. (2020). Artificial intelligence adaptive learning tools: the teaching of English in focus. *BELT-Brazilian English Language Teaching Journal*, *11*(2), e38749-e38749.

Dhakal, A. P., & Devkota, B. (2024). Use of Artificial Intelligence in Teaching and Learning Environment: A case of using Chat GPT. *NPRC Journal of Multidisciplinary Research*, *1*(9), 12-23.

Eke, D. O. (2023). ChatGPT and the rise of generative AI: Threat to academic integrity?. *Journal of Responsible Technology*, *13*, 100060.

Fahimirad, M., & Kotamjani, S. S. (2018). A review on application of artificial intelligence in teaching and learning in educational contexts. *International Journal of Learning and Development*, *8*(4), 106-118.

French, F., Levi, D., Maczo, C., Simonaityte, A., Triantafyllidis, S., & Varda, G. (2023). Creative use of OpenAI in education: case studies from game development. *Multimodal Technologies and Interaction*, *7*(8), 81.

Funda, V., & Mbangeleli, N. B. A. (2024). Artificial Intelligence (AI) as a Tool to Address Academic Challenges in South African Higher Education. *International Journal of Learning, Teaching and Educational Research*, *23*(11), 520-537.

Funda, V., & Piderit, R. (2024). A review of the application of artificial intelligence in South African Higher Education. In *2024 Conference On Information Communications Technology And Society (Ictas)* (pp. 44-50). IEEE.

Goosen, W., & Mugumo, P. (2024). A framework for the application of AI in higher education in association with APPETD and Swiss Institute for Management and Innovation. In *International Conference on Medical Imaging, Electronic Imaging, Information Technologies, and Sensors (MIEITS 2024)* (Vol. 13188, pp. 57-70). SPIE.

Harry, A. (2023). Role of AI in Education. *Interdiciplinary Journal & Hummanity (INJURITY)*, *2*(3).

Ihekweazu, C., Zhou, B., & Adelowo, E. A. (2024). Ethics-Driven Education: Integrating AI Responsibly for Academic Excellence. *Information Systems Education Journal*, *22*(3), 36-46.

Johanyák, Z. C., Cserkó, J., & Pásztor, A. (2023). AI-assisted university programming education in practice. In *2023 IEEE 35th International Conference on Software Engineering Education and Training (CSEE&T)* (pp. 185-186). IEEE.

Kshirsagar, P. R., Jagannadham, D. B. V., Alqahtani, H., Noorulhasan Naveed, Q., Islam, S., Thangamani, M., & Dejene, M. (2022). Human intelligence analysis through perception of AI in teaching and learning. *Computational Intelligence and Neuroscience*, *2022*(1), 9160727.

Liu, J., & Li, S. (2024). Toward artificial intelligence-human paired programming: A review of the educational applications and research on artificial intelligence code-generation tools. *Journal of Educational Computing Research*, *62*(5), 1385-1415.

Lytvynova, S. H., Rashevska, N. V., & Proskura, S. L. (2024). The use of artificial intelligence in teaching students programming languages. In *Proceedings of the IX International Workshop on Professional Retraining and Life-Long Learning using ICT: Person-oriented Approach (3L-Person 2024) co-located with 19th International Conference on ICT in Education, Research, and Industrial Applications* (No. 3781, pp. 10-29). CEUR Workshop Proceedings.

Madhu, M., Kumar, K. M., Pratyaksha, B., Sushmita, S., & Javed, G. S. (2023). Striking ethical balance in AI-TAI: Promoting academic integrity through AI-powered tools. In *2023 IEEE Technology & Engineering Management Conference-Asia Pacific (TEMSCON-ASPAC)* (pp. 1-5). IEEE.

Mbangeleli, N. B. A., & Funda, V. (2024). Mapping the Evidence Around the Use of AI-Powered Tools in South African Universities: A Systematic Review. In *Proceedings of the International Conference on Education Research*. Academic Conferences and publishing limited.

Mubofu, C., & Kitali, L. (2024). Artificial Intelligence In Education: Ethics & Responsible Implementation. *Journal of interdisciplinary studies in education*, *13*(2).

Or, C. (2024). Thirty-Five Years of the Technology Acceptance Model: Insights From Meta-Analytic Structural Equation Modelling. *The Open/Technology in Education, Society, and Scholarship Association Journal*, *4*(3), 1-26.

Patel, S., & Ragolane, M. (2024). The implementation of artificial intelligence in South African higher education institutions: Opportunities and challenges. *Technium Education and Humanities*, *9*, 51-65.

Reunanen, T., & Nieminen, N. (2024). Artificial Intelligence as a Catalyst: A Case Study on Adaptive Learning in Programming Education. *Human Factors, Business Management and Society*, *135*(135).

Rodriguez, L. F. (2012). *The Technology Acceptance Model (TAM) as a Viable Model to Determine the Acceptance of E-learning Technologies in Higher Education Institutions (HEI's)*.

Saari, M., Rantanen, P., Nurminen, M., Kilamo, T., Systä, K., & Abrahamsson, P. (2022). Survey of AI tool usage in programming course: early observations. In *International Conference on Agile Software Development* (pp. 182-191). Cham: Springer Nature Switzerland.

Tarisayi, K. (2024). Preparing for AI's transformational potential: rethinking teacher education in South Africa. *International Education Trend Issues*, *2*(1), 31-40.

Vidalis, S. M., & Subramanian, R. (2023). Impact of AI Tools on Engineering Education. In *2023 Fall Mid Atlantic Conference: Meeting our students where they are and getting them where they need to be*.

Zhai, C., Wibowo, S., & Li, L. D. (2024). The effects of over-reliance on AI dialogue systems on students' cognitive abilities: a systematic review. *Smart Learning Environments*, *11*(1), 28.

Zviel-Girshin, R. (2024). The Good and Bad of AI Tools in Novice Programming Education. *Education Sciences*, *14*(10), 1089.

UNIVERSITY STUDENTS' ACCEPTANCE AND AVERSION TO ARTIFICIAL INTELLIGENCE

Carlos A. Torres-Gastelú, & Karla Enríquez-Ortega
School of Administration, Universidad Veracruzana (Mexico)

Abstract

The increasing adoption of generative artificial intelligence (AI) tools necessitates an evaluation of their impact on students' emotions to ensure a balanced integration into educational practices. The objective of this document is to know the perception of students from a Mexican public university towards the emotional reactions to the use of Artificial Intelligence tools. The survey is made up of ten items rated using a Likert scale ranging from totally disagree, disagree, indifferent, agree and totally agree. The survey was validated through reliability (Cronbach's alpha = 0.949) and content validity (Expert judgment and Literature review). Two dimensions are presented: Acceptance towards the use of AI and Aversion towards the use of AI. The sample was made up of 314 students from two degrees: Information Technologies in Organizations and International Logistics and Customs, of which 56.8% were women and 43.2% men. Data processing was done using descriptive statistics. Results indicate higher levels of acceptance, with students perceiving AI as a facilitator of self-paced learning, task efficiency, and personalized education, while fostering interest in technological trends. Conversely, aversion was significantly lower, with most students rejecting notions of AI as unnecessary, frustrating, or distracting. These findings underscore the potential of AI tools in education and highlight the need for strategies to enhance their acceptance, such as addressing emotional barriers and integrating AI into curricula.

Keywords: *Artificial Intelligence, students, emotional reactions, acceptance, aversion.*

1. Introduction

The advance of Artificial Intelligence has revolutionized the educational field, since these systems adapt to the way each student learns, providing certain benefits (Cota, 2024). However, despite the exponential growth in the adoption of AI tools, questions persist about what are the positions that students perceive and adopt before this emerging technology in their education.

The emotional reactions that may arise are acceptance and aversion to artificial intelligence. Understanding these perceptions could influence the effectiveness of AI integration in educational systems. Enthusiasm, interest, confidence and optimism are manifested in a way that the student is willing to use the tool, on the other hand, fear, lack of confidence or discomfort are part of aversion towards AI.

This article focuses on knowing the level of acceptance and aversion of university students towards artificial intelligence in the educational field; the work is composed of four main sections: literature review, methodological design, results discussion and conclusions.

1.1. Previous studies on the topic

The literature review on the emotional reactions of university students suggests the following classification of articles: Positive perception towards AI use (Idroes et al., 2023; Chan et al., 2023; Bakti et al., 2023; Ravi et al., 2022; Schei et al., 2024), AI implementation for teaching-learning process improvement (Subaveerapandiyan et al., 2024; Grájeda et al., 2024; Almaraz et al., 2023; Zhou et al., 2020; Nidhishree et al., 2024), and finally concerns in students towards AI use (Famaye et al., 2023; Wu et al., 2022; Billy et al., 2023).

These studies investigate how students perceive the role of artificial intelligence (AI) in education. The findings indicate that many students consider AI as a valuable tool that can improve both teaching and learning processes. In addition, they highlight that students find chatbots very useful and motivating AI tools, especially as personal assistants for academic tasks. However, despite the positive perceptions towards these tools, students expressed concerns about the accuracy and reliability of the answers provided by chatbots.

In the same vein, the study by Ravi et al. (2022) showed that students have a generally positive view of artificial intelligence (AI), considering it a beneficial tool for both the teaching-learning process and academic administration.

Subaveerapandiyan et al., (2024) mention the possibility of developing personalized interventions that address students' emotional concerns. This approach can not only reduce anxiety but also promote positive attitudes and successful integration of AI into the academic environment. Similarly, Grájeda et al. (2024) highlight the need for comprehensive training for educators considering the ethical issues of AI use, concluding that its integration in the classroom can improve the learning environment considerably.

Also, Almaraz et al. (2023) raise the importance of strengthening AI training across all academic disciplines to prepare students for the growing impact of artificial intelligence in their future professions.

In addition, Zhou et al. (2020) conclude that AI has the potential to significantly transform teaching and learning by improving educational resources, facilitating collaborative activities, and increasing efficiency in teaching processes.

However, negative emotional reactions are also present. Famaye et al. (2023) found that students show apprehension regarding the potential for AI to facilitate academic fraud, spread misinformation, and affect personal development and career prospects. These concerns underscore the need for clear guidelines and ethical and responsible integration of AI in educational settings. A study by Wu et al. (2022) found that college students exhibited “weak rejection” toward AI-assisted learning environments, suggesting that, in general, there is openness to the implementation of this technology in the educational setting. Factors such as performance expectation, effort, and social influence were positively associated with students' willingness to accept these AI-assisted learning environments. However, psychological risk had a negative impact on students' willingness toward these technologies, indicating that concerns about the effects of AI hinder their acceptance.

Students' emotional reactions play a crucial role in how they perceive both the benefits and drawbacks of artificial intelligence (AI) in education, as mentioned by Li (2023), perceived usefulness and perceived ease of use play a key role in shaping students' attitudes, behavioral intentions, and their actual use of AI systems.

Many studies have highlighted the need to open dialogues to address and clarify misconceptions about AI, which could help students better understand its potential applications and benefits.

2. Methods

This study adopted a quantitative, non-experimental, cross-sectional design with explanatory scope to analyze the emotional reactions of university students towards artificial intelligence, both in a posture of acceptance and aversion towards this tool. A survey composed of ten items on a 5-point Likert scale, whose values range from totally disagree, disagree, indifferent, agree and totally agree.

The reliability of the instrument was evaluated using Cronbach's alpha, obtaining a value of .949, which indicates high internal consistency. Content validity was established through expert judgment and literature review. The study results were structured into two dimensions: Acceptance toward the use of AI (alpha = .854) and Aversion toward the use of AI (alpha = .878).

The survey was applied in person to the students. Prior to its application, informed consent was requested from the participants in which they provided their names and signatures. They were also informed that this was a non-profit study where the confidentiality and anonymity of their responses would be respected. The sample consisted of 314 university students, including men (43.2%) and women (56.8%), selected by random convenience sampling. Most of the students were in their fifth (36.6%), third (28.7%) and seventh (27.1%) semesters, representing 92.4%; the rest were distributed among other semesters.

The bachelor's degrees were Information Technologies in Organizations (64.4%) and International Logistics and Customs (35.4%). The study was carried out in the period August 2024-January 2025 in the School of Administration. Quantitative data was analyzed using descriptive statistics with SPSS version 25 software.

3. Results

This section presents the findings of the analysis of students' emotional reactions to artificial intelligence, evaluated in the dimensions of acceptance and aversion. The results are organized to respond to the objectives set out in the study (Table 1).

3.1. Acceptance towards the use of AI

This dimension assesses the acceptance towards the use of AI in the academic environment expressed in the way in which AI allows them to learn at their own pace, reduces the effort in performing

tasks, helps to overcome academic difficulties, allows them to personalize learning and is attractive for them to learn about this type of tools.

The results show that 55.4% of students feel that they learn at their own pace when using AI. In addition, 54.5% feel that the use of AI reduces the effort needed to complete their assignments. As for overcoming difficulties in their studies more easily with AI 58.3% agree with the assertion, 64.6% of students feel more connected to current technological trends when using AI in their education. 59% of respondents agree that AI personalizes their learning experience, while 61.4% of students find it exciting to discover new AI tools for their studies.

3.2. Aversion toward the use of AI

The dimension of aversion towards AI encompasses students' perceptions of the necessity, frustration, trust, and distraction associated with the use of Artificial Intelligence. It reflects the degree to which students perceive AI as essential or unnecessary in their education, experience frustration or ease when using AI in their assignments, hold trust or distrust towards AI for their tasks, and view AI as a helpful tool or a distraction in their studies.

The findings indicate that at least half of the students (56%) consider the use of AI in education necessary. 64% of the students do not perceive frustration when using AI in their work. Nearly half of the students (48%) trust AI. Finally, 59% of the students do not consider artificial intelligence a distraction.

Table 1. Descriptive statistics.

Statistics	Mean	Median	Mode	Standard deviation
Aversion	2.44	2.25	1	1.059
Acceptance	3.67	3.67	4	.797

4. Discussion

As for trust toward AI, the results show that it varies significantly among students. Some trust AI systems as expert advisors, while others maintain considerable skepticism. This trust is influenced by factors such as perceived accuracy, familiarity with the tools, and previous experiences (Wu et al., 2022). However, more than half of the students surveyed do not trust AI absolutely, especially due to its tendency to generate incorrect or "hallucinated" information (Lepik, 2024). This phenomenon suggests that, although students may start with a high level of trust in AI-generated content, this trust decreases when faced with inaccuracies, reinforcing the need to verify the information provided by these tools.

According to Krasna et al. (2024) students are increasingly using AI to perform tasks that were traditionally done manually, particularly in understanding unfamiliar concepts. Research indicates that while students are proficient in adopting AI technologies, they often review and correct AI-generated responses in more than half of the cases. This shift highlights a generational disparity, as younger students are more inclined to integrate AI into their learning processes, making it a crucial tool for academic support and understanding while the results show that half of the students surveyed do not make this substitution.

In terms of supporting struggling learners, Mallillin (2024) found that AI systems can identify those facing challenges and provide personalized interventions, ensuring that everyone receives the necessary support. Studies confirm that AI personalizes learning by tailoring educational content to individual learner needs, thereby improving engagement and learning efficiency (Supelano, 2024).

Research by Vázquez-Parra et al. (2024) highlights that students' positive perceptions of AI tools significantly influence their motivation and engagement in learning, supporting that university students are indeed excited to discover and engage with new AI technologies.

University students agree that they do not consider AI unnecessary in education, Alvarez-Herrero (2024) found that advantages such as speed, efficiency and personalization of learning are identified. However, he also mentions drawbacks such as lack of personalization and technological dependence. According to Fawns et al. (2024) University students find the use of AI frustrating, as many reported that GenAI tools sometimes provided incorrect information or leading to significant additional work and concerns about the quality and accuracy of the output, in contrast to this, most do not find the use of AI for the completion of their assignments frustrating.

Finally, students show increasing interest in AI education, suggesting that, with proper training and ethical guidelines, their perceptions could evolve positively (Lee et al., 2024). Although some studies indicate that AI might inhibit critical thinking (Jaiteh et al., 2024).

5. Conclusions

The results revealed a perception of high acceptance towards the use of AI. Most of the students expressed that thanks to artificial intelligence they learn in a personalized way at their own pace, reducing the effort needed to complete their tasks, it also helps them to overcome the difficulties they face and generates interest in discovering new AI tools as it makes them feel more connected to current technological trends.

On the other hand, with respect to the students' perceptions about the aversion towards AI, it is concluded that there is no significant presence expressed in that students do not show a rejection towards the incorporation of artificial intelligence, they oppose the idea of considering it unnecessary, frustrating, or a distraction. Nor do they distrust its use.

It should be noted that between two to three of ten students adopted an indifferent position towards the use of AI, which implies the need to generate strategies in the university on the guidelines, policies and training mechanisms to promote the use of AI in the educational environment in order to combat the apparent apathy that some students have and to glimpse the direction that the institution has on the incorporation of this technology.

College students view AI as a valuable and beneficial tool for their learning. Positive perceptions far outweigh negative ones, suggesting fertile ground for effective integration of AI in higher education. However, it is important to address concerns about mistrust and promote greater familiarity with the tool to reduce indifference and maximize the potential benefits of AI in education. Future research could focus on assessing the actual impact of AI on students' academic performance and skill development.

References

Almaraz-López, C., Almaraz-Menéndez, F., & López-Esteban, C. (2023). Estudio comparativo de las actitudes y percepciones de los estudiantes universitarios en administración y dirección de empresas y en la educación hacia la inteligencia artificial. *Ciencias de la Educación, 13*(6), 609. https://doi.org/10.3390/educsci13060609

Álvarez-Herrero, J. F. (2024). Opinión del alumnado universitario de educación sobre el uso de la IA en sus tareas académicas. *European Public & Social Innovation Review, 9*, 1-18. https://doi.org/10.31637/epsir-2024-534

Bakti, I. K., Zulkarnain, A. Y., Rusdi, M. S., & Syafaq, H. (2023). The Role of Artificial Intelligence in Education: A Systematic Literature Review. *Journal Iqra': Kajian Ilmu Pendidikan, 8*(2), 182-197. https://doi.org/10.25217/ji.v8i2.3194

Billy, I., & Anush, H. (2023). A study of the perception of students and instructors on the usage of Artificial Intelligence in education. *International Journal of Higher Education Management, 9*(2), 66-73. https://ijhem.com/cdn/article_file/2023-09-22-00-30-11-AM.pdf

Chan, C. K., & Hu, W. (2023). Students' voices on generative AI: perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education 20*, 43 https://doi.org/10.1186/s41239-023-00411-8

Cota-Rivera, E. I., González Correa, M. E., Bernal Marín, L. A., Marquez Montenegro, M. Y., Herrera, A. M., & Martinez Martinez, M. A. (2024). Transforming Education with the Power of Artificial Intelligence: Case Studies. In Ș. Demir & M. Demir (Eds.), *Enhancing Higher Education and Research with OpenAI Models* (pp. 113-140). https://doi.org/10.4018/979-8-3693-1666-5.ch006

Famaye, T., Adisa, I. O., Irgens, & G. A. (2023). To Ban or Embrace: Students' Perceptions Towards Adopting Advanced AI Chatbots in Schools. In G. Arastoopour Irgens, & S. Knight (Eds.), *Advances in Quantitative Ethnography. ICQE 2023. Communications in Computer and Information Science, vol 1895*. Springer, Cham. https://doi.org/10.1007/978-3-031-47014-1_10

Fawns, T., Henderson, M., Matthews, K. E., Oberg, G., Liang, Y., Walton, J., Corbin, T., Bearman, M., Buckingham Shum, S., McCluskey, T., McLean, J., Shibani, A., Bakharia, A., Lim, L., Pepperell, N., Slade, C., Chung, J., & Seligmann, A. (2024). Gen AI and student perspectives of use and ambiguity: Amulti-institutional study. *Proceedings ASCILITE 2024*, 132-134. https://doi.org/10.14742/apubs.2024.1218

Grájeda, A., Córdova, P., Córdova, J. P., Laguna-Tapia, A., Burgos, J., Rodríguez, L., Arandia, M., & Sanjinés, A. (2024). Embracing artificial intelligence in the arts classroom: understanding student perceptions and emotional reactions to AI tools. *Cogent Education, 11*(1), 2378271. https://doi.org/10.1080/2331186X.2024.2378271

Idroes, G. M., Noviandy, T. R., Maulana, A., Irvanizam, I., Jalil, Z., Lensoni, L., Lala, A., Abas, A. H., Tallei, T. E., & Idroes, R. (2023). Student Perspectives on the Role of Artificial Intelligence in Education: A Survey-Based Analysis. *Journal of Educational Management and Learning, 1*(1), 1-15. https://doi.org/10.60084/jeml.v1i1.58

Jaiteh, J., Hasan, M., Karim, A., Mamun, M. A., & Khan, M. S. (2024). Students' perceptions of using artificial intelligence in tertiary education: A phenomenographic study. *Proceedings ASCILITE 2024*, 506-511. https://doi.org/10.14742/apubs.2024.1233

Krašna, M., & Bratina, T. (2024, June). *The use of AI and student population: The change is inevitable*. Paper presented at the 13th Mediterranean Conference on Embedded Computing (MECO), Budva, Montenegro. Retrieved from https://doi.org/10.1109/MECO62516.2024.10577853

Lee, Y. J., Oh, J., & Hong, C. (2024). Exploratory research on understanding university students' artificial intelligence literacy in a Korean university. *Online Journal of Communication and Media Technologies, 14*(3), e202440. https://doi.org/10.30935/ojcmt/14711

Lepik, K. (2024). Trust, but Verify: Students' Reflections on Using Artificial Intelligence in Written Assignments. Information Experience and Information Literacy. *ECIL 2023. Communications in Computer and Information Science, 2042*, 27-38. https://doi.org/10.1007/978-3-031-53001-2_3

Li, K. (2023). Determinants of College Students' Actual Use of AI-Based Systems: An Extension of the Technology Acceptance Model. *Sustainability, 15*(6), 5221. https://doi.org/10.3390/su15065221

Mallillin, L. L. D. (2024). Artificial Intelligence (AI) Towards Students' Academic Performance. *Innovare Journal of Education, 12*(4), 16-21. https://doi.org/10.22159/ijoe.2024v12i4.51665

Nidhishree, M. S., Singh, A. K., Mohan, M., & Kumar, V. K. (2024). Emotional Artificial Intelligence: Methodologies,Benefits, and Drawbacks. International *Journal for Research in Applied Science & Engineering Technology (IJRASET), 12*(4), 4004-4009. https://doi.org/10.22214/ijraset.2024.60851

Ravi Kumar, V. V., & Raman, R. (2022, October). *Student Perceptions on Artificial Intelligence (AI) in higher education*. Paper presented at the 2022 IEEE Integrated STEM Education Conference (ISEC), pp. 450-454, https://doi.org/10.1109/ISEC54952.2022.10025165

Schei, O. M., Møgelvang, A., & Ludvigsen, K. (2024). Perceptions and Use of AI Chatbots among Students in Higher Education: A Scoping Review of Empirical Studies. *Education Sciences, 14*(8), 922. https://doi.org/10.3390/educsci14080922

Subaveerapandiyan, A., Radhakrishnan, S., Tiwary, N., & Guangul, S. M. (2024). Student satisfaction with artificial intelligence chatbots in Ethiopian academia. *IFLA Journal*. https://doi.org/10.1177/03400352241252974

Supelano Londoño, M. L. (2024). Incidencia de la inteligencia artificial en el aprendizaje de los estudiantes universitarios. *Plumilla Educativa, 33*(2), 1-24. https://doi.org/10.30554/p.e.2.5153.2024

Vázquez-Parra, J. C., Henao-Rodríguez, C., Lis-Gutiérrez, J. P., & Palomino-Gámez, S. (2024). Importance of University Students' Perception of Adoption and Training in Artificial Intelligence Tools. *Societies, 14*(8), 141. https://doi.org/10.3390/soc14080141

Wu, W., Zhang, B., Li, S., & Liu, H. (2022). Exploring Factors of the Willingness to Accept AI-Assisted Learning Environments: An Empirical Investigation Based on the UTAUT Model and Perceived Risk Theory. *Frontiers in Psychology, 13*, 870777. https://doi.org/10.3389/fpsyg.2022.870777

Zhou, W. (2020). Sociocultural Theory and Its Implications in College English Teaching and Learning in the Age of Artificial Intelligence. *Journal of Physics: Conference Series, 1*(1646), 012142. https://doi.org/10.1088/1742-6596/1646/1/012142

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

LEARNING SUSTAINABILITY THROUGH IN-CLASS DEBATES

Jonna Käpylä
Faculty of Management and Business, Tampere University (Finland)

Abstract

The study aims to answer the research question: *How can in-class debates be used for learning sustainability in higher education?* The research was conducted as an action-oriented case study at a Finnish university in an international master's course for business and engineering students. In-class debates were used as part of a transformative pedagogical model aimed at developing learners' thinking, identity and agency in promoting sustainability. The results suggest that debates are particularly effective for learning a subject as complex as sustainability and related competencies and fit well with the transformative learning for sustainability, as they allow one to delve deeper into issues, justify points of view and weigh opposing points of view. It is also important to select debate topics where both of the perspectives are possible and worth pursuing from a sustainability perspective and to focus on the "how" of achieving sustainability. As a practical implication, this study provides a pedagogical model for learning sustainability through debates in higher education, including the identification of appropriate debate topics, when teaching sustainability transformation, implementation practices, a debate assessment rubric, and development ideas for improving the exercise further.

Keywords: *In-class debate, debating, sustainability, transformative learning, higher education.*

1. Introduction

In-class debates have been found to be an effective active learning method, but one that is relatively under-utilised in education (Osborne, 2010). Practices of using in-class debates in higher education have been studied in the previous literature (Goodwin, 2003; Roy & Macchiette, 2005; Oros, 2007; Kennedy, 2009; Cariñanos-Ayala et al., 2021), but not so much in the context of education for sustainable development (recent exceptions Rodriguez-Dono & Hernández-Fernández, 2021; Georgallis & Bruijn, 2022). However, the use of debate in education for sustainability could be a fruitful approach, as it could support competencies considered crucial for promoting sustainability, such as systems thinking, values thinking and interpersonal skills, as well as fostering the deep transformative learning considered essential in the context of sustainability, which requires challenging existing worldviews and paradigms (Käpylä & Auvinen, 2024). This study focuses on the use of classroom debates in learning sustainability. The study aims to answer the research question: *How can in-class debates be used for learning sustainability in higher education?* The research was conducted as an action-oriented case study at a Finnish university in an international master's course for business and engineering students, where a pedagogical model for learning sustainability through in-class debates was developed.

2. In-class debates in higher education and in education for sustainable development

Because argumentation is a fundamental process in constructing knowledge, it should also be strongly present in science education (Osborne, 2010). Significant learning gains can be achieved from interactive learning activities that require collaborative discussion and argumentation (Osborne, 2010). Classroom debates not only improve argumentation skills but also help to learn content, the substance in question, deeply, broadly and personally (Kennedy, 2009). Overall, there seems to be a consensus in the previous literature on the virtues of debating, for example in developing critical thinking skills and citizenship skills (Roy & Macchiette 2005; Oros, 2007) and better learning the course content (Goodwin, 2003; Kennedy, 2009). However, very different ways of organising debates have been studied; for example, ways of evaluating debates, the structure and length of debates, the degree of integration (i.e., continuous mode of operation in the course vs. one-off nature), preparation methods, the size of debate teams and the presence of moderators have varied widely across the study settings (cf. Roy & Macchiette 2005; Oros,

2007; Rodriguez-Dono & Hernández-Fernández, 2021). Previous studies on classroom debates in the education for sustainable development indicate that the learning method can be beneficial for developing sustainability and critical thinking competences (Rodriguez-Dono & Hernández-Fernández, 2021) and can elicit participation and enhance reflexivity by engaging students in the complex nature of and multiple viewpoints of sustainability issues (Georgallis & Bruijn, 2022). Despite their recognized potential, classroom debates have not been discussed a lot in the education for sustainable development.

3. Research context and method

The research was conducted in the autumn of 2024 as an action-oriented case study at a Finnish university as part of an international master's course on "Knowledge-based Decision making for Sustainability" for business and engineering students. In total 58 students completed the course. The author of this paper worked as the course responsible teacher together with her colleague. In-class debates were used for the first time in the course as part of a transformative pedagogical model aimed at developing learners' thinking, identity and agency in promoting sustainability (previous version of the course is described and evaluated in Käpylä and Auvinen, 2024). The course consisted of various elements in which interactional and active learning methods played a key role. The course consisted of three lectures, three negotiation exercises, six workshops (one of which was a debate training session), a debate seminar, an exam and a personal written reflection. Data, which consisted of teachers' experiences, course feedback survey (n=50) and a survey about the students' experiences of the debate (n=16), was gathered from the course implementation of 58 participating students. Data was mainly qualitative and analysed using the principles of thematic analysis according to Braun & Clarke (2006).

4. Results and discussion

4.1. Pedagogical model for learning sustainability through in-class debates

The debate exercise part of the course, i.e., the pedagogical model for learning sustainability through in-class debates, consisted of preparation (to be done independently in the teams of two), debate training session and the actual debate seminar (including peer assessment), where four different-themed debates about issues relevant to sustainability transformation took place. Students debated in teams of two against the other debater team of two. Each debate seminar event was thus made for a total of 16 students, and altogether four debate seminars were held at the end of the course. Each student had to attend one debate seminar. The course teachers developed the debate topics based on the course themes, and taking into account that both perspectives should be grounded in sustainability and worth defending. The issues for debate on sustainability transformation are described in Table 1.

Table 1. Issues for debate on sustainability transformation.

Theme	Opposing perspectives of the debate
Economic models	The pursuit of green and sustainable growth vs. Degrowth as a goal
Twin transition	Digitalisation as a cause of sustainability problems vs. Digitalisation as a solution to sustainability problems
Sustainability transition	Business as a driver of sustainability vs. Political decision-making and governance as drivers of sustainability
Sustainability transition	Technological development as a driver of sustainability VS. Change in actions and mindsets as a driver of sustainability

In the debate training session, debate groups of four were formed (two against two) and each group received one debate topic on sustainability related matters. These topics concerned more detailed questions of sustainability compared with the final debate seminar topics in Table 1. Then the group divided the positions between the pairs, and both pairs dig into the topic independently and made a plan for their argumentation. Pairs had half an hour to prepare, after which they debated for 15 minutes and then reflected on their exercise. The aim was to familiarise students with debating as a way of working before the final debate seminar. Along with the timeline and assessment guidelines, students were also introduced to Toulmin's argument diagram, and for the training session, students prepared by watching Dhar's (2018) TED Talk. In the debate seminar, each debate was allocated 30 minutes, including 22 minutes of debate and 8 minutes of discussion and peer feedback. The timeline of the debates was following: 1. Opening speech by pair A (3 min. / 1,5 min. per person), 2. Pair B's response (1 min.), 3. Opening speech by pair B (3 min. / 1,5 min. per person), 4. Pair A's response (1 min.), 5. Free debate 10 min. (max. 30-second speeches per person), 6. Pair B's closing speech (2 min. / 1 min. per person), and 7. Pair A's closing speech (2 min. / 1 min. per person). Students were informed in advance about the evaluation matrix for the debate

(Table 2). Each criterion was considered equally important, and team members received the same grade. Peers provided immediate anonymous feedback after listening to the debate by filling in the feedback forms. After the debate seminars, teachers gave each pair of debaters written feedback on their own performance, along with a grade.

Table 2. Evaluation criteria for the debate performance.

Criterion	Grade 5	Grade 3	Grade 1
Reasoning and evidence	Information and arguments are well justified/motivated and reliable facts are presented.	Most of the information and arguments are presented clearly and accurately, but they are usually not thoroughly justified/motivated.	Information and arguments had some major inaccuracies or were usually not clear.
Strategy and method	The speech is clearly structured and responses to others' arguments are effective and objective.	The speech is mostly clearly structured and responses to others' arguments are for the most part effective and objective.	The speech is often not clearly structured and responses to others' arguments are affected by one's own opinions or upset.
Expression and delivery	The speech is clear and audible, and the speaker speaks at a calm pace. The speaker makes eye contact.	The speech is mostly clear and audible, and the speaker speaks at a calm pace. The speaker mostly makes eye contact.	The speech is unclear and/or inaudible or there is no eye contact.
Teamwork	The pair supports each other.	The pair mostly supports each other.	There are contradictions or repetition.
Communication and listening	All statements, body language, and responses were respectful and were in appropriate language. The debater listens when the others speak.	Most statements and responses were respectful and in appropriate language, but there was one sarcastic remark. The debater mostly listens when the others speak.	Statements, responses and/or body language were consistently not respectful. The debater often does not listen when others speak.

4.2. Experiences of learning sustainability through in-class debates

In total of 58 students completed the course. In the course feedback survey (n=50, 86 % of course participants), the overall assessment of the course was 3.8 (on a scale of 1–5, meaning close to very good). In the open course feedback, debates were often mentioned in response to the question "Which aspects of the course went well in terms of your learning?". Based on the feedback survey, it seems that debating was one of the most valued elements in the course:

- *"I really enjoy the negotiations and debate, so these parts were great."*
- *"I found the negotiation exercises and debates useful, and it was interesting to learn about them, because they are not emphasised much in other courses but they are useful in working life."*
- *"I liked that the negotiations and the final debate were relaxed occasions, and there was no need to excite them in advance."*
- *"The debate was the most useful part of learning. I liked the fact that the course had a variety of different activities."*

16 students (28 % of course participants) responded to a separate questionnaire about their experience of the debate. Of these, three found the debate (preparation, debating practice, debate event, evaluation) very useful in terms of learning, eleven found it useful and two found it quite useful. None of the students found it to be 'not very useful' or 'not at all useful'. When students were asked which factors in the debate (preparation, debate practice, debate event, evaluation) promoted their learning, the following aspects were highlighted: 1. forming arguments and justifications, 2. a deeper understanding and better retention of the issues, 3. choice of topics relevant to the real life and studying the course material in more depth through them, 4. an understanding of different alternative perspectives, and 5. gaining practical experience of debating and thereby increasing self-confidence and academic competence.

Many stressed the importance of the preparatory phase for learning, although the debate event itself was also seen useful. The value of debating was seen as forcing you to form reasoned arguments and think about the alternative position on the issue as well, as described by three students:

- *"It forces you to form in depth arguments about a specific topic and also to understand the opposing side's point of view."*
- *"The preparation phase is the longest and, of course, the most important phase for learning the substance. Debate as a concept offers two positive things for the preparation: everything learned must also be able to justify and, on the other hand, one must consciously try to put oneself in the position of the opposing party. This brings a considerable depth to the learning compared to, for example, reading for exams."*
- *"Hearing other people's debate was a great way of finding out alternative perspectives to the topics."*

Classroom discussions also revealed that most students had not participated in debates during their studies, so the debate event itself (without the substance) provided a new experience, as one student said: *"The event itself, I'd never had the chance to take part in a debate before in my life, and taking part in one has enriched my academic training."* Some practical aspects were also appreciated such as written feedback from teachers together with the grade given, appropriate number of participants at the debate event, pre-supplied scientific material on the topic of the debate and the possibility to choose the language (English or Finnish) of the debate.

When asked in the open course feedback "How would you develop the course?" the final debate was mentioned as something that needed more training and guidance.

- *"Preparing for the debate was challenging, and the workshop did not prepare well for it."*
- *"Maybe practice the debate exactly as it will be in one of the workshops."*

In the individual mention, the debate was also perceived as exciting. There was also a hope that the topics of the debate would be more contradictory or more specific.

- *"I also didn't understand what lessons should have been learnt from the debate. All the energy went just to excite the debate."*
- *"Debate topics could be either more specific or more "contradictory"."*

These three challenges were also brought up in the separate debate survey. When students were asked how the debate (preparation, debate practice, debate event, evaluation) could be developed to be more useful in terms of learning, some issues were mentioned more than once: 1. more training and better guidance for the preparation, 2. stress and tension of performing (debating in front of others), 3. more confrontational debate topics, 4. more comments on topics and feedback from the teachers immediately after the debate, 5. peer assessment practices not useful or not very useful for learning, and 6. too little time for the debate. Some students hoped for more debate training before the seminar, and a clearer idea of what is expected of debate performance. For example, one student argued that *"It is better to explain to the students what you expect them to do in the debate. In this case they would be more prepared and less confused*." Some felt stress and tension of performing, which affected their ability to learn from the seminar: *"I think what makes a debate difficult is the tension of the presentation. As in my case, when I'm presenting, I always feel like I'm forgetting everything. So, there's not much memory of my own performance."* In addition, more immediate feedback from the teachers was hoped for, and one student wished that the shared reflection in the classroom after the debates could have been more fruitful: *"Students could be better motivated to share their own thoughts and ideas."* Some felt that there was too little time for the debate, and there was also a concern that *"one's performance and grade depended a lot on the other team"*. There was also an idea to better link the debates to current affairs. Table 3 summarises the perceived benefits and challenges in debating as experienced by the students.

Table 3. Perceived benefits and challenges in debating.

Perceived benefits	Perceived challenges or suggestions for development
▪ Forming arguments and justifications ▪ Deeper understanding and better retention of issues ▪ Choice of topics relevant to the real life and studying the course material in more depth through them ▪ Understanding of different alternative perspectives ▪ Practical experience of debating: increased self-confidence and academic competence	▪ More training and better guidance needed for preparation ▪ Stress and tension of performing (debating in front of others) ▪ More confrontational debate topics ▪ More comments on topics and feedback from the teachers immediately after the debate ▪ Peer assessment practices not useful or not very useful for learning ▪ Too little time for the debate ▪ Better linked to current affairs

4.3. Evaluation of the pedagogical model

The pedagogical model worked in many respects. Debating itself suited well for learning sustainability, because it enabled active, personal and interactive learning allowing students to delve deeper into issues, justify points of view and weigh opposing points of view. Implementation needs some improvements though. First, the chosen issues for debate on sustainability transformation, seemed to work, especially if the guidance is sharpened. Teachers noticed that some aspects need to be clearly highlighted for the students. It is important to guide students to focus on the "how" of achieving sustainability, i.e., to broadly consider with practical and theoretical examples for example, *how* business is the driver of sustainability, instead of just answering *why*. Because some students felt that opposing topics were too close to each other, teachers should make it clearer what is expected of the performance, e.g. that the idea is to argue and justify one's own point of view even though it is also possible to change one's own perspective during the debate. In the negotiation exercises, students had learnt a collaborative approach to negotiations,

which was reflected in the debates as an attempt to build common ground rather than to defend one's own position. It should be also highlighted to the students that *their job* is to link their rather broad topics to current affairs and independently look for practical and theoretical knowledge on the topic. Second, because the idea of debating was strongly appreciated, debating as a learning method could be used more extensively in the workshops. This would allow students to practice debates much more, which could relieve the tension, stress and anxiety of performing that hindered some students' learning. It would also familiarise students with the timeline of the debate. Third, the evaluation criteria could be further developed by putting more emphasis on the use of relevant knowledge and evidence as well as argumentation. Now the matrix guided students to focus more on communicating successfully. Finally, the peer assessment could be further developed by better training the students for the task and emphasising the learning benefits of giving and receiving feedback. If the peer assessment could be developed as the main assessment method, there would also be also opportunities to scale up the pedagogical model for mass classrooms.

5. Conclusions

The results suggest that debating has many advantages as a learning method for sustainability. It allows students to delve deeper into issues, justify points of view and weigh opposing points of view. However, the implementation needs to be well-designed, and students should be carefully guided. Previous literature presents different ways in which classroom debates can be implemented and provides evidence of their many benefits for learning. However, there is no systematic comparison of the advantages and disadvantages of different debate formats. This is particularly evident in the field of education for sustainability, where there is a lack of studies on classroom debates. The findings of this study are based on the experiences of students and teachers and the data was gathered from one implementation. Further research is therefore needed to develop the pedagogical model and validate its learning benefits, particularly from the perspective of transformative learning for sustainability.

Acknowledgments

The author would like to thank her colleague Hannele Auvinen for designing the course and the debate exercise together.

References

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101.

Cariñanos-Ayala, S., Arrue, M., Zarandona, J., & Labaka, A. (2021). The use of structured debate as a teaching strategy among undergraduate nursing students: A systematic review. *Nurse Education Today, 98*, 104766.

Dhar, J. (2018). *How to disagree productively and find common ground*. Retrieved Feb. 17, 2025, from https://www.ted.com/talks/julia_dhar_how_to_disagree_productively_and_find_common_ground.

Georgallis, P., & Bruijn, K. (2022). Sustainability teaching using case-based debates. *Journal of International Education in Business, 15*(1), 147-163.

Goodwin, J. (2003). Students' perspectives on debate exercises in content area classes. *Communication Education, 52*(2), 157-163.

Kennedy, R. R. (2009). The power of in-class debates. *Active Learning in Higher Education, 10*(3), 225-236.

Käpylä, J., & Auvinen, H. (2024). Pedagogical model for teaching sustainability in higher education: Engaging head, hands and heart. In Carmo, M. (Ed.), *Education and New Developments 2024, 2*, 391-395. Porto, Portugal: InScience Press.

Oros, A. L. (2007). Let's debate: Active learning encourages student participation and critical thinking. *Journal of Political Science Education, 3*(3), 293-311.

Osborne, J. (2010). Arguing to learn in science: The role of collaborative, critical discourse. *Science, 328*(5977), 463-466.

Rodriguez-Dono, A., & Hernández-Fernández, A. (2021). Fostering Sustainability and Critical Thinking through Debate – A Case Study. *Sustainability, 13*(11), 6397.

Roy, A., & Macchiette, B. (2005). Debating the issues: A tool for augmenting critical thinking skills of marketing students. *Journal of Marketing Education, 27*(3), 264-276.

TOURISM STUDENTS' USE OF AI TOOLS: A PRELIMINARY STUDY

Ana Pires[1], Laura Chagas[1,2], & Sónia Pais[1,3]
[1]CiTUR – Centre for Tourism Research, Development and Innovation, Polytechnic Institute of Leiria (Portugal)
[2]School of Tourism and Maritime Technology, Ci&DEI, Polytechnic Institute of Leiria (Portugal)
[3]CIDMA, Center for Research and Development in Mathematics and Applications, University of Aveiro (Portugal)

Abstract

The use of artificial intelligence (AI) in education has grown exponentially, especially since the introduction of ChatGPT in 2022. Teachers and students have started to become aware of other tools that allow them to work and study more efficiently. In the case of students, besides the generalised use of chatbots, some examples are useful for content creation, research, image generation, proofreading, productivity and others. In this context, this study aims to identify the main AI tools that students use in their self-study routine. As this is an ongoing study, the preliminary results are presented and the aim is that the final results will make it possible to identify the tools that students use for two specific areas of study, namely Mathematics and English. Therefore, undergraduate tourism students from a Portuguese university are being surveyed about their use of these tools through a quantitative survey. The results are expected to shed light on the knowledge and use of AI Tools, as well as the main features to support studies, thus contributing to the optimisation of teaching practices and autonomous learning.

Keywords: *AI in education, mathematics, English, tourism, higher education*.

1. Introduction

The integration of AI tools in Education is somehow recent but has already shown how the traditional learning paradigms can change. It can bring both benefits and challenges, so it is important that institutions are aware of the new possibilities.

Denecke, Glauser, and Reichenpfader (2023) conducted a study which concluded that lecturers and students find the main strengths of these tools to be the personalization of the learning experience or increased efficiency by automating repetitive tasks, whereas the main downsides include data protection, bias and skills teaching. A more recent research study showed that higher education students use AI tools to "define or clarify concepts (69,2%), to generate ideas while writing (53,3%), for translation (50,7%) (Almassaad, Alajlan andAlebaikan, 2024). The main benefits perceived included ease of access and use, time-saving on tasks, instant feedback and increased confidence while learning, whereas the greatest challenges identified were associated with unreliable information, plagiarism and cheating, as well as inaccurate or false references.

2. AI tools use in higher education

AI tools are playing an important role in what it comes to students' self-study routines, particularly in the areas of Mathematics and English, as they provide real-time feedback, personalized instruction and tailored support (Mukkala et al., 2025), which have the potential to address some of the main traditional challenges of these two fields of study. By integrating AI into their study routine, students can foster their critical thinking and problem-solving skills as well as improve their communication skills and ultimately enhance their retention and understanding (Cai, Msafiri and Kangwa 2024; Delcker et al, 2024).

At the higher education level, students are expected to have reached a stage of autonomy (Henri, Morrell and Scott, 2018), in which they are responsible for their own learning and seek resources that allow them to develop their knowledge. AI tools can therefore offer support that can adapt to the learner's progress.

A recent study by Akhmadieva et al. (2024) comprised a bibliometric analysis on the use of AI in education showed that the use of AI in higher education has significantly grown in the past few years, particularly after 2019.

According to Crompton and Burke (2023), who worked on a systematic review of AI in higher education, undergraduate were the most studied students and the most dominant subject was Language Learning (17%), whereas Math accounted for only 4%. They concluded that AI was mostly used for assessment and evaluation (feedback and automatic assessment), predicting (forecasting trends in data) and Managing Student Learning (identifying learning patterns, for instance). The main tools were AI Assistant (which includes nomenclature such as virtual assistant or intelligent tutor) and Intelligent Tutoring System (which involves the use of AI techniques and educational methods).

Other studies show some current trends on the use of AI tools, such as generative AI models and image/content creation tools, which can contribute to enhance student creativity but also raise concerns about academic integrity (Nguyen, 2025). Besides, it can also bring benefits in respect to the processes of research, proofreading and productivity (Khalifa and Albadawy, 2024).

3. Methodology

To investigate how undergraduate Tourism students use AI tools for self-learning in English and Mathematics, a quantitative study using a survey was conducted. The questionnaire used in this study was adapted from von Garrel & Mayer (2023), previously tested and validated as a research instrument. The survey was divided into the following sections: demographic information, general use of AI tools and main characteristics, use and purpose of AI tools for English and Mathematics. The online questionnaire was designed using Microsoft Forms and distributed to students enrolled in Tourism undergraduate programs via email and learning platforms.

To determine the minimum sample size, we used the calculation formula with correction for finite populations (Triola, 2022):

$$n = \frac{Nz^2p(1-p)}{(N-1)E^2 + z^2p(1-p)}$$

where:

- N - size of the population or universe
- z - critical value of the standard normal distribution corresponding to the degree of confidence
- E - margin of error (in this case, 7.1%)
- p - estimated proportion

For a universe of 839 students, with a degree of confidence of 90 per cent (z=1.645) and a margin of error of 7.1 per cent, considering the worst-case scenario (maximum variability: p=0.5), we found that the minimum sample size should be 116 students. We received 120 responses to the questionnaire, slightly exceeding our target of 116 responses.

Due to time constraints, only preliminary results could be extracted, as the research is still ongoing.

4. Results and discussion

Regarding the demographic information of the participants, namely students of different courses and degrees in the field of tourism, the majority of the respondents are female (63%), aged between 18 and 20 years (75%), and undergraduate students (75.83%). The results are presented in Table 1.

Table 1. Demographic information (n=120).

	Attributes	Frequency	Percentages
Gender			
	Male	43	36.0%
	Female	75	63.0%
	Other	1	0.5%
	Rather not respond	1	0.5%
Age			
	18-20	90	75.0%
	21-23	24	20.0%
	≥24	6	5.0%

Academic Level			
	Professional Higher Technical Courses (TeSP)	29	24.17%
	1st year	28	
	2nd year	1	
	Undergraduate degrees	91	75.83%
	1st year	68	
	2nd year	19	
	3rd year	4	

In terms of previous knowledge and use of AI tools, the results show that the vast majority of students know what AI tools are (98.33%), a very large number have already used AI tools to support their studies (90.68%), but only 10.28% of respondents say they use these tools very often. A similar percentage of students say they use these tools often (37.38%) or only sometimes (37.38%).

Table 2. Knowledge and use of AI Tools (n=120).

Do you know what AI tools are?			
	Yes	118	98.33%
	No	2	1.67%
Have you ever used AI tools to support your studies?			
	Yes	107 (out of 118)	90.68%
	No	11 (out of 118)	9.32%
Frequency of use of AI in support of your studies			
	Very rarely	2 (out of 107)	1.87%
	Rarely	14 (out of 107)	13.08%
	Sometimes	40 (out of 107)	37.38%
	Often	40 (out of 107)	37.38%
	Very often	11 (out of 107)	10.28%

Using a five-point Likert scale (where 1 = Not at all relevant and 5 = Very relevant), students were asked to indicate the relevance they attributed to a number of aspects of their experience as users of AI tools to support their studies. The results are presented in the heatmap of Table 3, which also includes the median, mean and standard deviation (s. d.) of the responses. We can see that, overall, the results are very positive and very few respondents consider any of the attributes to be unimportant. These results are in line with other studies (Almassaad et al., 2024; Chan and Hu, 2023).

Table 3. AI Tools features to support studies (n=107).

	1	2	3	4	5	median	mean	s. d.
Immediate Feedback	0	2	19	49	37	4	4,13	0,58
Acessibility	0	1	1	56	39	4	3,96	0,44
Clarity of answers	0	1	35	46	25	4	3,89	0,59
Answers without inaccuracies	0	7	51	31	18	3	3,56	0,71
Detailed answers	0	2	24	49	32	4	4,04	0,60
Indication of information sources	3	11	34	36	23	4	3,61	1,04
Development of digital skills	1	6	33	47	20	4	3,74	0,74
Personalised learning	0	6	29	50	22	4	3,82	0,67

5. Conclusions

According to Batista, Mesquita and Carnaz, (2024), the adoption of Gen-AI is irreversible and it is transforming the learning process by enhancing student support and teaching efficiency, but assessment strategies need to be reconsidered in order to "maintain academic integrity and ensure the quality of education" (p. 24).

With the definite results, we intend to clarify how students employ AI tools in both Mathematics and English.

Acknowledgments

This work is financed by national funds through FCT - Foundation for Science and Technology, IP, within the scope of the reference project UIDB/04470/2020

References

Akhmadieva, R. S., Kalmazova, N. A., Belova, T., Prokopyev, A., Molodozhnikova, N. M., & Spichak, V. Y. (2024, October). Research trends in the use of artificial intelligence in higher education. *Frontiers in Education*, *9*, 1438715.

Almassaad, A., Alajlan, H., & Alebaikan, R., (2024). Student Perceptions of Generative Artificial Intelligence: Investigating Utilization, Benefits, and Challenges in Higher Education. *Systems, 12*, 385. https:// doi.org/10.3390/systems12100385

Batista, J., Mesquita, A., & Carnaz, G. (2024). Generative AI and Higher Education: Trends, Challenges, and Future Directions from a Systematic Literature Review. *Information 2024, 15*, 676. https://doi.org/ 10.3390/info15110676

Cai, L., Msafiri, M. M., & Kangwa, D. (2024). Exploring the impact of integrating AI tools in higher education using the Zone of Proximal Development. *Education and Information Technologies*, 1-74.

Chan, K., & Hu, W. (2023). Students' voices on generative AI: perceptions, benefits, and challenges in higher educationInternational. *Journal of Educational Technology in Higher Education, 20*, 43. https://doi.org/10.1186/s41239-023-00411-8

Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: the state of the field. *International journal of educational technology in higher education*, *20*(1), 22.

Delcker, J., Heil, J., Ifenthaler, D., Seufert, S., & Spirgi, L. (2024). First-year students' AI competence as a predictor for intended and de facto use of AI-tools for supporting learning processes in higher education. *International Journal of Educational Technology in Higher Education, 21*(18). https://doi.org/10.1186/s41239-024-00452-7

Denecke, K., Glauser, R., & Reichenpfader, D. (2023). Assessing the potential and risks of ai-based tools in higher education: Results from an eSurvey and SWOT analysis. *Trends in Higher Education*, *2*(4), 667-688.

Henri, D. C., Morrell, L. J. & Scott, G. W. (2018). Student perceptions of their autonomy at University. *Higher Education, 75*, 507-516. https://doi.org/10.1007/s10734-017-0152-y

JISC. (2023). *Report on Student Perceptions of Generative AI*. National Centre for AI in Tertiary Education, University of Manchester: Manchester, UK. Available online: https://www.jisc.ac.uk/reports/student-perceptions-of-generative-ai (accessed on 4 November 2024)

Khalifa, M., & Albadawy, M. (2024). Using artificial intelligence in academic writing and research: An essential productivity tool. *Computer Methods and Programs in Biomedicine Update*, 100145.

Mukkala, P. R., Vuyyuru, T., Murthy, B. S. N. R., Rao, A. S., & Al Said, N. (2025). Integrating ICT with Artificial Intelligence for Transformative Education. *Journal of Information Systems Engineering and Management, 10*(10s), 546-555. https://doi.org/10.52783/jisem.v10i10s.1418

Nguyen, K. V. (2025). The Use of Generative AI Tools in Higher Education: Ethical and Pedagogical Principles. *Journal of Academic Ethics*, 1-21.

Triola, M. F. (2022). *Elementary Statistics* (14th ed.). Pearson.

von Garrel, J., Mayer, J. (2023) Artificial Intelligence in studies—use of ChatGPT and AI-based tools among students in Germany. *Humanities & Social Sciences Communications, 10*, 799. https://doi.org/10.1057/s41599-023-02304-7

HOW TO FOSTER INTERDISCIPLINARY PROJECT-BASED LEARNING IN DISTANCE EDUCATION: FINDINGS FROM A 24-HOUR DIGITAL HACKATHON

Gianluca Carella[1,2], Marta Conte[1], & Francesco Zurlo[1]
[1]*Department of Design, Politecnico di Milano (Italy)*
[2]*MIT Morningside Academy for Design, Massachusetts Institute of Technology (USA)*

Abstract

Global current challenges such as climate change, public health crises, and technological advancements also require collaboration that transcends disciplinary and cultural boundaries. To cope this scenario, it is necessary to start from education to prepare people for the complexities of the modern environment. Higher education must equip students with essential skills such as critical thinking, adaptability and cross-cultural communication. Alongside traditional teaching methods, more interactive approaches are gradually gaining relevance, as they immerse students in real-world challenges and encourage them to apply their knowledge in practical settings. Interdisciplinary Project-Based Learning (IPBL) addresses these needs by creating opportunities for students to work in diverse teams on authentic problems. Moreover, these paradigms have shifted in recent years due to new technological-driven settings. This paper explores the effectiveness of Interdisciplinary Project-Based Learning (IPBL) in distance learning, using a "digital hackathon" as the learning format. The paper discusses the key challenges that emerged during the hackathon, such as communication barriers and time and resources management. The aim is to provide practical insights and recommendations for managing the online innovation challenges and how it is possible to engage teams, involving higher levels of collaboration, guidance, and empathy to foster IPBL in distance learning. Findings highlighted the potential of IPBL to spark creativity and enhance problem-solving skills when students from diverse backgrounds work together.

Keywords: *Interdisciplinary project-based learning, intercultural collaboration, digital hackathon, distance learning, global challenges.*

1. Introduction and theoretical background

In the context of today's complex and ever-changing society, uncertainty places new demands and challenges on students preparing to enter the working environment. Indeed, the contemporary professional landscape is characterized by multifaceted and ill-defined problems that often cannot be handled by a single individual or monodisciplinary teams but must be tackled systemically through interdisciplinary collaborations (Brassler & Dettmers, 2017; Yusri et al., 2024). It is thus essential for students to develop and strengthen skills such as critical thinking and problem solving, communication, collaboration and team building, creativity and innovation (Brassler & Dettmers, 2017; Stentoft, 2017), all essential to critically and innovatively navigate challenges typical of the 21st century (Yusri et al., 2024).

An approach that has proven effective in providing students with the skills needed to cope with today's work environment is interdisciplinary education, which can be defined as "a process by which learners integrate information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines to craft products, explain phenomena, or solve problems, in ways that would have been unlikely through single-disciplinary means" (Boix Mansilla, 2010; Brassler & Dettmers, 2017). Here, students can manage complex information and combine insights from different areas to generate innovative ideas (Brassler & Dettmers, 2017; Hart, 2019), enabling them to solve problems and answer questions that "cannot be satisfactorily addressed using single methods or approaches" (Klein, 1990) and thus providing them with a comprehensive set of personal and social skills that will make them ready for the contemporary world of work.

Another approach particularly well-suited to prepare students to the complexities of the modern working environment is Project-Based Learning (PBL), a method widely discussed and studied in recent decades (Kokotsaki et al., 2016; Carella & Colombo, 2024; Yusri et al., 2024) that can be described as a student-centered form of education based on context-specific learning, the active involvement of students in

the learning process, and the sharing of knowledge through social interactions among participants (Kokotsaki et al., 2016). PBL encourages students to focus on a realistic project aimed at solving authentic questions and challenges within real world, helping them to collaborate with each other in proactively designing, investigating, making decisions, and ultimately solving problems, usually through the design of a product that addresses the driving question (Blumenfeld et al., 1991; Brassler & Dettmers, 2017; Yusri et al., 2024). By using the project as a learning tool, PBL offers students a more active opportunity to the acquisition and retention of the discipline's core concepts (Carella & Colombo, 2024; Hart, 2019) while also allowing them to develop skills such as creative and critical thinking, problem-solving, communication and self-confidence (Yusri et al., 2024).

When integrated with an interdisciplinary approach, PBL can provide students with a more comprehensive and systemic perspective on the discipline being studied and with the opportunity to develop and exploit a broader range of knowledge and skills (Brassler & Dettmers, 2017; Hart, 2019; Chang et al., 2022). In Interdisciplinary Project-Based Learning (IPBL), the integration of interdisciplinarity into the learning process occurs through the creation of multidisciplinary work teams. The interface between members from different disciplinary areas helps to gain a deeper understanding of the problem and stimulates critical and creative thinking (Chang et al., 2022). By promoting interaction between students and members of other knowledge communities, IPBL facilitates communication across professional languages and encourages students to transcend the boundaries imposed by their respective academic disciplines, thereby enriching their global perspective (Brassler & Dettmers, 2017). This pedagogical approach enables students to develop not only inquiry, knowledge creation, and problem-solving skills (Carella & Colombo, 2024), but also teaches them to understand different perspectives, data, and information, and to apply a variety of context-dependent techniques and tools so as to generate a truly innovative and effective solution to the challenge at hand (Brassler & Dettmers, 2017). Beyond the many benefits of IPBL, it is important to note that teams frequently encounter challenges in managing different perspectives, as well as in establishing the appropriate boundaries and associated knowledge pertinent to the problems at hand (Redshaw and Frampton, 2014; Stentoft, 2017). Disagreements concerning common objectives, unrealistic expectations, and underestimation of the time and effort required may be other relevant barriers to effective IPBL implementation (Repko, 2008; Brassler & Dettmers, 2017).

Another factor that is increasingly affecting education and pedagogical approaches such as (I)PBL is digitalization, i.e. the introduction of digital tools to support and execute activities in a distributed and remote environment rather than in a collocated physical one. Indeed, the ongoing digital transition accelerated by the COVID-19 pandemic resulted in a significant shift toward virtual collaboration in a variety of disciplinary fields (Patricio et al., 2024), fostering the development and diffusion of e-learning and distance learning formats. Despite being theorized for face-to-face interactions, multiple studies describe the benefits of introducing technological means such as collaboration software and digital workspaces in PBL (Carella & Melazzini, 2023). Bringing PBL and IPBL to the online context can indeed enhance student engagement, facilitate information retrieval, analysis and exchange and increase the opportunities for networking and cross-disciplinary and cross-cultural collaboration (Donaldson et al., 2021; Vallis & Redmond, 2021). Furthermore, remote collaboration offers several other advantages over traditional settings, including reduced costs due to minimized travel and material consumption, a potentially higher retention rate of team members due to lower participation effort, and better scalability of formats such as workshops and hackathons due to the lack of space constraints (Donaldson et al., 2021; Patricio et al., 2024). Despite these advantages, some undeniable problems remain: while distance education can increase opportunities for interdisciplinarity by removing spatial barriers, a completely remote context can dampen interaction and discourage active participation, leading to difficulties in project development and flattening creative problem-solving efforts (Carella & Melazzini, 2023).

Despite the abundance of research on (I)PBL and distance learning, the potential of a mixed approach bringing the two together has rarely been investigated. This research aims to fill this gap, focusing on how IPBL can be applied in distance learning. To support this theory, a practical case involving a "digital hackathon" bringing together international students from Politecnico di Milano and MIT is examined.

2. Methodology

This paper is based on a 24-hour hackathon organized by Politecnico di Milano and MIT, bringing together international students from the two academic institutions to design innovative startups.

Forty students, half from Politecnico di Milano and half from MIT, were selected based on their curriculum and competences to create multidisciplinary teams with a balanced mix of skills. The project was carried out in small, interdisciplinary teams composed of two students from the Design School at Politecnico di Milano and two from various disciplines at MIT. The main brief proposed was to design impactful solutions for a rapidly changing climate and urgent societal conditions.

The agenda had to take into account the different time zones of Politecnico di Milano and MIT: in order to allow students to work both synchronously and asynchronously, the activities were carried out using Miro, a digital workspace platform chosen for its flexibility of use and accessibility, and a communication platform of their choice. Because of the short amount of time and the consequent "sprint"-like effort required, four mandatory breaks were also planned to ensure participants' wellbeing.

Digital tools were implemented to facilitate collaboration and guide students through the project, with the recommendation of adapting the proposed process to their specific needs. More in specific, the activities where designed and organized in alignment with the principles of PBL, aiming for a student-centric learning experience capable of fostering active learning through interaction among students, the sharing of knowledge from different disciplines, and the understanding the subject matter through a hands-on approach (Dewey, 1959). A series of templates were designed to guide each team through the following twelve-steps process: Problem Identification; Trend Analysis; Interviews & Need Analysis; Idea Generation; Stakeholders Analysis; Competitive Analysis; Customer Journey; Revenue Model; Roadmap; Final Presentation. Moreover, throughout the 24 hours, students could benefit from the support of experts with vertical skills, available at different timeslots during the whole activity to provide feedbacks and suggestions. The final part of the hackathon was dedicated to final presentations and evaluation of the ideas proposed by each team through a panel of judges, two from Politecnico di Milano and two from MIT.

This paper builds its analysis on a survey distributed among participants of the 24-hour digital hackathon to evaluate the experience in terms of how effectively it supported learning, teamwork and skills development. The questionnaire received 32 responses. Specifically, respondents were administered a questionnaire divided into four sections to verify the most relevant findings emerging from literature. Thus, the sections focused on: Online Workspace & Teamwork, Skill Development & Interdisciplinary Collaboration, Hackathon Format & Schedule and Overall Experience & Suggestions. Both open questions and Likert scale questions were used to measure each area of inquiry and all the answers were collected in an .xls file, which was used for data analysis through descriptive graphs and diagrams (Hays, 1973). The results were analyzed using Excel and the associated data visualizations for each research area and were then discussed by a team consisting of two professors and three researchers.

3. Results

The objective of the survey was to assess different aspects of the digital hackathon based on students' individual experiences, such as the usefulness of specific practices in completing the planned activities, the level of difficulty perceived by the participants and the impact of the activity on the development and reinforcement of specific skills. The open questions allowed to gather qualitative data about the experience, with a specific focus on the impact of interdisciplinarity on the problem-solving process and possible benefits and challenges experienced by participants due to the 24-hours format. The Likert scale questionnaire, with parameters ranging from 1 to 5, allowed to gather some quantitative data. The lowest parameter "1" represented the most negative connotation or the least impact in the IPBL context evaluation, while the highest parameter "5" represented the most positive connotation or the greatest impact.

The first section of the questionnaire aimed to investigate how well digital tools, practices and planned activities supported collaboration and structured teamwork. Upon analysis, findings from this section reveal that the digital tools (Miro, the process templates and the communication platform) had a strong impact on the effectiveness of collaboration within the interdisciplinary team, registering an average score of 4.20/5. Similarly, the support offered by the experts through feedback on specific aspects of the entrepreneurial idea was also evaluated positively, receiving an average score of 4.27/5. On the other hand, the evaluation of the impact of technical problems of various kinds related to the use of technology (e.g., connectivity problems or platform glitches) returned highly variable scores within the sample analyzed, with ratings ranging from 1 to 5 and an average score of 2.27/5.

The second section of the questionnaire aimed to investigate the skills participants developed and/or strengthened during the hackathon and how interdisciplinary teamwork influenced their approach to problem solving. Based on the analysis of the responses provide, the data from this section show that interdisciplinarity within teams helped students in both developing and strengthening skills such as critical thinking and problem-solving (e.g., analyzing complex issues and identifying effective solutions), communication and collaboration (e.g., sharing ideas clearly and working well with team members), creativity and innovation (e.g., generating novel ideas and approaches) and effective collaboration in multidisciplinary teams (e.g., integrating diverse perspectives and expertise).

Moreover, working with peers from different cultural or national backgrounds registered a positive influence on student's approach to problem-solving and innovation as well as on the overall learning experience. With an average score of 4,53/5, participants reported that the interdisciplinary composition of the team enriched problem-solving by merging different ways of thinking. While there were challenges in aligning

perspectives and making decisions, the diversity of backgrounds ultimately led to a more innovative and well-rounded approach to tackling problems.

The third section of the questionnaire aimed to understand how the time-limited structure of the hackathon affected productivity, decision-making, and group dynamics, as well as the impact of collaboration in different time zones. When asked to describe the benefits and challenges experienced due to the 24-hour format, participants reported that the intense time constraint pushed them to make quick decisions and think creatively under pressure. Many valued the opportunity to collaborate with talented peers and receive expert guidance, though some found mentorship access could be improved. Some struggled with rushed decision-making and rigid problem-solving approaches. Despite these challenges, most found the experience enriching and suggested adding team-building activities or extending the event for better idea development.

The fourth and final section of the questionnaire aimed to collect participants' overall thoughts as well as suggestions for improvement, in order to refine the proposed "Distance IPBL" format to better support student collaboration and learning. When asked to provide suggestions to improve the experience, participants emphasized several key areas. Many recommended extending the hackathon duration to allow for longer breaks, more sleep, and deeper engagement with the tasks, while also calling for a clearer and more concise briefing to reduce excess material. Team collaboration improvements were also highlighted, with suggestions to form larger teams or incorporate team-building activities ahead of the event to foster stronger connections. Some participants advocated for pre-defined schedules to optimize organization and reduce load and fatigue. Finally, expanding the range of topics to choose from and ensuring balanced team participation were seen as beneficial for enhancing the overall experience.

4. Discussion and conclusions

The study analyzed the potential of a mixed approach bringing together IPBL and distance learning formats through a practical case involving a "digital hackathon" that gathered international students from Politecnico di Milano and MIT. The results from the 32 students who answered the survey confirmed the positive impact of IPBL in developing personal and social skills such as cross-disciplinary communication, teamwork and collaboration, complex information analysis and management and the ability to innovate by bringing together insights from different fields (Brassler & Dettmers, 2017; Hart, 2019), while also shedding light on some prerequisites necessary for such skills to be developed. In fact, many participants reported that the IPBL experience provided them with a more comprehensive and systemic perspective on the discipline at hand, as well as the opportunity to develop and exploit a broader range of knowledge and skills and to apply context-dependent techniques and tools to generate innovative and effective solutions to the challenge at hand (Brassler & Dettmers, 2017). Moreover, findings from this research are consistent with literature affirming how IPBL facilitates communication across professional languages, promoting empathetic teamwork and encouraging students to transcend the boundaries imposed by their respective academic disciplines in favor of a deeper understanding of interdisciplinary concepts (Brassler & Dettmers, 2017; Stentoft, 2017; Chang et al., 2022). Nonetheless, appropriate time allocation emerged as an essential prerequisite when carrying out IPBL activities in distance learning. It emerges as necessary to give the right time to let students find a collaboration framework and a shared vocabulary optimized for the problems at hand, nor to properly prioritize tasks to complete the assignment, all crucial elements for effective collaboration and skills development (Redshaw and Frampton, 2014; Stentoft, 2017)

Regarding the distance learning format, findings from the analysis allow for multiple reflections. On one side, digital tools were well received by students, most of whom were already familiar with digital workspaces and had already experienced online education due to the COVID-19 pandemic. In line with literature (Donaldson et al., 2021; Vallis & Redmond, 2021; Carella & Melazzini, 2023; Patricio et al., 2024), participants reported that the introduction of the mixed setting (partially physical, partially remote) increased the opportunities for networking and cross-disciplinary and cross-cultural collaboration. On the other hand, while collaboration among students physically in the same space was reported to be consistently effective despite the difficulties imposed by the hackathon format, some participants reported difficulties in maintaining active and consistent collaboration in the digital environment. In fact, mainly due to the different time zones and the underestimation of the effort required by the event, some students developed expectations on the hackathon structure, which led to their partial engagement and, therefore, to hiccups in project development and a flattening of creative problem-solving efforts within the team. Good management of hybrid collaboration, in terms of clear presentation of planned activities, composition of working teams and consistent engagement of all participants, thus emerges as another prerequisite for the success of mixed educational formats such as IPBL in distance learning.

In conclusion, the study demonstrates that a combination of Interdisciplinary Project Based Learning and distance education can remarkably enhance interdisciplinary communication, teamwork, and innovative problem solving. However, the efficacy of this approach is dependent on two key conditions: allowing

sufficient time for meaningful collaboration and effectively managing a hybrid context that balances digital and physical interactions. Ensuring clear communication, realistic time allocation, and active engagement in both contexts is essential to maximize the benefits of this educational format.

Future efforts should focus on exploring alternative time frames and on developing hybrid models that ensure robust participation, even in fully remote settings. By addressing these challenges, educators can harness the full potential of IPBL in distance learning, ultimately creating more inclusive and innovative learning environments that prepare students to tackle complex, real-world problems.

References

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning. *Educational Psychologist*, *26*(3-4), 369-398. https://doi.org/10.1080/00461520.1991.9653139

Boix Mansilla, V. (2010). Learning to Synthesize: The Development of Interdisciplinary Understanding. In R. Frodeman, J. T. Klein, & C. Mitcham (Eds.), *The Oxford Handbook of Interdisciplinarity* (pp. 288-306). Oxford University Press.

Brassler, M., & Dettmers, J. (2017). How to Enhance Interdisciplinary Competence—Interdisciplinary Problem-Based Learning versus Interdisciplinary Project-Based Learning. *Interdisciplinary Journal of Problem-Based Learning*, *11*(2). https://doi.org/10.7771/1541-5015.1686

Carella, G., & Colombo, F. (2024). Teaching Design and actively applying it through project-based learning format: A practical case study of a collaboration between a university course and a company. In *INTED2024 Proceedings* (pp. 2391-2398). https://doi.org/10.21125/inted.2024

Carella, G., Conte, M., Italia, M., & Parolini, F. (2024). How to adopt Strategic Design inside universities: Transforming research in educational formats. In *ICERI2024 Proceedings* (pp. 3927-3936).

Carella, G., & Melazzini, M. (2023). Teaching Design in a Fully Remote Environment: Challenges and Changes in the Pedagogical Approach During the Covid-19 Pandemic. In *ICERI2023 Proceedings: 16th annual International Conference of Education, Research and Innovation* (pp. 3985-3990).

Chang, T.-S., Wang, H.-C., Haynes, A. M., Song, M.-M., Lai, S.-Y., & Hsieh, S.-H. (2022). Enhancing student creativity through an interdisciplinary, project-oriented problem-based learning undergraduate curriculum. *Thinking Skills and Creativity*, *46*, 101173.

Dewey, J. (1959). *The school and society.* University of Chicago Press.

Donaldson, J. P., Choi, D., & Layne, J. (2021). *Online Design Thinking Faculty Development Workshops: A Design-Based Research Study*. https://repository.isls.org//handle/1/7319

Hart, J. L. (2019). Interdisciplinary project-based learning as a means of developing employability skills in undergraduate science degree programs. *Journal of Teaching and Learning for Graduate Employability*, *10*(2), 50-66. https://doi.org/10.21153/jtlge2019vol10no2art827

Hays, W. L. (1973). *Statistics for the social sciences* (2nd Ed.). Holt, Rinehart and Winston.

Klein, J. T. (1990). *Interdisciplinarity: History, Theory, and Practice*. Wayne State University Press.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools*, *19*(3), 267-277. https://doi.org/10.1177/1365480216659733

Patricio, R., Dias, J., Carella, G., & Gancho, S. (2024). Managing design innovation challenges in a digital environment. *International Journal of Design Creativity and Innovation*, *12*(3), 139-162.

Redshaw, C. H., & Frampton, I. (2014). Optimising inter-disciplinary problem-based learning in postgraduate environmental and science education: Recommendations from a case study. *International Journal of Environmental and Science Education*, *9*(1), 97-110.

Repko, A. F. (2008). *Interdisciplinary Research: Process and Theory*. SAGE.

Stentoft, D. (2017). From saying to doing interdisciplinary learning: Is problem-based learning the answer? *Active Learning in Higher Education*, *18*(1), 51-61. https://doi.org/10.1177/1469787417693510

Vallis, C., & Redmond, P. (2021). Introducing design thinking online to large business education courses for twenty-first century learning. *Journal of University Teaching and Learning Practice*, *18*(6), 213-234. https://doi.org/10.53761/1.18.6.14

Yusri, R., Yusof, A. M., & Sharina, A. (2024). A systematic literature review of project-based learning: Research trends, methods, elements, and frameworks. *International Journal of Evaluation and Research in Education (IJERE)*, *13*(5), 3345. https://doi.org/10.11591/ijere.v13i5.27875

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

INCLUSIVE EDUCATION IN THE ERA OF ARTIFICIAL INTELLIGENCE AND TECHNOLOGY

Kamelia Nusheva[1], & Boryana Yankova-Hadzhieva[2]
[1]Chief Assist. Prof. Dr., ULSIT (Bulgaria)
[2]Assoc. Prof. Dr., ULSIT (Bulgaria)

Abstract

The report examines the key role of artificial intelligence (AI) and modern information technologies in the transformation of inclusive education, emphasizing the provision of equal access to quality education for all learners, regardless of their individual characteristics and needs. The report focuses on identifying the main challenges facing inclusive education, such as lack of accessibility, difficulties in personalizing the learning process and limited opportunities for adaptation to different needs. The methodology of the report includes an analysis of existing scientific research, practical applications of AI and technologies in education, as well as a study of successful international practices. The approach is based on combining theoretical research with real-world examples, which allows for an objective assessment of the impact of technologies on inclusion processes. The main tasks of the report are aimed at revealing the role and potential of artificial intelligence and modern technologies in the transformation of inclusive education. Identifying existing technological solutions that support inclusive education processes, focusing on their functionalities and application possibilities. The potential of artificial intelligence for personalizing the learning process is assessed, with the aim of adapting educational resources to the individual needs of learners and improving accessibility to learning materials. Adaptive technologies are analyzed that offer solutions to support learners with different individual needs, including those with physical, cognitive or sensory disabilities. The results achieved demonstrate the significant contribution of AI to improving the accessibility and effectiveness of inclusive education. By using adaptive systems, virtual assistants and applications that provide personalized learning, a more accessible learning environment is created for students with different abilities. The report highlights the successes of specific technological solutions that have proven their effectiveness in a real educational environment. It is concluded that artificial intelligence and modern technologies are not only catalysts for the transformation of inclusive education, but also tools for sustainable solutions to socially significant problems related to inequality in access to education. This paper was developed within the framework of a scientific research project “A model for evaluating the effectiveness and quality of inclusive education, training and lifelong learning” with contract № КП-06-Н80/1, funded by National science fund of Bulgaria.

Keywords: *Inclusive education, Artificial Intelligence, technology, transformation.*

1. Introduction

Inclusive education is an educational model aimed at ensuring equal access to quality education for all students, regardless of their individual needs, abilities or socio-economic status. Its main goal is to remove barriers to learning and create conditions for the active participation of all learners in the educational process. This includes not only children with special educational needs (SEN), but also those from marginalized communities, migrants, students with different learning styles and individual challenges.

In the context of rapidly developing technologies, inclusive education plays a key role in reducing social inequalities by providing adapted solutions to the individual needs of learners. Through personalized learning resources, accessible digital platforms and innovative teaching methods, education systems can ensure that no student is left out of the learning process.

Artificial intelligence (AI) and modern technologies offer significant opportunities for the transformation of inclusive education. AI can provide personalized learning experiences by adapting content and teaching methods to the individual needs of students. Among the main benefits of technology in education are: **Personalized learning** – adaptive platforms and software solutions that analyze student progress and offer individualized learning materials; **Improved accessibility** – speech assistants, text and voice recognition technologies, as well as devices to assist people with visual, hearing or motor disabilities;

Automated feedback and assessment – intelligent systems that analyze student knowledge and provide recommendations for improvement; **Virtual teachers and chatbots** – AI-based platforms that provide real-time assistance and guidance to students; **Gamification and engaging methods** – using gamification and virtual reality to more effectively engage students.

Despite the significant potential of AI and technology, a number of challenges still face inclusive education:

- ✓ Lack of access to technology – the uneven distribution of digital resources can limit some students' access to quality education.
- ✓ Insufficient digital literacy of teachers and students – effective use of AI requires training and adaptation to new technologies.
- ✓ Challenges in personalizing the learning process – despite the progress of adaptive systems, many technologies are still unable to fully adapt to the diversity of educational needs.
- ✓ Ethical and social issues – including the protection of personal data, the possibility of bias in algorithms and the risk of addiction to technologies.
- ✓ Resistance to change – traditional educational institutions often encounter difficulties in integrating technological innovations into the learning process (UNESCO, 2023).

In view of these challenges, it is necessary to seek innovative and sustainable solutions that combine the potential of AI and technology with the principles of inclusive education. This report focuses on an analysis of existing technological solutions and their impact on inclusive education, offering practical guidelines for their effective implementation.

This report uses a methodological approach to systematically analyze the impact of artificial intelligence (AI) and modern technologies on inclusive education. The methodology includes three main aspects of the study: analysis of scientific research and existing practices, assessment of technological solutions in the field of education, and study of international good practices and the current state of integration of AI in education in Bulgaria.

2. Technological solutions for inclusive education

The rise of artificial intelligence (AI) and modern technologies is transforming the educational process by facilitating personalized learning, increasing accessibility, and optimizing assessment methods. In these conditions of real change in the learning process, the next change is also taking place: the emergence of the need for a new type of literacy – digital literacy, which is related to new technologies, the way they are used and applied in life. [Evgenieva, 2020]

Artificial intelligence plays a key role in personalizing the educational process by ensuring the adaptation of educational material to the individual needs of students, which is a fundamental element of inclusive education. Through the use of adaptive learning systems, AI analyzes the progress of students and automatically adjusts the content to meet their specific needs. These intelligent platforms allow for dynamic adjustment of the difficulty of tasks according to the student's skills, offer personalized recommendations for learning resources, and help identify knowledge weaknesses by providing targeted support. In this way, artificial intelligence facilitates individual learning and contributes to more effective learning.

Example: Platforms such as Knewton, Smart Sparrow, and DreamBox offer adaptive learning by using data analysis to optimize the learning process.

Personalized content powered by AI significantly improves the learning process by creating interactive and engaging materials tailored to the individual needs of students. By automatically generating text explanations, audiovisual materials, and interactive simulations, AI supports better learning and facilitates learning. It also provides the ability to translate learning resources into different languages or convert them into alternative formats, such as audio versions for students with dyslexia, making education more accessible. In addition, AI enables the creation of virtual tutors who guide students through individualized strategies, offering personalized guidance and support in real time.

Example: IBM Watson Education and Squirrel AI use algorithms to analyze each student's learning style and offer appropriate content.

Digital technologies facilitate access to education for students with physical, cognitive, and sensory disabilities. Many technological solutions have been developed to ensure equal access to education through:

- ✓ Screen readers (e.g., JAWS and NVDA) – software that converts text into speech, assisting people with visual impairments.
- ✓ Speech-to-text programs – such as Dragon NaturallySpeaking, which help students with motor disabilities or dyslexia.
- ✓ Specialized keyboards and alternative interfaces – for students with physical disabilities.

Example: Microsoft Learning Tools includes tools to improve reading and writing by automatically recognizing errors and customizing the interface.

AI-based virtual assistants can provide personalized support by: Answering questions in real time; Directing students to appropriate learning materials; Providing emotional support and encouraging motivation to learn.

Example: Google Assistant, Siri, and Amazon Alexa can be integrated into the educational process, helping students with dyslexia, visual impairments, or language barriers.

Automated feedback and assessment using artificial intelligence provide new opportunities for analyzing and improving the learning process, offering personalized and adaptive assessment methods. Intelligent learning progress analysis systems allow tracking the progress of students and provide detailed analyses of their strengths and weaknesses in knowledge, while suggesting strategies for improving results. In addition, through the collected data, AI can generate individual recommendations for teachers and parents, supporting a personalized approach to learning and increasing the effectiveness of the learning process.

Example: GradeScope and Coursera AI Grader use algorithms to grade essays and tests, providing fast and objective feedback.

Examples of successful practices: Edmentum – an adaptive learning platform that analyzes individual student needs and provides personalized learning paths. Carnegie Learning – uses AI to automatically detect weaknesses in math knowledge and offer personalized exercises. Turnitin – a text analysis tool that helps identify plagiarism and offers guidance for improving writing skills.

3. Analysis of the impact of technology on inclusive education

The introduction of innovative technologies in education leads to significant changes in the way students interact with the learning process. The main improvements include:

Increased accessibility

- ✓ Technologies provide greater access to learning resources through digital platforms that offer alternative formats of content (e.g. audio files, sign language translation, adapted text).
- ✓ Automated assistive technologies such as screen readers, speech assistants and adaptive interfaces support students with visual, hearing and motor disabilities.
- ✓ Online learning systems allow students from remote or underdeveloped areas to receive quality education without physical presence.

Improved learning efficiency

- ✓ Adaptive platforms such as AI-based systems analyze student progress and offer personalized content that reduces learning difficulties.
- ✓ Gamification and virtual reality increase student engagement and facilitate understanding of complex concepts through interactive methods.

Automated assessment tools provide immediate feedback and guidance for improvement, making it easier for teachers and accelerating the assessment process.

Technology can reduce social inequalities by providing equal access to knowledge and educational opportunities.

Reducing educational segregation

- ✓ Online platforms bridge geographical and socio-economic gaps by providing educational resources to students from different social backgrounds.
- ✓ Access to learning in a native or foreign language through automatic translations and voice recognition technologies improves the integration of students from different cultural backgrounds.

Social and emotional support

- ✓ Virtual assistants and chatbots offer emotional support to students who feel isolated or anxious during their studies.
- ✓ Online communities and collaboration platforms (e.g. Google Classroom, Microsoft Teams) encourage communication between students with different abilities and interests, thus building a more inclusive learning environment.

Despite the benefits, there are a number of challenges associated with the implementation of artificial intelligence in inclusive education:

Technological challenges

- ✓ Lack of digital infrastructure – some regions lack the necessary resources to implement advanced technologies.
- ✓ Quality of algorithms – AI may contain bias in algorithms, which can lead to discrimination in the provision of learning resources.

- ✓ Limited personalization – although AI systems offer adaptability, they cannot yet fully replace the human factor in learning.

Social and ethical challenges

- ✓ Data privacy concerns – the collection and processing of students' personal data raises questions about the protection of personal information.
- ✓ Risks of over-reliance on technology – excessive use of digital resources can reduce students' critical thinking and social skills.
- ✓ Need for teacher training – a large part of the teaching staff is not sufficiently prepared to effectively use AI and technology in the classroom.

Economic Challenges

- ✓ High initial investment – implementing smart technologies in education requires significant financial resources.
- ✓ Access Gaps – schools with limited funding may remain at a disadvantage, which exacerbates educational disparities.

4. The current state of AI integration in education in Bulgaria

In December 2020, the Council of Ministers adopted the "Concept for the Development of Artificial Intelligence in Bulgaria by 2030", which outlines the vision and goals for the development and implementation of AI in the country. (Ministry of e-Government, 2022).

In January 2024, the first large-scale, free training on artificial intelligence aimed at teachers, organized by the Applied Academy of Education "Sindeo", ended. This training aims to increase the competences of teachers in the use of AI technologies in the classroom. (Economy.bg, 2025).

The Ministry of Education and Science (MES) launched a pilot project in cooperation with Google, covering over 200 Bulgarian schools. These schools received access to Google's latest educational tools, including those based on AI. The Ministry of Education and Science has an agreement with Intel, according to which Intel will provide 200 lessons in STEM education, which our country can use both to build the national STEM center and to support all educational institutions. (AI Bulgaria, 2024).

Despite these initiatives, a January 2024 survey by the Education Without Backpacks Association shows that 72% of Bulgarian teachers still do not use artificial intelligence in their practice, which highlights the need for additional training and resources. (Economy.bg, 2025).

The Goethe-Institut in Sofia, together with partners from other European cities, launched the EthicAI project, which explores how artificial intelligence and algorithms are changing art and culture. (Goethe Instityt Bulgaria, 2021).

The University of Library Studies and Information Technologies (ULSIT) offers a master's program focused on developing algorithms and models for AI, as well as analyzing large volumes of data. The program combines theoretical knowledge with practical skills, preparing students for the challenges in the field of AI and data processing. Partners such as IBM, ESRI Bulgaria and the Institute of Robotics at the Bulgarian Academy of Sciences participate in the training, providing opportunities for internships and real-world projects (ULSIT, 2025).

In 2023 ULSIT has opened an innovative laboratory combining AI and virtual reality (VR). Equipped with state-of-the-art technologies such as KAT WALK C2+, HTC Vive Cosmos and Oculus, the laboratory provides students with opportunities to create virtual worlds and develop AI algorithms. The laboratory team is working on projects such as recreating the ancient city of Skaptopara and developing methods to support children with special educational needs by combining VR and AI (Global Diplomatic, 2024).

5. Conclusion

Technological solutions not only facilitate access to educational resources, but also stimulate the participation and engagement of everyone in the learning process. Their successful implementation requires constant support from institutions, investment in appropriate devices and training of teachers in their effective use (Stancheva, 2014). Technological solutions based on artificial intelligence create opportunities for the transformation of inclusive education by personalizing the learning process, improving accessibility and automating assessment. They reduce barriers for learners with different educational needs and offer more effective teaching and support methods. Despite these advantages, challenges to the implementation of such technologies include the need for digital literacy, protection of personal data and overcoming unequal access to technological resources. In the future, it is important to seek sustainable strategies for integrating AI into the educational process so that it is accessible to all learners. One of the most frequently discussed ethical challenges in artificial intelligence is bias. It should be noted that data-driven AI systems

are essentially systems that find biases in the data that they are trained on. The question therefore is: what are the socially and culturally acceptable biases and how should they be taken into account in the development, implementation and use of AI systems. (Likova-Arsenova, Vasya, 2020). The adoption of these technologies by education systems provides an opportunity to innovate and improve both the learning process and pedagogical strategies (Grimus, 2020).

Acknowledgments

This paper was developed within the framework of a scientific research project “A model for evaluating the effectiveness and quality of inclusive education, training and lifelong learning” with contract № КП-06-Н80/1, funded by National science fund of Bulgaria.

References

AI Bulgaria. (2024). *Bulgaria v erata na AI: Kak MON podgotvya balgarskoto obrazovanie za digitalno badeshte?* aibulgaria.com

Economy.bg (2025). *Prouchvane: 72% ot uchitelite v Bulgaria vse oshte ne izpolzvat izkustven intelekt*. https://economy.bg/bulgaria/view/57327/Prouchvane-72%25-ot-uchitelite-v-Bylgariya-vse-oshte-ne-izpolzvat-izkustven-intelekt

Economy.bg (2025). *Kak shte izglezhda uchilishteto na badeshteto i kakva shte e rolyata na AI v nego?* https://www.economy.bg/bulgaria/view/60750/Kak-shte-izglezhda-uchilishteto-na-bydeshteto-i-kakva-shte-e-rolyata-na-AI-v-nego

Evgenieva, E. (2020). *Priobshtavashto obrazovanie - inovatsii i paradoksi*. Sofia. https://www.researchgate.net/publication/367036058_Izdatelstvo_na_BAN_Prof_Marin_Drinov_PRIOBSAVASO_OBRAZOVANIE_-_INOVACII_I_PARADOKSI

Global Diplomatic. (2024). *Laboratoria za "Izkustven Intelekt i Virtualna Realnost" kam ULSIT*. https://www.youtube.com/watch?v=VJcG1hUpPEo

Goethe Instityt Bulgaria. (2021). [official website]. *Izkustven intelekt i kultura.Mozhe li izkustveniyat intelekt da sazdava izkustvo?* https://www.goethe.de/ins/bg/bg/kul/mag/22225162.html?utm_source=chatgpt.com

Grimus, M. (2020). Emerging Technologies: Impacting Learning, Pedagogy and Curriculum Development. In S. Yu, M. Ally, & A. Tsinakos (Eds.), Emerging Technologies and Pedagogies in the Curriculum (pp. 127-151). Springer: Singapore. https://scholar.google.com/scholar_lookup?title=Emerging+Technologies:+Impacting+Learning,+Pedagogy+and+Curriculum+Development&author=Grimus,+M.&publication_year=2020&pages=127%E2%80%93151

Likova-Arsenova, V. (2020). Izkustven intelekt v obrazovanieto. // *E-spisanie Pedagogicheski forum. № 3*, 49-56. https://drive.google.com/file/d/19tAsjLjI90YsRwqEroYqZ3gmniKnj4Or/view

Ministerstvo na elektronnoto upravlenie. (2022). *Ofitsialen sayt. Kontseptsia za razvitieto na izkustvenia intelekt v Bulgaria do 2030*. https://egov.government.bg/wps/portal/ministry-meu/strategies-policies/digital.transformation/itis-national-strategic-documents/ai.development.concept.2030?utm_source=chatgpt.com

Stancheva, S. (2014). *Obrazovatelni strategii v bibliotekite: Uchebno pomagalo*.- Sofia: Za bukvite- O pismenehy, 2014, 124 s. http://booksinprint.bg/Publication/Details/477cf0f6-835a-448f-89e4-0f875f53bf16

ULSIT. [official website]. https://specialnosti.unibit.bg/magistyrski-programi-unibit/specialnosti/izkustven-intelekt-i-obrabotka-na-danni?utm_source=chatgpt.com

UNESCO. (2023). *Guidelines on AI and Education: Policies for Equitable Learning*. https://unesdoc.unesco.org/ark:/48223/pf0000376709

TEACHING SCENARIOS FOR DIGITAL LEARNERS

Ana Pongrac Pavlina, Krešimir Pavlina, & Silvija Muselinović
Faculty of Humanities and Social Sciences, University of Zagreb (Croatia)

Abstract

From year 2015 to 2023, the Republic of Croatia implemented the e-Schools program, officially titled: "e-Schools: A Comprehensive Informatization of School Operations and Teaching Processes to Foster Digitally Mature Schools for the 21st Century". As part of this initiative, the project titled "Development of the System of Digitally Mature Schools" (widely known as e-Schools) was implemented. The program aimed to digitally transform schools by modernizing both their administrative systems and educational processes. Key priorities included providing schools with advanced technological infrastructure and enhancing the digital competencies of both teachers and students to support this transformation. A core component of the project involved integrating information and communication technology (ICT) into teaching and learning practices. To achieve this, teaching scenarios were developed as resources for educators, offering guidance on incorporating digital tools into lesson planning. These scenarios were tailored to meet the needs of digital-native learners, with the ultimate goal of fostering the achievement of learning outcomes. This paper highlights the findings of a survey conducted among computer science teachers (N=54) to explore their use of these teaching scenarios in primary and secondary school classrooms.

Keywords: *Teachers, teaching scenario, digital competences, digital educational materials.*

1. Introduction

The contemporary teaching process is facing significant challenges. Classrooms today are occupied by members of Generation Z (born between 1997 and 2012) and Generation Alpha (born after 2010) (Holubova, 2024). Generation Z is characterized by the use of modern information and communication technologies, which they enjoy using daily while practicing multitasking (e.g., simultaneously browsing the internet, doing homework, and chatting with friends). They retain information more effectively when it is presented visually (e.g., through graphs or diagrams) (Adamska, 2021), prefer learning through demonstrations and self-directed study, but tend to have shorter attention spans and struggle with developing critical thinking skills (Rončević & Vrcelj, 2020). Generation Alpha, on the other hand, is highly interested in technology and uses it for independent learning. They expect the use of visual, auditory, and kinesthetic elements in teaching. Their interpersonal intelligence is less developed, as they form social relationships in different ways. Nevertheless, they are entrepreneurial, curious, and open to new challenges (Ziatdinov & Cilliers, 2021).

It is evident that modern students learn differently, and a common trait shared by both Generation Z and Generation Alpha is their use of information and communication technologies. Consequently, the contemporary education system must adapt to the evolving nature of learning and teaching.

In the Republic of Croatia, the current framework is the National Curriculum (Ministry of Science and Education, 2017), which, through various curricular documents, prescribes the educational principles from preschool to secondary school levels. Accordingly, there has been a recognized need for implementing changes, driven in part by the digital era in which we live.

The program e-Schools: A Comprehensive Informatization of School Administrative and Teaching Processes with the Aim of Creating Digitally Mature Schools for the 21st Century was active from 2015 to 2023. Within this program, the project titled e-Schools: Establishing a System for the Development of Digitally Mature Schools—abbreviated as e-Schools—was implemented. The program was led by the Croatian Academic and Research Network (CARNET). Its goal was to digitally transform both administrative and teaching processes in educational institutions.

The first phase of the project, a pilot phase, lasted from 2015 to 2018 and involved 10% of Croatian schools. The second phase spanned from 2018 to 2023. This phase focused on the digital transformation of both administration and the educational process. A key emphasis was placed on infrastructure, ensuring

that schools and educational staff received the necessary equipment to participate in the project. This included the development of local networks and providing schools and staff with computers.

The digital transformation of the teaching process was based on the development and use of digital educational content created for all subjects from 5th grade of primary school to the final year of secondary school (12th grade). In addition to digital educational content, teaching scenarios were developed for school subjects and cross-curricular topics. Educators were provided support to develop their digital competencies through in-person meetings, practitioner-led sessions, and online workshops.

Teachers' digital competencies were defined by the European Framework for the Digital Competence of Educators and are intended for educators at all levels of education, from preschool to higher education. These competencies are divided into three main elements (professional competences, pedagogical competences, and student competences), encompassing six areas and a total of 22 digital competences (Croatian Academic and Research Network – CARNET, 2020).

Throughout the project, various services used by teachers were continuously improved, such as Moodle (an e-learning platform used in Croatian education), EMA (an application enabling teachers to register for professional development programs), and Edutorij (a repository of digital educational materials) (CARNET, 2019). Our research interest focused on the use of teaching scenarios, which can be described as digital lesson plans designed for teachers of specific subjects. We were particularly interested in the subject Computer science, which is a mandatory subject in the 5th and 6th grades of primary school in Croatia and is compulsory in the first grade of general secondary school (gymnasium).

At the time of conducting this study in May 2023, there were a total of 48 available teaching scenarios intended for students in the 5th and 6th grades of primary school and the first grade of gymnasium for the subject of computer science. These teaching scenarios were created based on previously developed digital educational content, which covered 60% of the learning outcomes from the computer science curriculum for the respective grades.

The development guidelines for teaching scenarios are grounded in the didactic principles of computer science education. Each scenario is based on learning outcomes derived from the official subject curriculum, which are then further operationalized in specific activities.

Each teaching scenario includes three activities based on operationalized learning outcomes, varying levels of ICT integration, and interdisciplinary connections with other subjects and cross-curricular themes. Each activity includes detailed lesson content structured by lesson stages, teaching forms and methods, and suggested use of ICT (basic, intermediate, and advanced levels). Furthermore, each activity includes adaptations for gifted students as well as those requiring additional support. One activity is also designed for online implementation. Since these teaching scenarios were developed within a national project, we were interested in examining the extent to which computer science teachers are familiar with and make use of these scenarios.

2. Methodology

The survey was conducted among primary and secondary school computer science teachers in the Republic of Croatia. The sample was created based on the available list of primary and secondary schools in Croatia, which is accessible on the official website of the Ministry of Education. A random (systematic) sampling method was used, and a total of 54 Computer Science teachers responded to the survey. These teachers taught computer science in the 5th and 6th grades of primary school and the 1st grade of secondary school. The survey consisted of four sections: general information, recognition of teaching scenarios, use of teaching scenarios, and digital tools.

3. Results and discussion

A total of 33 female teachers (61.1%) and 21 male teachers (38.9%) participated in the survey. In addition to general demographic information, the survey also included questions related to the participants' years of teaching experience and the type of school (primary or secondary) in which they are employed. The highest number of teachers (19 participants or 35.2%) have been employed at their school for between 11 and 20 years. A total of 20.4% (11 participants) have between 1 and 5 years of teaching experience. Both the 6 to 10 years and the 21 to 30 years categories each include 9 participants (16.7%). Four respondents (7.4%) have been working at their school for between 31 and 40 years. Of the total sample, one teacher has been employed for less than one year (1.9%), and one for more than 40 years (also 1.9%).

Regarding the type of school in which they are employed, more respondents work in primary schools (31 teachers or 57.4%) compared to those employed in secondary schools (23 teachers or 42.6%).

The second set of questions focused on the recognition of teaching scenarios. Majority of respondents (49 participants or 90.7%) are aware that the teaching scenarios were developed as part of the e-Schools project. The majority of respondents (34 or 63%) are aware that teaching scenarios have been developed for the subject of computer science.

More than half of the respondents (33 participants or 61.1%) have never created their own teaching scenario using the template provided within the e-Schools project. A total of 24.4% (13 participants) have considered creating their own e-Schools teaching scenario, while 14.8% (8 participants) have created one.

The third set of questions focused on the use of pre-existing e-Schools teaching scenarios.

Of the total number of respondents, 38.9% (21 participants) reported that they rarely use teaching scenarios, specifically 1 or 2 times per month. A large portion, specifically 29.6% (16 participants), indicated that they never use the teaching scenarios. Approximately once a week, 20.4% (11 participants) use the prepared teaching scenarios, 7.4% (4 participants) use them 2-3 times per week, while 3.7% (2 participants) stated that they use the scenarios almost every day.

We examined the relationship between the use of teaching scenarios and gender. Based on the Pearson Chi-Square test (3.05) with df (4) and a p-value of 0.549, it was found that there is no statistically significant difference. Therefore, both male and female respondents use the developed teaching scenarios equally.

We also examined the relationship between the use of teaching scenarios and the type of school in which the teachers are employed. Based on the Pearson Chi-Square test (5.25) with df (4) and a p-value of 0.263, it was determined that there is no statistically significant difference. Teachers employed in both primary and secondary schools use the developed teaching scenarios equally.

We were interested in the relationship between the use of teaching scenarios and years of service in the school. Based on the Pearson Chi-Square test (46.51) with df (24) and a p-value of 0.004, it was found that there is a statistically significant difference in the use of teaching scenarios based on years of service in the school. Teachers with more years of experience (11-20 years and 21-30 years) use the prepared teaching scenarios more frequently than those with fewer years of service (1-5 years and 6-10 years). Teachers with more experience have gained greater proficiency in lesson planning. Participation in various professional development programs has enabled them to recognize relevant teaching materials that they can use in their teaching process, and as a result, they will use the prepared teaching scenarios more frequently than their younger colleagues.

Respondents use the teaching scenarios in various domains of the computer science subject.

Table 1. Use of Teaching Scenarios in domains of the computer science Subject.

Domain	Number of respondents	%
Information and Digital Technology	12	27,3 %
Computational Thinking and Programming	11	25,0 %
Digital Literacy and Communication	11	25,0 %
e-Society	10	22,7 %

It is evident from Table 1 that teaching scenarios are used equally across all domains.

Since the teaching scenario is divided into several activities, the respondents were asked whether they use all the proposed activities.

Table 2. Use of All Activities in Teaching Scenarios.

Activities	Broj ispitanika N	%
Yes	4	8,16 %
No	20	40,81 %
Sometimes yes, sometimes no	25	51,02 %

Table 2 shows that respondents will not necessarily use all the proposed activities, which is understandable, as one teaching scenario is written for multiple teaching units. Given this, some activities will be more suitable for teachers, while others will be less suitable.

Teachers also answered statements related to the quality of teaching, which focused on whether using teaching scenarios contributes to greater student motivation to participate in lessons, and whether it allows for the modernization and improvement of the quality of teaching. Respondents were asked to rate their agreement with each statement on a Likert scale from 1 (strongly disagree) to 5 (strongly agree).

Table 3. Use of Teaching Scenarios to Ensure Teaching Quality.

Statement	Value	Number of Respondents	%
Using prepared teaching scenarios can contribute to greater student motivation to participate in lessons	1	0	0,00
	2	2	4,08
	3	13	26,53

	4	29	59,18
	5	5	10,20
Using prepared teaching scenarios can modernize and improve the quality of teaching	1	0	0,00
	2	1	2,04
	3	20	40,81
	4	21	42,85
	5	7	14,28

It is evident from Table 3 that respondents mostly agree with the statement that teaching scenarios can influence student motivation as well as modernize and improve the teaching process. Teachers need to prepare their lessons. The prepared teaching scenarios provide them with new ideas that they can use in their lessons. Respondents were able to answer this question positively, negatively, or choose a neutral answer.

Table 4. Time Spent Preparing for Lessons Using Teaching Scenarios.

Statement	Answer	Number of Respondents	%
Prepared teaching scenarios can shorten the teacher's preparation time for lessons	Yes	34	68
	No	5	10
	Not sure	11	22

Table 4 shows that teachers believe that using teaching scenarios can shorten the time they spend preparing for lessons, which is understandable, as teaching scenarios provide ideas on how to organize the teaching process based on the learning outcomes that need to be achieved.

In this final part, two open-ended questions were asked with the aim of allowing teachers to express their views on the advantages and disadvantages of using teaching scenarios.

Table 5. Advantages and Disadvantages of Using Teaching Scenarios.

Advantages	**Disadvantages**
Modernization of teaching	Not always applicable to all students
Quality of teaching	Specificities of each school that are not covered
New ideas for teaching	May contain content that has not been covered earlier
Shortened preparation time	Decreased creativity of teachers
Interesting way of conducting lessons	Technical issues when implementing teaching scenarios
Helps the teacher deliver the lesson in a different way	

Table 5 shows that computer science teachers have recognized both the advantages and disadvantages of the provided teaching scenarios. They appreciate the possibility of receiving new ideas based on which they can deliver their lessons in a different way compared to their usual approach. On the other hand, the recognized disadvantages include the potential issue of the teaching scenario building on content that has not been covered earlier. In the Republic of Croatia, the curriculum-based approach is implemented, which means that the computer science subject curriculum prescribes the learning outcomes for each domain of a specific grade but does not specify the time when each outcome should be realized. As a result, different teaching content can be covered simultaneously in different counties of the Republic of Croatia. Furthermore, since the teaching scenarios suggest the use of various digital tools, technical problems may arise during lesson delivery. Ready-made teaching scenarios can also negatively affect the teacher's creativity if they decide to rely solely on the prepared materials.

The last group of questions referred to the digital tools proposed for use in the teaching scenarios.

Table 6. Digital Tools in Teaching Scenarios.

Mark and/or write the digital tools you use in teaching based on the suggested teaching scenarios.	Digital Educational Tools	Number of Respondents
	MS PowerPoint	45
	MS Word	45
	MS Teams	35
	Mentimeter	20

	Padlet	19
	Canva	26
	Other	Coggle, PosterMyWall, Prezi, Powtoon, OneNote, Forms, Sway, Wordwall, Bookwidgets, Kahoot, Excel, Access, Python, Gorms, Sway, HTML, Notepad, Paint 2D i 3D, Scratch.

Table 6 shows what tools computer science teachers use in teaching scenarios. Accordingly, the most frequently used tools are MS PowerPoint and MS Word. For videoconferencing, they use MS Teams. They also use Canva and Padlet, which offer the possibility to create multimedia posters, worksheets, leaflets, etc. Additionally, when self-reporting, it is evident that teachers/instructors use other tools, such as Prezi or MS Sway, which allow for the creation of more interactive presentations, Powtoon, which allows the creation of digital stories/comics, or Kahoot!, which allows the creation of digital quizzes.

4. Conclusions

Modern education adapts to contemporary students who are users of various digital educational tools. The subject of computer science in primary and secondary schools in the Republic of Croatia follows contemporary trends in the use of digital educational tools for educational purposes. As part of the E-Schools project, which was implemented between 2015 and 2023, teaching scenarios for the subject of computer science were created for the 5th and 6th grades of primary school and the 1st grade of secondary school. The survey aimed to examine the opinions of computer science teachers regarding teaching scenarios. A total of 54 participants responded to the survey. The survey results showed that more women (61.1%) completed the survey. The largest percentage of respondents (35.2%) had 11-20 years of experience, and the majority of respondents are employed in primary schools (57.4%). Although the respondents (63%) are aware that teaching scenarios have been created for the subject of computer science, most (38.9%) use them rarely (1-2 times per month) in their teaching. Teachers and instructors with longer teaching experience (11-20 years and 21-30 years) more frequently use the created teaching scenarios compared to teachers and instructors with less experience (1-5 years and 6-10 years). Encouragingly, teachers and instructors use teaching scenarios equally across all four domains, and only occasionally do most (51.1%) use all the proposed activities. The respondents believe that teaching scenarios influence students' motivation, can modernize and improve the quality of teaching, and shorten the time teachers spend preparing for classes. The respondents use the digital educational tools proposed in the teaching scenarios, which is understandable since the scenarios were developed by long-term employees of educational institutions, meaning the proposed tools are grounded in their practical use.

References

Adamska, M. (2021). *Expectations of Generation Z - A Challenge for Academic Didactic Staff*. NORDSCI. 55-67. 10.32008/NORDSCI2021/B1/V4/05.

Holubova, R. (2024). Developing key competences. In M. Nodzynska-Moron (Ed.), *What is the appropriate methodology for Generation Z (and Generation Alpha) education?* (pp. 65-81). Krakow: University of the National Education Commission.

Hrvatska akademska i istraživačka mreža-CARNET (2020). *Europski okvir digitalnih komptencija za obrazovatelje*-DigCompEdu. Zagreb: CARNET.

Hrvatska akademska i istraživačka mreža – CARNET (2019). *e-Škole. Razvoj sustava digitalno zrelih škola (II. faza)*. Zagreb: CARNET.

Ministarstvo znanosti i obrazovanja (2017). *Okvir nacionalnoga kurikuluma*. Zagreb: Ministarstvo znanosti i obrazovanja.

Rončević, M. i Vrcelj, S. (2020). Uporaba informacijsko-komunikacijskih tehnologija u odgojno-obrazovnom radu s generacijom Z. *Odgojno-obrazovne teme, 3*(5), 41-64. https://hrcak.srce.hr/249114

Ziatdinov, R., Cilliers, J. (2021). Generation Alpha: Understanding the Next Cohort of University Students. *European Journal of Contemporary Education 10*(3), 783-789. https://eric.ed.gov/?q=generation+alpha&id=EJ1324088

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

FROM THE PEDAGOGY OF RESISTANCE TO DIGITAL CONFORMISM: A STUDY OF ANALOG LITERACY IN A DIGITAL EDUCATION

Cristina Coutinho[1], & Pedro Amado[2]
[1]*Polytechnic University of Cávado and Ave (Portugal) / ID+ Research Institute for Design, Media and Culture (Portugal)*
[2]*Faculty of Fine Arts, University of Porto / i2ADS (Portugal)*

Abstract

This study explores the concept of analog literacy in the context of predominantly digital design education, addressing its relevance as a complementary and innovative pedagogical approach. The qualitative methodology consisted of exploratory interviews with five teachers and specialists in the field of design and multimedia from Portuguese higher education institutions. The analysis revealed three fundamental themes: processes, the role of error, and the hybrid approach. The participants pointed out that digital processes and tools, while efficient and productive, often hide creative processes and minimize the importance of error as an essential element of learning. In contrast, an analog workflow values material exploration and promotes patience, resilience, and critical thinking. The integration of analog and digital methodologies is presented as an effective pedagogical model that combines the efficiencies of digital with the depth and tangibility of analog, allowing for more reflective and creative learning. Based on the teaching and professional experience of the interviewees, this study presents the argument that analog literacy is not a nostalgic reminiscence, but an essential skill that should be developed in parallel and complementary to digital skills. This approach aligns with the Sustainable Development Goals (namely SDG 4.4) by promoting the development of technical and professional skills relevant to real work contexts and innovation. Its implementation in design education proposes an ethical and innovative response to the challenges of digital standardization, promoting diversity, innovation, and a culture of critical and reflective practices.

Keywords: *Analog literacy, education, design, reflexivity, creativity.*

1. Introduction

In the teaching practice of the design field (especially in recent years), we have been witnessing the growing contrast between analog practice and the digital context; digital, due to its speed, productivity, and infinite possibilities, has become essential in the contemporary world. Analog—in its multidimensional aspect—with weight, texture, and matter—is increasingly presented as a complex and slow medium, something that doesn't fit in with the times we live in, when digital design and production media and technologies offer us faster, apparently easier, and less expensive alternatives. The contrast between difficult and easy, slow and fast, analog and digital has become a central concern in my teaching practice. As observed by Pereira (2022), in the Portuguese binary higher education system (university and polytechnic), despite the diversity offered in the different groups of transversal skills, there is "no established doctrine of any kind" (p. 201). Despite considering the skills provided or to be acquired to be valid and stressing the importance of the material characteristics in training in Curricular Units (CUs) such as Projects, Workshops, or Laboratories given their experimental nature. Pereira admits that the practical, physical, or material nature can be reinforced, with the need and due access to laboratories equipped with the appropriate materials and tools. If, on the one hand, the Bologna Process* presupposes the creation of freer and more autonomous paths for students, the search for and access to the different methods — specific analog and digital — implies knowing the necessary skills. Although institutions have different approaches, the exploitation of materials in design education is at the root of it (Zhou and Rognolli, 2019).

Working manually—cutting, gluing, scratching, making mistakes, and starting again, respecting the time needed for tools and materials to fulfill their function and physically interact with each other—is

* https://education.ec.europa.eu/pt-pt/education-levels/higher-education/inclusive-and-connected-higher-education/bologna-process

not just a technical formality. It's a process that requires time, attention, knowledge, and a deep understanding of materials and creative processes, requiring preparation and reflection before and during the process on the part of the students. Analog and digital practices are not antagonistic; quite the contrary, digital tools mimic the analog reality in their processes, work tools, and even terminology. Digital tools should not be seen as a substitute for analog tools but rather as an extension of them, enabling designers to explore and manipulate materials in new ways, promoting creativity and innovation in design ideation and creation processes (Grigg, 2020, p. 202).

This research proposes to reflect on and problematize the place of the analog in a digital world, exploring how both approaches can (or cannot) coexist in a hybrid way to improve learning processes.

To contextualize this research, exploratory interviews were conducted with professionals and other teachers. This reflection is not about choosing between the past and the future but about knowing how to integrate the two strands—digital and analog—to improve the present.

2. Literature review

Literacy is understood as a way of identifying, understanding, interpreting, creating, and communicating in an increasingly digital, text-mediated, information-driven, and rapidly changing world. Literacy is a continuous process of learning and articulating knowledge in reading, writing, and the use of numbers throughout life and is part of a broader set of competencies, including digital competencies, media literacy, education for sustainable development and global citizenship, as well as specific competences for work (UNESCO, 2024).

The concept of literacy can also be broadened to include specific dimensions such as reading literacy, which represents students' ability to understand, use, evaluate, reflect on, and interact with verbal information to achieve their goals; mathematical literacy, which involves the ability to reason mathematically and to formulate, use and interpret mathematics to solve problems in real-world contexts; and scientific literacy, which translates into participation in reasoned discourse about science and technology, requiring skills to scientifically explain phenomena, evaluate and design scientific investigations and interpret data and evidence (OECD, 2023).

Thus, for this study, the definition of analog literacy is proposed as the ability to understand, use, evaluate, and create meaning through analog processes and tools, bringing together skills to interpret, manipulate, and communicate using non-digital media, to stimulate creativity, critical thinking and problem-solving in diverse contexts. These are fundamental skills that can be applied in various dimensions and can be reused and put into practice throughout the lives of students and future designers.

The choice of the term “analog literacy” reflects a conscious permissiveness, recognizing the absence of a consolidated definition in scientific literature. This designation was adopted for its ability to comprehensively synthesize the multiple dimensions that integrate the use of non-digital processes and tools in educational contexts related to art and design. The term conveys a clear intention to value materiality and tangibility as a counterpoint to the immateriality that predominates in the digital context, as it makes it possible to amplify and accelerate the process of artistic development in a comprehensive and integrated way [with other processes, namely digital] in a broader context of acquiring design skills (Olsen, 2024, p.129).

Otl Aicher explores the relationship between the concepts of analog and digital in graphic communication design, highlighting their interdependencies and cultural and philosophical implications. According to Aicher (2015), the interaction between the two concepts is essential to promote creativity and innovation, proposing that design should integrate both the sensory and qualitative aspects of analog and the structural and functional elements of digital. The author concludes that the balance between analog and digital is not only technical but also ethical and philosophical, arguing that the exclusive prioritization of digital can result in a reduction of the complexity of the human experience to simplistic metrics.

Jenny Grigg (2020) introduces the concept of material literacy related to the ability of designers to interpret and articulate meanings in the properties of materials, recognizing that materials, like words and images, constitute a form of design language. According to the author, material literacy involves haptic perception, expanding the designer's understanding beyond mere vision.

Material literacy in the context of teaching can enable students to develop a holistic understanding of materials, extrapolating their surface characteristics and recognizing their exploratory potential. Through hands-on experimentation, direct manipulation, and “conversations” with materials, students explore creative possibilities and integrate “thinking” and “doing” into the design process, recognizing the influence of materials on the formulation of ideas and their ability to generate innovative solutions (Grigg, 2020). This dialogue between student and material refers to Ingold (2013), according to whom making is understood as an active process of correspondence between the craftsman and the materials. From this perspective, knowledge does not result from the mechanical execution of previous plans but comes from

the dynamic and reciprocal interaction between thought, body movement, and the specific properties of materials (Ingold, 2013; Grigg, 2020). The integration of this experimentation (materials, techniques) must be in-depth and not just incidental or haphazard in the learning process (Skulmowski and Rey, 2018), since high physical involvement is linked to educational gains. However, it is necessary to recognize that there is a risk of cognitive overload and that not all students, or contexts, are prepared for a high level of interactivity.

The material knowledge acquired in educational contexts occurs subtly and implicitly, through embodied practices that articulate tacit and explicit forms of knowledge (Budge, 2016). Embodied learning takes place between the dynamic and reciprocal material dialog between the student and the active materials (Groth & Nimkulrat, 2025). This dialog highlights the central role of materials as active agents in the creative process, continuously guiding and influencing the development of students' thinking and actions, contributing to the construction of deep, tacit, and explicit knowledge that goes beyond superficial and merely technical educational approaches (Groth & Nimkulrat, 2025; Ingold, 2013).

3. Methodology

The methodology adopted for this study is qualitative, utilizing exploratory, unstructured interviews carried out through personal communication. Five professors and specialists from the fields of design and multimedia participated, all actively teaching in Portuguese higher education institutions (universities and polytechnics). Participants were selected based on their experience and recognition in the areas of digital design, typography, illustration, editorial design, and media arts, providing a comprehensive perspective on the role that digital and analog tools and processes literacy for visual communication design. The purpose of the interviews was to understand the participants' perceptions and experiences regarding the use of analog practices and their relationship with digital contexts in design education.

The interviews were conducted openly, facilitating a fluid and reflective conversation. Interviews were carried out via telephone during the first weeks of December 2024, and notes from the conversations were sent by email to all participants for validation of the discussed content.

Data analysis followed an interpretive approach, identifying common themes and patterns within the responses.

4. Results and discussion

The findings derived from this study highlight three central themes concerning the role of analog processes within contemporary design education: the intrinsic educational value of analog methodologies, the significance of error as a critical component of the learning process, and the advantages presented by adopting hybrid approaches that integrate analog and digital practices.

Firstly, analog methodologies emerge as exceptionally beneficial for fostering deeper, embodied experiences among students. An Associate Professor specializing in Digital Design and Typography articulated that the value of manual processes transcends the tangible results, emphasizing their importance in facilitating reflective practice, enhancing process awareness, and promoting meaningful experiential learning. The slower pace inherent in analog practices is advantageous, providing students the necessary temporal space for deeper internalization of techniques and conceptual thinking. Similarly, an Assistant Professor specializing in Illustration and Picture Books emphasized the effectiveness of initiating students' training with purely analog techniques, such as watercolor, charcoal, and inks. This methodological foundation proved crucial in enabling students to grasp essential principles like scale, dimension, and spatial relationships.

The second critical theme that emerged from the analysis is the educational significance of error within analog processes. Interviews underscored that mistakes and unforeseen outcomes are integral to analog methods, enhancing students' abilities to creatively respond to challenges. According to an Assistant Professor in Typography and Editorial Design, students engaging in digital processes often bypass valuable experimentation phases due to the immediacy and ease of correction provided by digital tools. This tendency was contrasted with analog approaches, where errors become explicit, tangible, and challenging to quickly rectify or ignore. Thus, students learn valuable lessons in resilience, patience, and adaptive problem-solving. This notion is supported by another Assistant Professor currently pursuing doctoral research in Digital Design, who pointed out that analog contexts inherently necessitate confronting and actively integrating mistakes into creative workflows, thereby significantly enriching the learning experience and fostering critical thinking.

Thirdly, the data illustrates substantial benefits arising from the strategic integration of analog and digital methods. Specialists across various design domains—including Digital Design, Typography, Illustration, and Media Arts—highlighted hybrid methodologies as a particularly effective educational

strategy. The rapid and productive capabilities of digital tools complement the reflective and explorative characteristics of analog methods, creating a balanced, inclusive, and comprehensive pedagogical model. One Assistant Professor in Audiovisual and Media Arts stressed that the combination of analog and digital practices enhances students' critical awareness, encouraging more intentional, thoughtful interactions with tools and materials. A balanced pedagogical model is particularly critical given the diversity of student interests and motivational profiles, ensuring inclusivity and broad relevance.

Furthermore, participants raised concerns regarding students' diminishing ability to perceive scale and dimension accurately when working solely in digital environments. An Assistant Professor noted how students frequently designed large-scale posters on smartphones without fully grasping the implications of their design choices due to limited visibility. Such digital limitations underscore the critical role analog practices play in grounding students' spatial and material understanding. Moreover, digital tools, despite their convenience, were criticized for potentially contributing to superficiality and reactive, rather than proactive, creative behaviors. Consequently, an Assistant Professor in Audiovisual and Media Arts recommended cultivating a more critical stance toward technological tools, emphasizing understanding and deconstructing digital workflows rather than merely using technology as an end.

The implications of these findings are significant for contemporary design education. Educators are encouraged to foster environments where analog practices are actively integrated into curricula, providing students with opportunities for meaningful material interactions and reflective practice. Acknowledging and valuing error as an inherent aspect of learning not only destigmatizes failure but also highlights its potential for pedagogical enrichment. Moreover, adopting hybrid analog-digital methodologies strategically cultivates versatile, critically reflective designers capable of adeptly navigating between traditional craft techniques and contemporary digital technologies.

5. Conclusion

Analog literacy within a predominantly digital educational context is a concept that warrants closer reflection. It is not simply about promoting tools or methodologies, but rather ways of promoting critical thinking and creation/design in educational contexts. Digital technologies are faster, more productive, and sometimes perceived as easier to handle. However, their use can be superficial, immediate, and insufficient regarding a critical and responsible understanding of creative processes and the achievement of outcomes. Conversely, analog technologies are slower, eminently sensory, fallible, and, precisely for these reasons, profoundly emotional and human.

The capacity to analyze, react, reflect, and incorporate error within the process and/or outcomes—or its absence—was a highlighted viewpoint shared by all interviewees. As emphasized in one of the interviews, in a digital context, it often appears that the deviations in the process itself have no place. Whereas in analog contexts, errors and accidents are considered essential components of the making and learning journey. Digital processes and technologies present themselves as immediately perfect, yet they diminish the opportunities for their users, particularly students, to explore and learn from their mistakes. In contrast, analog media involve procedural and tactile knowledge, based on direct interaction with materials. This approach demands time, dedication, and patience, enabling an embodied cognition of the properties and limitations of materials. Moreover, it encourages experimentation and the incorporation of error as an active part of the learning process.

Although there is no conclusive evidence that adopting more physical and analog processes or techniques, involving embodied learning, directly leads to improved educational performance, the literature and data gathered from interviews appear to confirm that the use of a minimal or moderate level—avoiding cognitive overload or facilitating its adoption by students—of analog approaches involving physical, sensory, and embodied manipulation of materials and tools in the design process appears to correlate with cognitive benefits and improvements in educational outcomes in design.

Integrating analog literacy into educational processes does not represent a nostalgic vision of the past; rather, it proposes a model that combines analog and digital media for a more comprehensive and responsible understanding of digital means and processes. This approach does not center on technology as an end in itself but rather on the human experience; it aims to achieve, promoting creativity, critical thinking, and a deeper understanding of materiality, facilitated by hybrid methodologies (analog-digital). The homogenization produced by digital conformism can be mitigated through analog literacy, promoting diversity, innovation, and a culture of reflective and critical practices.

Acknowledgments

I acknowledge the use of ChatGPT 4.0 (OpenAI, https://chat.openai.com) and Notebook LM (https://notebooklm.google.com) for text summarization and revision; Grammarly (https://www.grammarly.com) for text correction and plagiarism detection; DeepL Translator and Write

(https://www.deepl.com/en/translator) for translation and text review; QuillBot (https://quillbot.com) and Mendeley (https://www.mendeley.com) for bibliography and reference management.

References

Aicher, O. (2015). *Analogous and Digital* (2ª ed.). Ernst & Sohn.

Branco, J. M. (1972). *Inquietação* [Song]. On *Mudam-se os tempos, mudam-se as vontades* [Album]. Movieplay Portuguesa.

Budge, K. (2016). Teaching art and design: Communicating creative practice through embodied and tacit knowledge. *Arts and Humanities in Higher Education, 15*(3-4), 432-445. https://doi.org/10.1177/1474022215592247

Fischer, T. (2011). When is analog? When is digital? *Kybernetes, 40*(7/8), 1004-1014. https://doi.org/10.1108/03684921111160232

Grigg, J. (2020). Materials and tools as catalysts of invention in graphic design ideation. *Design Studies, 70*, 100960. https://doi.org/10.1016/j.destud.2020.100960

Grigg, J. (2022). Synergizing analog inquiry with digital tool use in graphic design ideation. *Dialectic, 4*(1). https://doi.org/10.3998/dialectic.14932326.0004.104

Groth, C., & Nimkulrat, N. (2025). Communicating embodied design knowledge: Towards an integrated conceptual framework. *International Journal of Design, 19*(1), 1-17.

Ingold, T. (2013). *Making: Anthropology, archaeology, art, and architecture*. Routledge. https://doi.org/10.4324/9780203559055

Knight, T., & Vardouli, T. (2015). Computational making. *Design Studies, 41*, 1-7. https://doi.org/10.1016/j.destud.2015.09.003

Johnson-Glenberg, M. C., Megowan-Romanowicz, C., Birchfield, D. A., & Savio-Ramos, C. (2016). Effects of Embodied Learning and Digital Platform on the Retention of Physics Content: Centripetal Force. *Frontiers in Psychology, 7*, 1819. Doi: 10.3389/fpsyg.2016.01819

OECD. (2023). *PISA 2022 Assessment and Analytical Framework*. Paris: OECD Publishing. https://doi.org/10.1787/dfe0bf9c-en

Olsen, D. (2024). *Media Arts Education: Transforming Education Through Multimodal Cognition, Holistic Learning, and Techno-embodiment*. Taylor & Francis.

Pereira, C. V. (2022). Ensino de Design Industrial de Produto ou de Equipamento: Hipóteses de um panorama atual, de desafios e de estratégias para o futuro. In A. Borges et al. (Eds.), *Towards a Design Observatory in Portugal: Models, Instruments, Representations and Strategies*. Faculty of Fine Arts of the University of Porto.

Pereira, P. (2024). *Quadratura do círculo* [Radio show]. Retrieved from https://tviplayer.iol.pt/programa/o-principio-da-incerteza/61967b8a0cf2cc58e7d3baee/video/671c29cc0cf2f130c299841e

Polanyi, M. (1966)**.** *The tacit dimension.* The University of Chicago Press.

Schrey, D. (2014). *Analog nostalgia and the aesthetics of digital remediation*, 27-38. https://doi.org/10.1057/9781137375889_2

Skulmowski, A., & Rey, G. D. (2018). Embodied learning: introducing a taxonomy based on bodily engagement and task integration. *Cognitive Research, 3*, 6. https://doi.org/10.1186/s41235-018-0092-9

Taylor, P. (2010). *The lo-fi phenomenon: Analogue versus digital in the creative process*. Future Places. Retrieved from https://futureplaces.org/essays/the-lo-fi-phenomenon-analogue-versus-digital-in-the-creative-process/

What you need to know about literacy. (2024, September 17). https://www.unesco.org/en/literacy/need-know

Yu, X., Inakage, M., & Ueki, A. (2021). *Aesthetic nostalgia mediated design for a long-distance relationship*, 1-5. https://dl.acm.org/doi/10.1145/3483529.3483745

Yu, G. (2020). Blended teaching strategies for art design major courses in colleges. *International Journal of Emerging Technologies in Learning (Ijet), 15*(24), 145. https://doi.org/10.3991/ijet.v15i24.19033

Zhou, Z., & Rognoli, V. (2019). Material Education in Design: from Literature Review to Rethinking. In N. Börekçi, D. Koçyıldırım, F. Korkut, & D. Jones (Eds.), *Insider Knowledge, DRS Learn X Design Conference 2019*, 9-12 July, Ankara, Turkey. https://doi.org/10.21606/learnxdesign.2019.17078

UNPACKING MOTIVATIONS BEHIND ABSENTEEISM IN HIGHER EDUCATION

Krista Sorri, & Pasi Hellsten
Information and Knowledge management, Tampere University (Finland)

Abstract

The past few years, especially after the Covid-19 pandemic, have challenged higher education in multiple ways globally. After two years of remote learning the students have, to a substantial extent, decided to skip in-class lectures. Research has shown that attendance in classes improves students' learning as it positively affects their learning habits and attitudes to learning, which are pre-requisites of academic achievement. While institutions could force the students to attend, it is not an effective way to increase student motivation and attending without motivation does not support learning. Therefore, it is important to understand which are the attendance-hindering factors, as well as how the institutions provide more motivating circumstances for the students. In this study, 43 Finnish masters' students of Information and Knowledge Management were asked to describe their reasons for absence and give suggestions, how to change the lectures to become more appealing. The main findings were that students were often already working and prioritized working over lectures. They also find three-hour lectures too long and especially exhausting later in the afternoon. It is noteworthy that over half of the students had more than two reasons for absence. The number of reasons varied from 0 to 5 reasons. Only one student had to skip one lecture due to being sick. The proposed improvement actions included e.g., splitting the lecture into two shorter ones, increasing discussion during classes, including case-based group discussions to the classes and giving points to increase the grade from each lecture attendance. Based on these results, compared to the time before pandemic, there is a clear change in student expectations and behavior. The concentration span of students has reduced. It can also be concluded that traditional lectures have seen their prime. Students expect to have active interaction during the learning events. The reasons behind the reduced concentration span could be studied further. Furthermore, it would be good to compare bachelor's student motivations to these results.

Keywords: *Higher education, on-/off-campus learning, lecture absenteeism.*

1. Introduction

The COVID-19 pandemic has brought about significant changes in higher education (HE), transforming how teachers teach, and students engage in teaching and how they learn. Rapid and global implementation of online and blended learning modes has addressed social distancing requirements and catered to the diverse needs of learners, including those in different geographical locations. From the students' perspective, smooth and flexible study opportunities are crucial to the quality of university operations (Tampere University (TAU), 2024). Teaching staff are responsible for supporting and enhancing students' engagement in studying, learning, and academic growth by employing varied teaching methods that consider the skills and abilities of diverse types of learners (Tampere University (TAU), 2025). Flexibility in education is increasingly seen as a core value, akin to diversity and equality (Naidu, 2018). The goal of flexible study opportunities is to ensure the smooth progression of all students' studies. Additionally, students appreciate courses that offer alternative study methods and teachers who consider different life situations and learning styles. But is this flexibility always for the good?

Remote learning has significantly increased flexibility in HE. Both students and teachers have identified flexibility as a major benefit of distance learning (Veletsianos and Houlden, 2019). Temporal flexibility allows recorded lectures to be accessed at any time, while spatial flexibility eliminates the need for physical travel to the classroom.

Simultaneously, remote learning requires more self-regulation from the students to manage the workload (Biwer et al., 2021; Díez-Pascual et al., 2025) reduces opportunities to peer-support and sense of belonging, which decreases the probability of graduating in their major (Cowit and Barker, 2023).

Although, the students appreciate the ability to combine work and studies, the flexibility of time and place, a recent study (Morales-Holguín and Mendoza-Morales, 2024) has demonstrated that students are more satisfied of synchronous in class learning event. Zhiling and Adkins (2022) support these findings by finding that students find the in-class teaching offering more peer-to-peer interaction, supporting active engagement to learning, and hindering procrastination, which enables them to complete even complex assignments.

Digital tools enable hybrid teaching, combining distance and contact methods, thus offering students the choice of how to attend lectures. The increased use of distance learning has also changed the value and meaning of lectures, challenging educators to make them more engaging and meaningful. Hybrid teaching reduces the temporal flexibility but when implemented successfully, it can offer possibilities to active peer-to-peer interaction, instantaneous feedback, and learning engagement (Wang et al., 2023; Zhiling and Adkins, 2022).

Gamvrelis and Timorabadi, (2022) found that online learning is hindered by technology as the discussion is not as fluent as in in-class learning events. In asynchronous remote class there is no interaction between students or students and the teacher, which can lead to misunderstandings but lessens the interactions and mutual learning to say the least.

From learning assessment point of view, the results vary. Various researchers have found that students generally have positive assessments of their distance learning experiences (Díez-Pascual et al., 2025; Gürler et al., 2020; Henckell, 2007). On the other hand, Leksuwankun and Vachatimanont (2024) have found that while the general level of assessment is similar, the remote asynchronous learners fail more often. Onyeaka et al. (2024) found that the assessed learning outcomes were equal but remote students had higher plagiarism index scores.

The above challenges in remote learning led us to questions, how could we increase the attendance rate of in class learning events without making those obligatory? What are the hindering factors for students attending the learning events? And, how to lower the barriers to attend?

2. Research setting

The data consists of 43 learning diaries of Finnish masters' students. The course in question is part of the advanced studies in Information and Knowledge Management, which the students are supposed to complete in the fourth year of their engineering studies. The course is based on lecturing and case discussions. The purpose of the case discussions is to enable students to reflect on what they have heard during the lectures and link the learning to real-life cases. The students who attended have found these discussions beneficial to their learning. The cases included e.g. finding solutions to scale a company's business through identifying potential novel business models and identifying new monetizable value from the business network.

The teachers recognized the benefits of attending the learning events. However, attending the learning events was optional as many of the masters' students in Finland are working alongside their studies. To support the attendance, students were offered points of attendance, which directly affected the course grade. This model has been found successful in other masters' courses. E.g., on Data project management -course students attended on average in four out of seven learning events (57%), only 5 (10%) students did not attend at all and 20% attended all learning events (10 students).

In this course there was one obligatory learning event, namely the final seminar. On average, students attended only two out of seven learning events (29%), 7 students (17%) did not attend any voluntary learning events and only one student attended all learning events (2%). Both courses are part of advanced studies in the same study program; hence the students are largely the same, one of the teachers is the same, all learning events are held in the afternoon. What causes the difference in attendance? While teachers were puzzled the only reasonable way to search for the answer was to ask from the students.

While the reasoning to skip a lecture was assumed to be complex, a qualitative interpretive approach was selected for this study. The students were asked to include in their learning diary a chapter, where they reflected the reasons why they attended or decided not to attend a lecture. The diaries were thematically coded and analyzed (Nowell et al., 2017).

3. Research results

As assumed the students had multiple reasons for not attending. On average a student had 1,7 reasons not to attend, the median being 1,9. One student found five distinct reasons not to attend. The most frequently mentioned reason was working or being otherwise busy (e.g. student society activities). This accounted for 28% of the mentions. While this was not a surprise, the second most frequently mentioned reason was. 23% of the students found a three-hour learning event to bee too long. Third most frequently

mentioned reason was the learning events were too late on the afternoon. They began at 2pm and ended at 5pm. Three next reasons were mentioned 5-6 times (7-8%). These were energy level, convenience, location of the student (lived hours away from the university) and prioritization between courses. Three students were completing their masters' thesis, two preferred to work alone, two found the lecture video to be a more effective way to learn and one found the subject boring.

Table 1. Summary of reasons of absenteeism.

Working or other non-study related prioritization	28 %
Lectures too long	23 %
Lectures end too late in the afternoon	16 %
Convenience, energy level	8 %
Student location	7 %
Prioritization between courses	7 %
Thesis work	4 %
Prefer working alone	3 %
Efficiency provided by the lecture videos	3 %
Boring subject	1 %

Fortunately, many of the most frequently mentioned reasons are "repairable". The university cannot affect students' work schedules, but it can affect the timing, length and structure of the learning event. The university can revise the timing of courses that are supposed to be completed during the same study year to be implemented at different times. This will, however, require increased coordination from the study services.

The students shared their improvement ideas, too. In total, the students gave 147 ideas for improvement. In total, 46 mentions (31%) included either more details in theory or additional assignments. For example, giving weekly assignments to be completed at home between the learning events and concrete proposals for additional subjects to be covered (e.g. how to plan to scale the business model, how to evaluate a business model and more about the business model maturity models). A sizable proportion was related to more detailed instructions and improving the Moodle-page, where the instructions were shared (25 mentions, 17% of all). Only five students (11%) would prefer a remote course, including remote team discussions or an interactive hybrid course implementation.

One of the ideas, which is probably easiest to implement is to send a weekly "learning event promotion"-message to the students. The message could include a concise summary of the subject to be covered and what the structure of the event is.

4. Conclusions

The world of higher education has been profoundly affected by both Covid-19 and digitalization. The students may seem to prefer remote learning as in some courses the attendance rate is low. However, while working is a major reason for absenteeism, there is only a small proportion of students who would like the courses to have remote implementations. The universities could increase the attendance rate through shortening but adding the number of the learning events from three hours to e.g., two hours, avoid scheduling them after 4 pm and promoting the learning events beforehand to explain why each of the events is important from a learning point of view.

The study also finds that the students would like to have clear instructions and weekly assignments to support their learning. Teachers may think that students in higher education are self-governing but based on our results they need more support in scheduling their learning assignments. While during the past decade the learning assessment in HE has transformed from exams to more applied problem solving. This challenges the young students as still in high school the assessment is largely done through exams. On the other hand, it also offers a possibility to learn through interaction, which is seen as an expectation from the present-day students.

Thirdly, the study finds that the students are not afraid of working hard. They want to learn more even if it requires more assignments. Teachers might want to consider more structured implementation with more assignments.

This study has its limitations. The study was conducted only on one masters' course. The conclusions would benefit from reproducing the study on multiple courses in different majors and in bachelors' courses, too. The reproduced studies would also benefit the reliability of the results. Furthermore, it would be interesting to understand in detail why the three-hour lecture is too long for the current students. It has been a de facto length of a lecture for ages. It can be that the concentration span has shortened or that the students feel more comfortable saying their views when asked. Understanding the de-motivating and motivating factors of students could help the higher education institutions to bring forth more capable and skilled experts for our society.

References

Biwer, F., Wiradhany, W., oude Egbrink, M., Hospers, H., Wasenitz, S., Jansen, W., & de Bruin, A. (2021). Changes and Adaptations: How University Students Self-Regulate Their Online Learning During the COVID-19 Pandemic. *Frontiers in Psychology, 12*. https://doi.org/10.3389/fpsyg.2021.642593

Cowit, N. Q., & Barker, L. (2023). How do Teaching Practices and Use of Software Features Relate to Computer Science Student Belonging in Synchronous Remote Learning Environments? In *Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 1, SIGCSE 2023* (pp. 771-777). https://doi.org/10.1145/3545945.3569876

Díez-Pascual, A. M., García-Díaz, P., Peña-Capilla, R., & Jurado-Sanchez, B. (2025). Face-to-face vs. online learning in science and engineering courses during covid-19 epoch. *Research in Science & Technological Education, 43*, 347-376. https://doi.org/10.1080/02635143.2023.2275136

Gamvrelis, T., & Timorabadi, H. S. (2022). Challenges with Online Teaching and Learnings for the Post-Pandemic Classroom. *Proceedings of the ASEE Annual Conference & Exposition* (pp. 1-20).

Gürler, C., Uslu, T., & Daştan, İ. (2020). Evaluation of distance learning from student perspective in Covid-19 pandemic. Atatürk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 24, 1895-1904.

Henckell, M. M. (2007). *Evaluating distance education: The student perspective*. Citeseer.

Leksuwankun, S., & Vachatimanont, S. (2024). Assessing the feasibility and outcomes of asynchronous and synchronous learning in nuclear medicine for medical students. *Iranian Journal of Nuclear Medicine, 32*, 175-182. https://doi.org/10.22034/irjnm.2024.129530.1604

Morales-Holguín, A., & Mendoza-Morales, G. (2024). University Learning Experience Between Physical and Virtual Environments, an Analysis from the Post-pandemic Context. In F. J. García-Peñalvo, M. L. Sein-Echaluce, & Á. Fidalgo-Blanco (Eds.), *Innovation and Technologies for the Digital Transformation of Education: European and Latin American Perspectives* (pp. 357-364). Singapore: Springer Nature. https://doi.org/10.1007/978-981-97-2468-0_35

Naidu, S. (2018). How flexible is flexible learning, who is to decide and what are its implications? *Distance Education, 38*, 1-4.

Nowell, L. S., Norris, J. M., White, D.E., Moules, N. J. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *International Journal of Qualitative Methods, 16*, 1609406917733847. https://doi.org/10.1177/1609406917733847

Onyeaka, H., Passaretti, P., & Miller-Friedmann, J. (2024). Teaching in a pandemic: a comparative evaluation of online vs. face-to-face student outcome gains. *Discover Education, 3*. https://doi.org/10.1007/s44217-024-00140-8

Tampere University (TAU) (2025). *Guidelines for academic ethics and procedures for handling allegations of misconduct at Tampere University* [WWW Document]. https://intra.tuni.fi/en/studying/studying-0/academic-integrity-and-study-regulations/guidelines-academic-ethics-and-procedures-handling-allegations-misconduct-tampere-university

Tampere University (TAU) (2024). *Education strategy of the Tampere university community* [WWW Document]. https://content-webapi.tuni.fi/proxy/public/2019-04/education_strategy_of_the_tampere_university_community.pdf

Veletsianos, G., & Houlden, S. (2019). An analysis of flexible learning and flexibility over the last 40 years of *Distance Education*. *Distance Education, 40*(4), 454-468. https://doi.org/10.1080/01587919.2019.1681893

Wang, H.-C., Maslim, M., & Kan, C.-H. (2023). A question–answer generation system for an asynchronous distance learning platform. *Education and Information Technologies, 28,* 12059-12088.

Zhiling, C. T. U., & Adkins, J. (2022). Comparing Students' Evaluation of Online, Hybrid, and Face-to-Face Classes. *Proceedings of the 13th International Conference on Society and Information Technologies: ICSIT* (pp. 97-100). https://doi.org/10.54808/ICSIT2022.01.97

MATH AND MAKING FOR MIDDLE SCHOOL YOUTH: A LONGITUDINAL SINGLE-CASE STUDY

Elise Levin-Güracar[1], Nuria Jaumot-Pascual[1], Teresa Lara-Meloy[1], & Jad Eways[2]
[1]TERC, Inc. (USA)
[2]Cesar Chavez Foundation (USA)

Abstract

In AMPED 4 Making, middle school youth engaged in design-and-making projects that address community goals aiming for changes in youth's relationship with mathematics and making. In each project, youth used mathematics to design, prototype, or build meaningful and useful artifacts. Part of AMPED 4 relies on the life and values of Cesar Chavez as a touchstone for Latinx youth's positive identity. AMPED 4 Making sought to understand how the program supported the development of positive math and making identities among participating youth. This longitudinal single-case study uses object elicitation data to show the changes in math and making identities that Rose experienced over the course of her participation in AMPED 4 Making over two school years. Object elicitation is a data collection method that centers the youth interview around an object that youth made in the program. Since the objects were created by the youth, the objects embody the youth's knowledge, skills, and attitudes. The findings in this longitudinal single-case study show that AMPED 4 Making provided Rose with opportunities to engage in consequential math and making for communities, supporting her development of a positive identity as a maker and math user.

Keywords: *Longitudinal single-case study, object elicitation, out-of-school learning, hands-on learning, STEM.*

1. Introduction

In AMPED 4 Making, middle school youth engaged in design-and-making projects that addressed community goals aiming to strengthen and improve youth's relationship with mathematics. Guided by an afterschool facilitator, in each project, youth used mathematics to design, prototype, or build meaningful and useful artifacts.

AMPED 4 Making was a research and curriculum design program designed by TERC and the Cesar Chavez Foundation (CCF) to serve Latinx youth across agricultural areas in the Southwest and California, USA. TERC is a nonprofit organization located in Cambridge, Massachusetts, U.S., that focuses on STEM education research, evaluation, and curriculum design. CCF's mission is to uplift the lives of Latinos through social enterprises. The curriculum design component included designing four semester units of making activities with pre and post assessments. The purpose of the research component was to understand the math content and practices youth learned through the program, and how youth agency and identity developed through participation. The program provided training to facilitators around math and making through hands-on making and modeling of math conversations. AMPED 4 Making ran at seven sites that served majority Latinx youth, including many multilingual learners and youth on free and reduced-price lunch programs. Generally, the program met once per week at each site.

Each semester of AMPED 4 Making focused on a different level of community: family, after-school club, school, and the larger community. This case study centers on Rose, a middle school student during her participation as a 7th and 8th grader. In the first year of Rose's participation, the program was focused on making related to family and classroom community and in the second year it was focused on making for the school community. In the first year, Rose made a muffin stuffie that represented her family and cubbies for the classroom for program materials. In the second year, Rose worked with peers to make a large planter for the school community.

2. Theoretical framework and literature review

This work is framed by the life and work of Cesar Chavez, using his values as a touchstone for rural Latinx youth's positive identity and agency, which is in line with research on programs that successfully meet goals of encouraging cultural knowledge while addressing academic content (Riggs et al., 2010). Cesar Chavez viewed education as a pathway to freedom; he believed, *"Students must have initiative; they should not be mere imitators. They must learn to think and act for themselves—and be free"* (United Farm Workers, n.d.). Freedom through this lens would be attained through youth agency (Zavala, 2014). Further, AMPED 4 Making's focus on community action aligns with Chavez's vision of community development: *"It is not enough to progress as individuals while our friends and neighbors are left behind"* (Chavez, 1991). Through this lens, AMPED 4 Making strove to engage youth in a blend of design and making in and for the community—consequential making (Barton & Tan, 2018)—to enhance and develop youth's agency and positive identity, as makers, mathematical doers and users, and community members. Further, AMPED 4 Making was structured to engage students in grade-appropriate mathematics, such as the volume and surface area of geometric shapes, within the context of informal learning projects.

AMPED 4 Making addressed youth's development of **agency and identity in mathematics, making, and community membership**. Martin defined mathematical identity as encompassing "a person's self-understanding … in the context of doing mathematics (i.e., usually a choice between a competent performer … or an incompetent, … but *often flowing back and forth)"* (2006, p. 206–207). More recently, Goff et al. (2020) unpacked identity as a cluster of "aspirations, interest, engagement, and perceived competence" (p. 276). Maker identity parallels mathematical identity. Maker identity consists of initiative and intentionality, conceptual understanding, problem solving and critical thinking, creativity and self-expression, social and emotional engagement (Bevan et al., 2020). While little has been written about the influence of maker identity specifically on *mathematics* identity, we take guidance from research addressing equity focused on STEM identity (Carlone & Johnson, 2007; Tan et al., 2013) and making (Tucker-Raymond, 2019) to study the relationship between the two. Our project engages Goff et al.'s definition of math identity and aims to develop it through deep mathematical understanding and hands-on learning through making. AMPED 4 Making is premised on the idea that everyday and community mathematics support learning school math with conceptual understanding.

3. Research design and methods

This longitudinal single-case study (Yin, 2003) explains the changes experienced by Rose over the course of her participation in AMPED 4 Making over two school years (2022-2023 and 2023-2024). We detail the changes in how Rose expressed her ideas and learning in two areas: maker identity and connections between making and math through two end-of-year object elicitation interviews (May 2023 and May 2024). In the first interview, Rose showcased a stuffie and connectors for the cardboard cubbies she was making. Later, in the second interview, Rose showcased a planter box.

3.1. Data collection and data analysis methods

AMPED 4 Making's data collection methods included a youth survey, a math learning assessment, interviews with facilitators, weekly facilitator feedback, and object elicitation interviews or focus groups with the youth. This longitudinal single-case study is exclusively based on the data and analysis of Rose's object elicitation focus groups. Object elicitation is a data collection method that centers the youth interview around an object that youth made in the program (Levin-Güracar et al., 2024). Since the objects were created by the youth, the objects embody the youth's knowledge, skills, and attitudes and make interviews easier by shifting the focus of attention from the interviewer-interviewee dyad to the object. This type of interview elicits richer information than regular interviews because images and objects facilitate recalling processes and memories in more detail (Harper, 2002).

The team used deductive coding to analyze the object elicitation data (Saldaña, 2003). Deductive coding is a top-down approach where the team develops codes from pre-existing knowledge, such as theory or a program's research questions, and uses those codes to identify excerpts in the data that fit those codes. In this study, we developed deductive codes based on the study's research questions.

3.2. Description of participants

Rose was one of over 200 middle school youth across California participating in AMPED 4 Making. She participated in the program for two semesters, in 2023 when she was in 7th grade and in 2024 when she was in 8th grade at a public middle school in the Central Valley of California, U.S. Rose was a female student who identified as Mexican, Native, and white and was part of object elicitation focus groups at the end of each year of her participation.

This longitudinal single-case study responds to two of the project's research questions that focus on Rose's development both in terms of her math learning and her identity as a maker:

- What math content and practices did Rose learn through participation in AMPED 4 Making?
- How did Rose's agency and identity as a maker, mathematics doer and user, and community member change with participation in AMPED 4 Making?

4. Findings

Based on the object elicitation focus groups that Rose participated in, the team identified growth in her ability to describe the math she used related to the projects, and an ability to discuss her making process more in depth.

4.1. Maker identity

As described earlier, maker identity includes initiative and intentionality, conceptual understanding, problem solving and critical thinking, creativity and self-expression, social and emotional engagement (Bevan et al., 2020). The comparison of Rose's two object elicitation interviews showed that she experienced changes in her maker identity from one year to the next thanks to her participation in the program.

In the first year, she shared that she went into the program knowing how to sew but didn't help anyone because no one asked. Rose did not demonstrate initiative or collaboration with peers related to sewing. In the second year, Rose explained how she worked with others in the program and how each of them took on their own roles, demonstrating increased social engagement.

In both object elicitations, Rose connected what she made to the community themes of the program, particularly family, school, and the larger community. She was able to describe the purpose of the item that she made and how it related to the community level she was making it for. Additionally, by the second interview Rose was more articulate when discussing the steps of her making process, going into detail about the prototype they created, showing increased conceptual understanding and problem solving. In both years, Rose was able to connect her making to the level of community intended by the project.

In the first year, Rose talked about how her muffin stuffie reflected her family as a community. She created this stuffie because baking is an activity that her family enjoyed engaging in together:

> *"[I made a muffin] because me and my family like to bake. One of the things we bake a lot is mostly cupcakes and cake … I showed this to my mom."*

Rose used her creativity and self-expression to respond to the making prompt, creating an object that embodied something meaningful about herself and her family. In addition, baking itself was a making skill that Rose already had, a fact she shared with her peers.

In the second round of data collection, Rose participated in a focus group with two youth who worked with her throughout the semester to create a raised garden box for the school. When talking about what she wanted to plant in these raised garden boxes, Rose said that she would like to put in flowers to make the school prettier:

> *"I'm pretty sure we're going to put flowers in these ones … Just to make the school more nice."*

Rose was thinking of her community in terms of providing a pleasurable environment for those in the school. Later in the interview, she also suggested that aloe vera would be useful to plant because of its medicinal properties:

> *"I was thinking we could put aloe vera because aloe vera can be used if a student has a burned sun or something."*

Here, Rose was thinking about helping her community, both in terms of beautifying the school, and more deeply about providing a solution for those at the school who might get hurt. Rose was thinking about how to use her newly developed skills to give back to her school community through beautification and providing a plant that can be useful. This shows that her maker identity developed to engage deeper social and emotional engagement.

4.2. Connections between making and math identity

As explained earlier, Goff et al. (2020) defined identity as a cluster of "aspirations, interest, engagement, and perceived competence" (p. 276). This section shows the dramatic changes that Rose experienced in her math identity through her engagement in making through AMPED 4 Making.

In her first object elicitation, Rose was not able to explicitly describe the math she used in her making of projects such the stuffie and the connectors for the cubbies, and did not conceptualize

measurement as being math. However, the second-year interview revealed a very different understanding of math. Rose articulated how she used measurement and other math concepts in her making of the planters. This difference demonstrates a change in Rose's understanding of what math is, and how it relates to making.

As a part of the object elicitation focus groups in both years, Rose was asked what math she used while in the program. The first year, Rose shook her head in disagreement when asked about math. Although math was intentionally woven into the AMPED 4 Making projects, Rose may not have been aware of it because it was not always made explicit and was not presented in the same way she typically experienced it in school (i.e., in worksheets). In the first interview, Rose did not express high interest or engagement when asked about the math related to the program, hinting that she had yet to make connections between her making and math.

In the second-year interview when the interviewer asked about her use of math, Rose said "*Oh, yeah!*" and went on to explain in detail math concepts that she used to measure wood beams while making the raised planter box.

> *"So, the full board was 72 inches, then we divided by 4 so we could use the tape measure. So, if you lay the tape measure all the way out you could make the 4 marks."*

Rose demonstrated her interest in and engagement with math by fluently describing her math use in her making. Further, she demonstrated confidence through her clear description of measurement and a creative way to measure the pieces of wood for the planter at once.

In addition to explaining the measurement used in the raised planter, Rose also explained that they were learning about volume both with the project and in school math. In this second interview she clearly and fluently discussed the math that was present in the making activity and connected it to math she was engaged in outside of the program. By the end of her second year in the program, Rose demonstrated a stronger math identity and was able to connect it with her maker identity through the project she created.

5. Conclusion

The findings in this single-case study show that AMPED 4 Making provided Rose with opportunities to engage in consequential math and making for communities (Barton & Tan, 2018). Through these opportunities, Rose was able to make connections and develop positive identities in math and making (Bevan et al., 2020; Goff et al., 2020; Martin, 2006). The growth Rose experienced in AMPED 4 Making shows that bringing together math and making in informal learning environments supports math skills development and an understanding of the relevance of making skills.

Acknowledgments

The current article and presentation are based upon work partially supported by the National Science Foundation (NSF-AISL #2215382). Any opinions, findings, and conclusions or recommendations expressed here are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. We would like to thank Rose for her participation in the program and data collection, and for sharing her insights with the team. Additionally, we would like to thank Vanessa Galeana, who as a summer intern at TERC through the REU program (NSF #2150364) began data analysis for this longitudinal single-case study.

References

Barton, A. C., & Tan, E. (2018). *STEM-rich maker learning: Designing for equity with youth of color*. Teachers College Press.

Bevan, B., Ryoo, J. J., Vanderwerff, A., & Wilkinson, K. (2020). "I see students differently": Following the lead of maker educators in defining what counts as learning. *Frontiers in Education, 5*, 121.

Carlone, H., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 44*(8), 1187-1218.

Chavez, C. (1991). *Remarks from Dedication Ceremony of Cesar Chavez Elementary School in Coachella, CA.*

Goff, E. E., Mulvey, K. L., Irvin, M. J., & Hartstone-Rose, A. (2020). The effects of prior informal science and math experiences on undergraduate STEM identity, *Research in Science & Technological Education*, *38*(3), 272-288.

Harper, D. (2002). Talking about pictures: A case for photo elicitation. *Visual studies, 17*(1), 13-26.

Levin-Güracar, E., Jaumot-Pascual, N., Rafanan, K., Lara-Meloy, T., Eways, J., & Mitchell, I. (2024, September 28–October 1). Object elicitation interviews: Engaging youth in conversations about their STEM learning through making [Conference presentation]. *ASTC Annual Conference*, Chicago, IL, United States.

Martin, D. B. (2006). Mathematics learning and participation as racialized forms of experience: African American parents speak on the struggle for mathematics literacy. *Mathematical Thinking and Learning*, *8*(3), 197-229.

Riggs, N. R., Bohnert, A. M., Guzman, M. D., & Davidson, D. (2010). Examining the potential of community-based after-school programs for Latino youth. *American Journal of Community Psychology*, *45*(3), 417-429.

Saldaña, J. (2003). *Longitudinal qualitative research: Analyzing change through time.* AltaMira Press.

Tucker-Raymond, E. (2019). *Principles for equity-centered design of STEAM learning-through-making*. https://circlcenter.org/wp-content/uploads/2019/10/Castek-STEAM-Learning-Making-Whitepaper.pdf

United Farm Workers. (n.d.). *Education of the heart. Cesar Chavez in his own words.* https://ufw.org/research/history/education-heart-cesar-chavez-words

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Sage Publications.

Zavala, M. (2014). Latina/o youth's perspectives on race, language, and learning mathematics. *Journal of Urban Mathematics Education, 7*(1).

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

WILLIAM SHAKESPEARE'S *HAMLET* (c. 1600): A DIDACTIC APPROACH THROUGH AN ESCAPE ROOM ACTIVITY

Germán Asensio Peral, & Ángeles Jordán Soriano
Department of Philology, University of Almería (Spain)

Abstract

The tragedy *Hamlet* (c. 1600) is one of William Shakespeare's most widely studied and researched plays in its exploration of themes of political intrigue, revenge, existential doubt, and the nature of madness. Deeply entrenched in the intellectual and cultural context of the English Renaissance, the play reflects anxieties about power, succession, and human mortality, while simultaneously showcasing the complexities of Shakespearean language and dramaturgy. To enhance students' engagement with *Hamlet* as part of a bachelor's degree course on 16th-century Renaissance Literature, an Escape Room activity was designed as a complementary session to the study of the play. The activity required students to work in small teams to solve a series of interrelated challenges located around the campus of the University of Almería (Spain). These tasks included deciphering excerpts from the text, identifying key historical influences (such as Renaissance humanism and the Elizabethan worldview), and uncovering the thematic core of the play's dramatic structure. The objective was to facilitate a deeper, more interactive exploration of *Hamlet* while promoting critical thinking and collaborative learning on the part of our students. To assess the impact of this methodology, students completed pre- and post-activity surveys measuring their comprehension of the play's historical and literary context, as well as their previous engagement with the material. The findings suggest that integrating gamification into the study of early modern drama not only improves retention of key concepts and themes but also fosters a more dynamic and participatory classroom environment in a course which has traditionally been perceived as dense content-wise, as well as linguistically challenging. This paper will outline the design and implementation of the Escape Room activity, analyze its effectiveness in meeting major and minor curricular objectives, and discuss its potential for broader applications in literature education.

Keywords: *William Shakespeare, Hamlet, escape room, 16th-century English literature, higher education.*

1. Introduction

This report compares student responses collected before and after participating in an educational Escape Room activity inspired by Shakespeare's *Hamlet*. The activity was titled "Something is rotten in the state of Denmark" and it took place as part of the curricular objectives of the course 16th-Century English Renaissance Literature (Literatura Inglesa del Renacimiento: Siglo XVI), course code 31104221, inscribed in the fourth year of the English Studies degree (fifth year for Double Degree in English Studies and Spanish Philology) curriculum. The purpose of the pre-activity questionnaire was to assess students' baseline knowledge, interpretive challenges, and attitudes toward innovative teaching. The post-activity survey measured perceptions of the activity's relevance, execution, and pedagogical impact. Together, these instruments provide insights into how gamified learning strategies can enrich literary education amidst rising interest in gamification as a pedagogical strategy.

2. Theoretical framework and literature review

In recent years, active learning methodologies have gained significant traction in higher education, particularly in the humanities, where traditional lecture-based models often dominate. Active learning emphasizes student-centered approaches that promote participation, critical thinking, and deeper cognitive engagement. Among these, gamification—the integration of game elements into non-game contexts—has emerged as a particularly effective tool for increasing motivation and involvement (Santamaría and Alcalde 2019). Gamification leverages elements such as goals, feedback, time constraints, and narrative immersion to transform passive learners into active participants, and this has been posited as a possible solution to lack

of engagement on the part of students (Cronk, 2012; Deterding, 2012; Stott and Neustaedter, 2013). In literature classrooms, it offers a means to revitalize canonical texts by situating students within meaningful, often collaborative tasks that require both interpretive and contextual thinking. One form of gamification gaining popularity in educational settings is the Escape Room, a team-based, problem-solving game where participants solve clues to "escape" a fictional scenario (Wood & Reiners, 2012). In educational contexts, escape rooms have been shown to enhance engagement, encourage collaboration, and foster content retention (Dorado Escribano, 2019; López Secanell & Ortega Torres, 2020; Armie & Membrive, 2022, 2025). Their narrative structure aligns particularly well with literary studies, allowing students to experience story elements interactively and deepen their understanding of plot, character, and historical context (Armie, Fernández, and Membrive, 2021, 2022). Applied to Shakespeare's *Hamlet,* a literary Escape Room can bridge the gap between early modern texts and contemporary learners by transforming complex content into an immersive, experiential learning challenge. This study builds on this pedagogical model to assess how gamified learning affects student comprehension, engagement, and appreciation for contextual knowledge.

3. Methodology and materials

3.1. Description of participants

The participants in this study were university students enrolled in the course 16th-Century English Renaissance Literature", part of the Degree in English Studies and Double Degree in English Studies and Spanish Philology on offer at the University of Almería. Specifically, the activity was implemented with 47 students in the fourth year of the English Studies degree and fifth-year students from the Double Degree in English Studies and Spanish Philology. Of these, 64.8% identified as female and 35.2% identified as male, aged 21-23. These students had prior academic exposure to literary analysis and historical contexts, making them suitable for a content-based gamified activity. Students were arranged in a total of eight teams made up of six students per team, except for two teams, which were made up of five students.

3.2. Structure of the Escape Room

The Escape Room, titled "Something is Rotten in the State of Denmark", was designed as a collaborative and immersive educational activity based on William Shakespeare's *Hamlet*.

3.2.1. Format. The activity consisted of a series of puzzles and challenges that required participants to solve literary, historical, and interpretive tasks in groups. These were adapted to the plot of *Hamlet* and required synthesizing information from class content and additional resources. A total of eight stations strategically and thematically located around campus were created, all of which contained a scannable QR code redirecting students to the task hosted in the Escape Room website. Upon successfully completing the html-based riddles (word searches, crosswords, and fill-in-the-gaps, among others) in each station, the students received a numerical clue which, added to the other numerical clues obtained in the remaining stations, they needed to translate into letters using a cypher (a=1, b=2, c=3, and so on) to then complete the anagram that would solve the mystery of the murder of Prince Hamlet.

3.2.2. Location. The Escape Room was implemented within a 0.5 km radius on the university campus, using various locations to simulate settings from Shakespeare's *Hamlet*. For example, the university gym was used for a task related to Laertes, symbolizing his physical strength, while a pond with water lilies represented Ophelia's scene. The students were asked whether they had any physical disabilities impeding their participation in the activity. There were no recorded disabilities and the activity was carried out as originally devised. All students convened in their usual classroom (Classroom 01, Faculty of Humanities), which was used as the activity's headquarters. After solving one of the riddles, students had to return to headquarters to receive another clue pointing them in another direction. Both the opening and the closing ceremony of the activity took place in Classroom 01.

3.3. Assessments of motivation and performance

The improvement in students' motivation and academic performance in their literature class following the implementation of the Escape Room was assessed through two questionnaires sent to the participants. One questionnaire was distributed prior to the activity and the other afterwards. Both were created using *Google Forms* and included Likert-scale items focused on four main areas: contextual knowledge, interpretive challenges, enjoyment, and perceived educational value. In the following section, we present a quantitative analysis of the data collected (see appendix). They have been analysed by combining *Google Sheets* and *ChatGPT*.

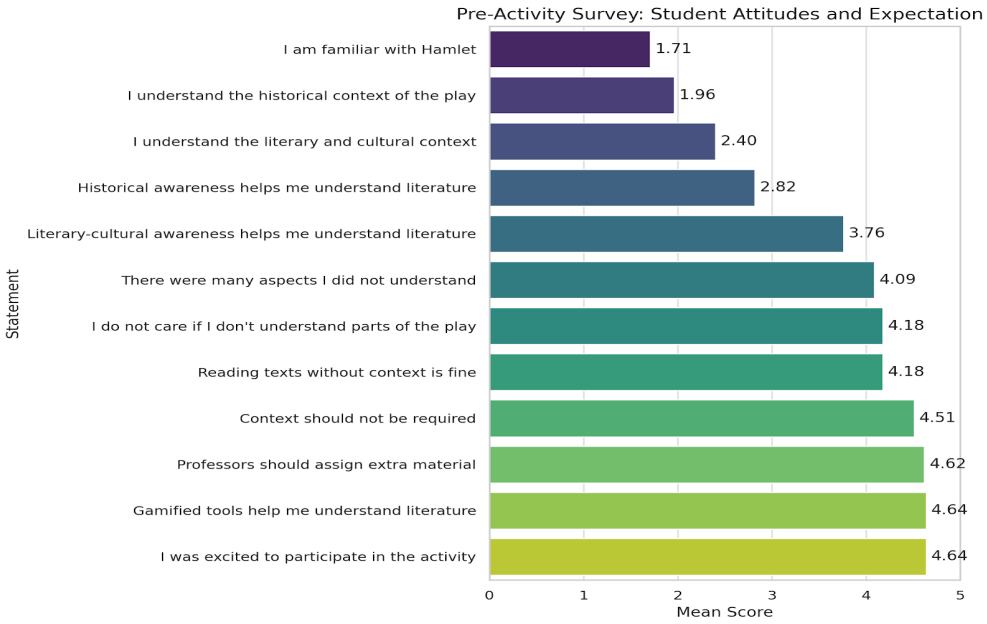
p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

4. Analysis

4.1. Prior knowledge and attitudes (pre-activity)

Students entered the activity with strong prior knowledge and a thoughtful approach to literary interpretation. A majority had read *Hamlet* in full (mean score: 4.56/5) and rated their familiarity with both the historical (4.18) and literary-cultural contexts (4.09) quite highly. More significantly, they believed that these contextual elements greatly enhance textual comprehension, assigning particularly high importance to literary-cultural awareness (4.64).

Figure 1. Pre-Activity Survey: Student Attitudes and Expectations.



Despite their confidence, students acknowledged certain interpretive barriers. The statement "There were many historical or cultural aspects I did not understand when reading *Hamlet*" received a moderate rating (2.82), suggesting students were aware of some knowledge gaps. Yet they rejected a dismissive stance toward these difficulties—scoring just 1.96 on "I do not care much if there are aspects I do not understand." This indicates a responsible attitude toward textual interpretation and a willingness to engage with complexity.

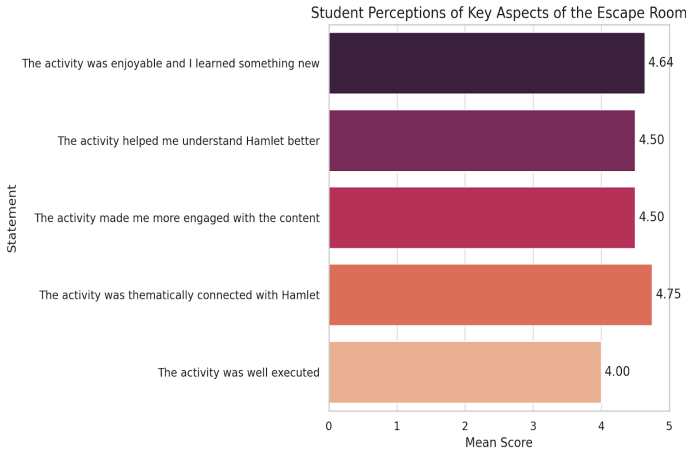
Furthermore, students disagreed with the idea that early modern texts can or should be read without context, with scores of 2.40 and 1.71 on statements rejecting the value of contextual information. These attitudes suggest that the student group already valued depth, historical framing, and critical inquiry prior to the activity.

Lastly, they expressed openness to both independent learning (3.76) and gamified pedagogy. When asked whether tools like Escape Rooms could enhance literary comprehension, students gave a strong endorsement (4.62). Their enthusiasm for the upcoming activity—"Something is Rotten in the State of Denmark"—was even stronger (4.64).

4.2. Post-activity reflections and perceived impact

The post-activity survey confirmed that the Escape Room met or exceeded students' expectations. The thematic connection between the activity and *Hamlet* was rated extremely highly (4.75), indicating that the narrative and puzzles were perceived as relevant and meaningful. In terms of educational outcomes, students found that gamification enhanced both their comprehension (4.50) and engagement (4.50). These scores aligned closely with pre-activity expectations, demonstrating that the activity fulfilled its pedagogical promise.

Figure 2. Student Perceptions of Key Aspects of the Escape Room.

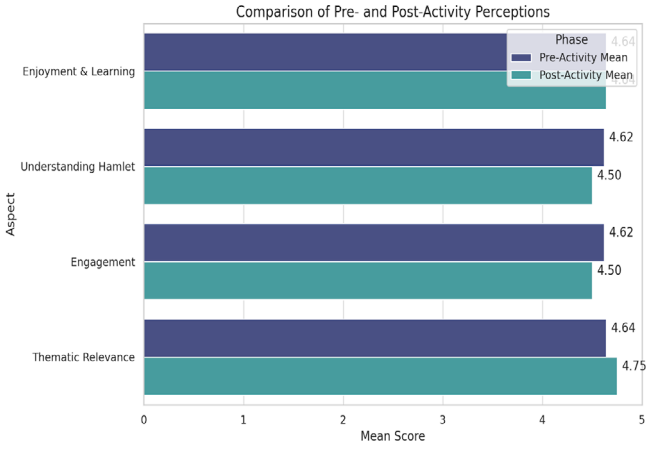


When asked about overall enjoyment and perceived learning value, students again responded positively (4.64), suggesting the experience was not only fun but also academically worthwhile. Execution of the activity was rated as solid (4.00), and the evaluation system—awarding one point for participation—was considered fair (4.18).

4.3. Comparative insights

The comparison between pre- and post-activity responses reveals alignment between expectations and outcomes. Students began the activity with a strong knowledge base and a receptive attitude toward contextual learning and innovative methods. Post-activity results suggest that the Escape Room succeeded in deepening their appreciation of *Hamlet*, reinforcing the importance of historical and literary-cultural understanding, and enhancing engagement through interactivity and play.

Figure 3. Comparison of Pre- and Post- Activity Perceptions.



The continuity between high pre- and post-activity scores on items related to gamification, thematic relevance, and learning benefits validates the Escape Room as a viable educational tool. The activity served not merely as entertainment but as a meaningful bridge between classical literature and modern pedagogy.

5. Discussion

Through indirect observation throughout the course, it has been noted that students have, on average, demonstrated ample interest in Shakespeare's play. Lectures have been conducted following a two-tier model: on the one hand, theory lectures in which the students were taught aspects related to the play's historical and literary context, intertextual and intratextual references, main topics and themes, and symbolism. On the other hand, seminars have been structured in a book club-like manner, with students being able to offer their views on different fragments and sections of the play and debate these thoughts with other students. In designing this Escape Room activity, it was our intention to ensure that this theoretical and practical engagement was sustained and materialised through a gamified activity in which

their knowledge about the play could be tested and enhanced. One of the most valuable outcomes of the activity was the reinforcement of student agency and interpretive responsibility. Unlike traditional assessments where meaning is often seen as fixed or instructor-led, the Escape Room placed students in the position of literary detectives. They had to make connections between scenes, interpret metaphorical language, and decide how to apply textual evidence to solve thematic and character-based challenges. This dynamic empowered students to trust their own readings of the text and to defend their interpretations collaboratively—practices that are essential to the study of literature at a university level.

The implications for teaching canonical literature through active learning are significant. *Hamlet*, like many classic texts, can be intimidating or abstract for students when confined to lecture-based formats. However, this activity demonstrated that active learning strategies, especially those involving narrative-driven, problem-solving tasks, can revitalize student engagement with the canon. They make space for exploration, dialogue, and creative thinking while remaining grounded in rigorous academic content.

6. Conclusions

The present research demonstrates that Escape Rooms, as a form of gamification, can be an effective tool for enhancing student motivation, performance, and collaborative work in the context of literature education. As part of active learning methodologies, this approach encourages narrative immersion, transforming students from passive recipients of information into engaged and active participants. The design based on *Hamlet* successfully connected literary content with creative problem-solving, giving rise to deeper contextual understanding and greater motivation for course material.

The data collected from pre- and post-activity questionnaires show a high level of student interest in this type of activity, with expectations being met or exceeded after the Escape Room experience. Students reported increased enjoyment, perceived educational value, and improved interpretive confidence. These findings suggest that gamified activities like this one represent a powerful and adaptable pedagogical tool for teaching literature at the university level. As such, Escape Rooms can be considered a valuable resource to complement traditional instruction and promote meaningful learning in higher education settings.

Acknowledgments

The research of this paper was carried out as part of the objectives of Teaching Innovation Project 24_25_1_74C, funded by the University of Almería, Teaching Innovation Division, Research Group HUM-807 (LINDISFARNE) and (Centro de Investigación, Comunicación y Sociedad).

References

Armie, M., Fernández Sánchez, J. F., & Membrive, V. (2021). Escape Room as a Motivating Tool in the English Literature Classroom at Tertiary Education. *Education and New Developments 2021* (pp. 270-274).

Armie, M., Fernández Sánchez, J. F., & Membrive, V. (2022). Working with Digital Escape Rooms: Adding Value to the Teaching of Literature. *Education and New Developments 2022* (pp. 231-240).

Armie, M., & Membrive, V, (Eds.) (2022). *Escaping Boredom in the Classroom: Breakouts, Breakout Boxes and Escape Rooms.* Cambridge Scholars Publishing.

Membrive, V., & Armie, M. (2025). *Escape Rooms as a Motivating Tool in the English Literature Classroom in Secondary Education.* Cambridge Scholars Publishing.

Cronk, M. (2012). Using Gamification to Increase Student Engagement and Participation in Class Discussion. *EdMedia+: Innovate Learning Association for the Advancement of Computing in Education (AACE)* (pp. 311-315).

Deterding, S. (2012). Gamification: Designing for Motivation. *Interactions, 19*(4), 14-17.

Dorado Escribano, G. (2019). New Approaches to Learning and Assessing through Escape Rooms in English and Science Areas. *Advances in Building Education, 3*(1), 9-19.

López Secanell, I., & Ortega Torres E. (2020). Educative Escape Rooms: The Conceptualisation of Future Teachers of Physical Education Teachers and Teachers of Technology about the Experience of Designing and Participating in an Educative Escape Room Designed for Secondary Education. *Didacticae, 8*, 176-192.

Santamaría, A., & Alcalde, E. (2019). Escaping from the English Classroom. Who Will Get out First? *Aloma, 37*(2), 83-92.

Stott, A., & Neustaedter, C. (2013). *Analysis of Gamification in Education*.

Wood, L. C., & Reiners, T. (2012). Gamification in Logistics and Supply Chain Education: Extending Active Learning. In P. Kommers, T. Issa, & P. Isaías (Eds.), *Proceedings of the IADIS International Conference on Internet Technologies & Society 2012* (pp. 101- 108). Lisbon, Portugal: IADIS Press.

BARRIERS TO DIGITALIZATION IN A PRESCHOOL INSTITUTION

Nina Mainerová
Peuni, Faculty of Business and Law (Czech Republic)

Abstract

This thesis explores the barriers to implementing digital applications in a small group setting from the perspective of early childhood care and education organizations. The author discusses the benefits and challenges of digitalization in early childhood education institutions and maps the current opportunities and limits in transforming some traditional practices into digital form, with an emphasis on defining the barriers from the perspective of educators. The study defines the barriers to the implementation of digital applications from the perspective of direct participants in the educational process, from the perspective of school management and educators. A mixed method research design was used for the study, which draws conclusions using quantitative and qualitative methods based on the principle of sequential design implemented in two steps, a questionnaire survey among respondents and direct observation of the phenomenon under study. The study concludes that although digitalization in early childhood education offers significant potential for improving learning and development, it also presents challenges that need to be addressed through careful implementation, teacher training and ongoing research. Barriers to digitalization in pre-school are mainly inadequate equipment (resources) on the part of schools, insufficient teacher qualifications, and perceived attitudes of teachers and parents towards the use of digital technologies in early learning.

Keywords: *Pre-school, ICT, digitalization.*

1. Introduction

Preschool age is a very important developmental stage in a person's life, which affects the whole future life. It is the age of play, of close attachment to a caring person, it is the time when a person's involvement in society is emerging, when innate potential is developing, it is the age when basic life needs need to be met. Digital technologies are becoming part of school policy in most European countries, learning in the age of digitalization carries the potential to promote changes in education, leading to thinking about so-called modern pedagogy, the context of educational research is changing as a result of digitalization. Digital competence is becoming a key cross-cutting competence in the Czech Republic (Neumajer, 2014) and most European countries (MŠMT, 2020), it would be interesting to compare the state of digitalization of Czech schools with other countries. Caregivers often use technology as babysitters (Lafton, 2015), parents gain time for their responsibilities through digital play (Magdalena et al., 2023), increasing numbers of children can use a mobile phone before they can talk (Sundus, 2018) , the average length of screen use can be up to two hours per day (Stewart et al., 2019). Digitalization is a growing trend (Atış Akyol et al., 2023), which aims to incorporate digital technologies (Tan & Mo, 2024). The process brings with it both opportunities and challenges as it seeks to improve educational outcomes while addressing concerns about potential negative impacts on young children (Paulus & Gerstner, 2023). A large-scale study in European schools has shown that the level of digitalization is improving, but many barriers remain, not only on the material side, but also on the operational and human side. Based on the above, this study will mainly address these research questions.

2. Literary research

The current rapid rise in the capabilities of digital technologies is affecting many areas of our lives, digitalization is not only present especially in industry, commerce, services, but is also gaining a prominent place in the field of education (Richert et al., 2016). The current digital world makes demands for a positive attitude towards the adoption of information technology and its aspects are also entering the education sector (Kundu et al., 2022). Digital technology in education has the potential to develop the effectiveness

of the learning process (Alia & Irwansyah, 2018), however, in preschool it is good to keep in mind the potential threats of exposure to digital technologies (Nurdiantami & Agil, 2020). Digitalization in early childhood education and evaluation offers not only the benefits of new possibilities and approaches to the educational process, benefits for students (Chen & Ding, 2024), but it is also important to be aware of the challenges associated with digitalization (Shykyrynska et al., 2024), which have a major impact on the effectiveness and way of educating preschoolers and the role of educators (Ciarko & Paluch-Dybe, 2021). Educational methods themselves have also seen rapid developments, such as open courses, personalized learning and gamification (Kursch, 2018) and the focus of society on creating optimal educational environments (Ciarko & Paluch-Dybe, 2021) or diversifying them (Otterborn et al., 2024). Digital technologies can improve learning outcomes, make learning more effective especially in mathematical (Preradovic et al., 2016) as well as the development of computational thinking (Su et al., 2024), literacy (Rakhimova et al., 2024) and social skills (Yadav & Vyas, 2021), emotional intelligence (Iksanova, 2022), the development of creativity (Kavak et al., 2024), and the quality of education of educators themselves (Yang, 2024), thus depending on the digital skills of educators. Preschool children are in quite intensive contact with digital technologies from early childhood(Palaiologou, 2016), i.e. they possess a certain level of computer literacy (Su, 2024), i.e. it is in the hands of families and especially young educators to work with this fact (Zevenbergen, 2007), for example through the teaching method of digital games (Behnamnia et al., 2023) , where children's increasingly frequent contact with digital devices can be taken into account (Pervolaraki et al., 2016).

The integration of digital technologies in preschool and early childhood education therefore presents both opportunities and challenges, as mentioned above. The strongest debate is generated by those who consider computers to be detrimental to health and learning, and those who believe that computers can be a key asset for children's social and intellectual development. An example of the conservative approach in the U.S. is the view of the Alliance for Childhood (Cordes & Miller, 2000), which calls for an immediate moratorium on the further introduction of computers in early childhood, except in the special cases of students with disabilities.

3. Data and methods

Based on the literature search, the main barriers to the implementation of digital technologies in kindergartens appear to be parameters in the following areas - technical barriers, barriers on the part of teachers, low digital competence, lack of training, lack of methodological materials, and inconsistency with traditional pedagogical methods. Last but not least, personal barriers, fear, mistrust, attitudes, low motivation and organizational and systemic barriers. At the same time, the relatively short time to define the risks for the children themselves and the associated cultural and social barriers in terms of the ambiguity of the impact of digitalization. Based on this research question - **RQ1:** What technical, financial, organizational or educational barriers do schools perceive to the adoption of new technologies and digitalization of learning? The following hypotheses were established:

H1: If teachers have the opportunity to use a sufficiently equipped classroom for teaching with digital technologies, they include these teaching methods more often.

H2: If teachers are supported with training opportunities in digital competences, they feel more confident in teaching children and use digital teaching methods more often.

Thus, the research aims to describe the main obstacles that hinder the implementation or integration of digital technologies in the environment of pre-school education institutions, kindergartens, children's groups mainly from the perspective of school management and teachers, from the perspective of the school organization. The aim of the research is to identify the main barriers (from the perspective of direct participants in the pedagogical process) that affect the implementation of digital technologies in the teaching and daily practice of preschool institutions, with the sub-goal of providing suggestions for overcoming these barriers. It seems optimal to design the research as a mixed-method study according to Tashakkori & Creswell (2007), who defined mixed-method research as "research in which the researcher collects and analyzes data, integrates findings, and draws conclusions using both qualitative and quantitative methods". Mixed methods research can facilitate a deeper understanding of research questions (Akyar et al., 2024). The research procedure is designed based on the principle of sequential design, implemented in two steps. The first step is data collection through a questionnaire and then data collection through observation of the phenomenon under study, which is done in order to clarify the situation more accurately. The questionnaire survey was conducted in 2025 among nannies and preschool teachers, employees of a non-profit organization providing preschool education in the country. The questionnaire on preschool teachers' attitudes towards ICT consists of three parts.

4. Results

Children may have better motor skills, better cognitive skills and competitive skills, while conversely, children may face serious problems such as speech delays, attention deficits, learning problems, even mental disorders that can impact their characters. Therefore, serious attention is needed from the environment where children grow and develop such as parents, caregivers, early childhood educators and the community holistically to minimize the negative effects of the internet on their character and moral edifice. The conclusions of this paper are in line with those of a large study in European countries. Teachers still believe that the biggest barrier to ICT use is lack of equipment, ICT is used for lesson preparation rather than actual teaching, and teacher training in ICT is rarely compulsory. If schools combine policies on the integration of ICT into teaching and learning, this area is more widely used by pupils and teachers, but most schools do not yet have such an overarching policy and this area awaits more radical change (Commission et al., 2013) Virtually all primary and secondary schools in the Czech Republic are already equipped with computers, with 24 computers per 100 pupils in 2023. Over 46% of schools operate a school information system and 75% of schools provide their own internet connection. Almost 100% of Czech students have a smartphone and use it to connect to the internet. Therefore, investment in technical equipment, the organization of regular training courses on digital literacy for teachers and, last but not least, the introduction of support programmes at national or regional level seems to be suggestions for improvement. Based on this brief initial research exploration, the possibilities for further research open up; in particular, it would be useful to investigate the impact of digitalization on learning outcomes in pre-school institutions, or the effectiveness of training.

5. Discussion and conclusion

Similarly to the study (Çelik et al., 2023), barriers within the sub-themes of physical conditions, teacher-parent collaboration, administrative barriers, policies and teachers' beliefs and opinions, and teachers' competencies appear to be barriers in the Czech context. Teachers encountered the following problems in incorporating digital tools in their teaching such as classroom facilities, lack of variety of digital tools in the school, parents' biases, lack of knowledge and negative attitudes towards the use of digital tools. As mentioned above, the digitalization of early childhood education presents both opportunities and challenges. While digital tools can enhance learning(Marklund, 2022), adapt to change and prepare children for the future (Çelik et al., 2023), their implementation faces several obstacles. These include insufficient facilities and connections, lack of teacher competence and lack of administrative support (Area-Moreira et al., 2020). Teachers' beliefs and pedagogical philosophies also play a crucial role, with many not fully exploiting the potential of ICT (Magen-Nagar & Firstater, 2019). The integration of digital technologies in kindergartens varies, reflecting different views on democracy and digital competence, digital tools can enhance social learning and inclusion in science education, but concerns remain about their impact on children's well-being and social development (Fleer, 2017) .

The results of this study confirm that digitalization in pre-school education has significant potential, but its implementation faces a number of barriers. Key barriers are the technical limitations of schools, low digital competences of teachers and persistent scepticism among some professionals. The analysis shows that effective integration of digital technologies into the educational process requires not only adequate technological infrastructure, but above all systematic training of teaching staff and well-thought-out implementation strategies. The study also pointed out that digitization can have a positive impact on the development of children's cognitive abilities if it is used adequately to their age needs. Although digitalization offers new opportunities to personalise learning and to assess pupils' progress more effectively, the extent to which technology should be integrated into early education remains a question. This issue requires further research focusing on the long-term implications of the use of digital technologies in early childhood settings. Recommendations based on this study include investing in technical equipment in schools, developing comprehensive methodological materials for teachers and introducing across-the-board training programmes aimed at developing teachers' digital competences. Research on measuring the effectiveness of digital tools in pre-primary education also needs to be strengthened in order to accurately identify their benefits and potential risks. Only in this way can it be ensured that digitalization will not only represent an administrative or technical challenge, but a real qualitative contribution to the educational process of the youngest generation.

References

Akyar, B. C., Monteiro, A., & Fernandes, P. (2024). Exploring Portuguese preschool educators' attitudes and practices on information and communication technology (ICT). *Education and Information Technologies, 29*(15), 19299-19320. https://doi.org/10.1007/s10639-024-12613-2

Alia, T., & Irwansyah, I. (2018). *Pendampingan Orang Tua pada Anak Usia Dini dalam Penggunaan Teknologi Digital* [Parent Mentoring of Young Children in the Use of Digital Technology].

Area-Moreira, M., Bonilla, P. J. S., & Mesa, A. L. S. (2020). La transformación digital de los centros escolares. Obstáculos y resistencias. *Digital Education Review*, (37), 15-31.

Atış Akyol, N., Turanoğlu, R., & Parpucu, N. (2023). Digital Technology in Preschool Education: A Systematic Review. *International Journal of Educational Research Review*.

Behnamnia, N., Kamsin, A., Ismail, M. A. B., & Hayati, S. A. (2023). A review of using digital game-based learning for preschoolers. *Journal of Computers in Education, 10*(4), 603-636.

Çelik, O. T., Candemir, B., Sağlam, M., Tunç, Y., Açar, D., & Kahraman, Ü. (2023). Focal points for digital technology integration in early childhood education: implications from practitioners' perspectives. *Education*, 3-13.

Ciarko, M., & Paluch-Dybe, A. (2021). The importance of digitalization in the education process. *E3S Web of Conferences*.

Commission, E., Society, D.-G. f. t. I., & Media. (2013). *Survey of schools – ICT in education – Benchmarking access, use and attitudes to technology in Europe's schools*. Publications Office of the European Union. https://doi.org/doi/10.2759/94499

Cordes, C., & Miller, E. (2000). *Fool's gold: A critical look at computers in childhood.*

Fleer, M. (2017). Digital role-play: The changing conditions of children's play in preschool settings. *Mind, Culture, and Activity, 24*(1), 3-17.

Chen, Y., & Ding, Z. (2024). Effects of digitalization in preschool education on the creative and cognitive development of children. *Education and Information Technologies*, 1-25.

Iksanova, Z. (2022). A new method of developing emotional intelligence in preschool children through interactive digital facial expression recognition technology. *2022 Fourth International Conference Neurotechnologies and Neurointerfaces (CNN)*, 51-54.

Kavak, Ş., Deretarla Gül, E., & Sarıay, M. (2024). The Relationship Between the Use of Digital Tools and Creativity in Preschool. *Kahramanmaraş Sütçü İmam Üniversitesi Sosyal Bilimler Dergisi.*

Kundu, A., Dey, K. N., & Bej, T. (2022). Subject-self affecting on teachers' perceived ict usability: A proposition for TAM3+. *International Journal of Distance Education Technologies (IJDET)*, 20(1), 1-24.

Kursch, M. (2018). Trendy v digitalizaci metod vzdělávání. *Vzdělávání dospělých*, 199-210.

Lafton, T. (2015). Digital literacy practices and pedagogical moments: Human and non-human intertwining in early childhood education. *Contemporary issues in early childhood, 16*(2), 142-152.

Magdalena, R., Sławomir, P., & Bujalski, M. (2023). Why preschool children use mobile devices parental perspective. *Educational Psychology*. https://doi.org/10.5604/01.3001.0016.3394

Magen-Nagar, N., & Firstater, E. (2019). The obstacles to ICT implementation in the kindergarten environment: Kindergarten teachers' beliefs. *Journal of Research in Childhood Education, 33*(2), 165-179.

Marklund, L. (2022). Swedish preschool teachers' perceptions about digital play in a workplace-learning context. *Early years, 42*(2), 167-181.

Matějček, Z., & Langmeier, J. (2011). *Psychická deprivace v dětství*. Karolinum Press.

MŠMT. (2020). *ET 2020, Strategický rámec evropské spolupráce ve vzdělávání a odborné přípravě*. https://msmt.gov.cz/uploads/odbor_30/Jakub/Strategicky_ramec_evropske_spoluprace_v_oblasti_vzdelavani_a_odborne_pripravy_ET_2020_.pdf

Neumajer, O. (2014). Strategie digitálního vzdělávání do roku 2020. *Moderní vyučování: časopis na podporu rozvoje škol, 20*(9-10), 4-6.

Nurdiantami, Y., & Agil, H. M. (2020). The Use of Technology in Early Childhood Education: A Systematic Review. *Proceedings of the International Conference of Health Development. Covid-19 and the Role of Healthcare Workers in the Industrial Era (ICHD 2020)*.

Otterborn, A., Sundberg, B., & Schönborn, K. (2024). The impact of digital and analog approaches on a multidimensional preschool science education. *Research in science education, 54*(2), 185-203.

Palaiologou, I. (2016). Children under five and digital technologies: implications for early years pedagogy. *European Early Childhood Education Research Journal, 24*(1), 5-24.

Paulus, F. W., & Gerstner, I. (2023). Preschool Children and Digital Media in the Second Modernity. *Paediatrie Und Paedologie, 58*(Suppl. 2), 99-102. https://doi.org/10.1007/s00608-023-01111-2

Pervolaraki, I. E., Garoufallou, E., Siatri, R., Zafeiriou, G., Virkus, S., & Antonopoulou, S. (2016). Use of Digital Tools by Preschool Children: Preliminary Results. *European Conference on Information Literacy*.

Potužníková, E., Lokajíčková, V., & Janík, T. (2014). Mezinárodní srovnávací výzkumy školního vzdělávání v České republice: zjištění a výzvy. *Pedagogická orientace, 24*(2), 185–221.

Preradovic, N. M., Lesin, G., & Boras, D. (2016). Introduction of digital storytelling in preschool education: A case study from Croatia. *Digital Education Review*, 94-105.

Rakhimova, D., Karibayeva, A., Karyukin, V., Turarbek, A., Duisenbekkyzy, Z., & Aliyev, R. (2024). Development of a Children's Educational Dictionary for a Low-Resource Language Using AI Tools. *Computers, 13*(10), Article 253. https://doi.org/10.3390/computers13100253

Richert, A., Shehadeh, M., Willicks, F., & Jeschke, S. (2016). *Digital transformation of engineering education-empirical insights from virtual worlds and human-robot-collaboration*.

Shykyrynska, O., Liapunova, V., Melnykova, O., Mnyshenko, K., & Petryshyna, T. (2024). Readiness of The Future Preschool and Primary Education Specialists to form the Foundations of Children's Cyber Security. *Vide. Tehnologija. Resursi - Environment, Technology, Resources*.

Scherer, R., Tondeur, J., Siddiq, F., & Baran, E. (2018). The importance of attitudes toward technology for pre-service teachers' technological, pedagogical, and content knowledge: Comparing structural equation modeling approaches. *Computers in human behavior, 80*, 67-80.

Sivachenko, I., Demchenko, O., Vakaliuk, I., Valentieva, T., & Kit, H. (2022). *Problems and Perspectives of Pedagogical Research in the Context of Digitalization*.

Stewart, T., Duncan, S., Walker, C., Berry, S., & Schofield, G. (2019). *Effects of screen time on preschool health and development*. Ministry of Social Development, New Zealand.

Su, J. (2024). Development and validation of an artificial intelligence literacy assessment for kindergarten children. *Education and Information Technologies, 29*(16), 21811-21831. https://doi.org/10.1007/s10639-024-12611-4

Su, J., Yang, W., Yim, I. H. Y., Li, H., & Hu, X. (2024). Early artificial intelligence education: Effects of cooperative play and direct instruction on kindergarteners' computational thinking, sequencing, self-regulation and theory of mind skills. *Journal of Computer Assisted Learning, 40*(6), 2917-2925. https://doi.org/10.1111/jcal.13040

Sundus, M. (2018). The Impact of using Gadgets on Children. *Journal of Depression and Anxiety, 6*(4).

Šabić, J., Baranović, B., & Rogošić, S. (2022). Teachers' self-efficacy for using information and communication technology: The interaction effect of gender and age. *Informatics in education, 21*(2), 353-373.

Tan, Y., & Mo, S. (2024). Safety protection using artificial intelligence internet of things for preschool education. *Internet Technology Letters, 8*(2), e537.

Tashakkori, A., & Creswell, J. W. (2007). Editorial: The new era of mixed methods. *Journal of Mixed Methods Research, 1*(3), 3-7. Sage Publications.

Yadav, S., & Vyas, C. (2021). Impact of Digital Technology on Preschoolers : A Review. International *Journal of Scientific Research in Science and Technology, 8*, 223-227.

Yang, Y. (2024). Research on intelligent teaching curriculum of preschool education majors in universities based on artificial intelligence technology support. *International Journal of Information and Communication Technology, 24*(7), 51-64.

Zevenbergen, R. (2007). Digital natives come to preschool: Implications for early childhood practice. *Contemporary issues in early childhood, 8*(1), 19-29.

Zounek, J., Záleská, K., & Juhaňák, L. (2020). Výuka s využitím ICT v mezinárodní perspektivě: na cestě k moderní pedagogice. *Lifelong Learning-Celoživotní Vzdělávání*(1).

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

TRANSFORMING UNIVERSITY EDUCATION WITH GENERATIVE AI: STRATEGIES, CHALLENGES AND IMPACTS

Haoning Xi
Newcastle Business School, The University of Newcastle (Australia)

Abstract

Generative artificial intelligence (GenAI) is rapidly shifting the contours of university teaching, learning, and administration. To identify concrete pathways for responsible adoption, we conducted 12 in-depth interviews with lecturers, students, and senior administrators at three research-intensive Chinese universities. Reflexive thematic analysis uncovered six inter-locking themes: GenAI as a pedagogical co-designer that accelerates content creation; heightened student engagement through low-stakes, iterative exploration; assessment redesign as a more effective integrity strategy than detection-and-deterrence; persistent digital-equity gaps driven by hardware, bandwidth, and licensing costs; staff capacity as the critical bottleneck, with structured "prompt-engineering" micro-credentials proving particularly effective; and the need for agile, participatory governance to keep pace with fast-moving tools. Taken together, the findings show that GenAI's transformative promise materialises only when technological affordances are matched by inclusive infrastructure, professional learning, and transparent policy. We therefore propose a three-pillar framework for institutions: i) pedagogical co-design: embed GenAI in curricula via task redesign and reflective documentation of AI use; ii) equitable enablement: invest in campus-wide compute resources, subsidised licences, and student support to prevent new digital divides; and iii) agile governance: establish multi-stakeholder committees that iteratively refine ethical guidelines, data-privacy safeguards, and citation norms. This study extends socio-technical theories of educational technology by linking micro-level user practice to macro-level organisational policy, and offers actionable recommendations for policymakers, educators, and technologists to cultivate a future-ready, ethically grounded learning ecosystem.

Keywords: *Generative AI, higher education, innovation, learning technologies, in-depth interviews.*

1. Introduction

The integration of artificial intelligence (AI) in education has evolved significantly over the past few decades, with generative AI emerging as a transformative force in recent years. Historically, AI in education was primarily focused on rule-based systems and basic machine learning models, which were limited in their ability to generate content or engage in creative tasks. However, the advent of large language models (LLMs) and generative AI (GenAI) has revolutionized the educational landscape, enabling personalized learning, automated content creation, and interactive tutoring systems (Rashid et al., 2024; Chakraborty, 2024).

The transition from traditional teaching methods to AI-enhanced education has been gradual. Early AI applications in education were confined to simple tasks such as grading and administrative support. However, with advancements in natural language processing (NLP) and deep learning, generative AI has become a powerful tool for creating educational content, simulating real-world scenarios, and providing personalized learning experiences (Singh, 2024; Łodzikowski et al., 2024).

Generative AI is reshaping university education by supporting personalized learning experiences, content creation, intelligent tutoring, assessment, and administrative efficiency. First, it enables tailored study guides, adaptive assessments, and individualized feedback that let students learn at their own pace, thereby boosting academic performance and engagement (Singh, 2024; Moore & Tsay, 2024; Fahlapi et al., 2024). Second, educators can rapidly craft high-quality lecture notes, case studies, and multimedia materials while also receiving AI-driven suggestions for learning objectives, outcomes, and assessment methods aligned with institutional goals, ensuring curricula remain current and relevant (Rashid et al., 2024; Chakraborty, 2024; Tillmanns et al., 2025; Nartey, 2024). Third, AI-powered intelligent tutoring systems deliver real-time guidance, answer complex questions, and simulate authentic

scenarios where students can safely apply newly acquired knowledge (Singh, 2024; Maity & Deroy, 2024). Fourth, generative AI automates grading and provides detailed, formative feedback that helps students pinpoint areas for improvement while reducing instructors' workload and grading bias (Francis et al., 2025; Moore & Tsay, 2024). Finally, by streamlining scheduling, enrollment, and record-keeping, generative AI frees educators to concentrate more on teaching and research (Singh, 2024; Chakraborty, 2024).

Despite its promise, integrating generative AI into education presents a set of intertwined challenges, maintaining academic integrity in the face of AI-enabled plagiarism and contract cheating (Francis et al., 2025; Nartey, 2024); mitigating algorithmic bias to avoid unfair treatment of particular student groups (Morandín-Ahuerma, 2024); safeguarding the significant volumes of learner data that underpin AI-driven personalisation (Singh, 2024); bridging the digital divide so that all learners can access and benefit from AI tools (Morandín-Ahuerma, 2024; Nartey, 2024); and ensuring transparency and accountability in AI decision-making, especially for grading and feedback, so that outputs remain auditable and trusted (Francis et al., 2025). These challenges manifest differently across educational tiers: higher-education institutions, which more often possess the infrastructure and expertise to deploy AI for personalised learning, content generation and assessment, must wrestle primarily with academic integrity, privacy and bias (Moore & Tsay, 2024), whereas vocational-training providers leverage generative AI for simulation-based skill acquisition and workplace support but must tailor tools to learners' specific industry contexts and address unequal technological access (Rashid et al., 2024; Chakraborty, 2024; Tillman, 2025).

2. Methods

2.1. Research design

This study adopted a qualitative, multiple-case design to explore how generative AI is being understood and trial-integrated at three research-intensive Chinese universities, Tongji University (Shanghai), Dalian Maritime University (Dalian) and Central South University (Changsha). A qualitative approach was selected because the phenomenon is emergent, context-dependent and best examined through the lived experiences of those directly involved. Semi-structured, in-depth interviews enabled participants to narrate their perceptions in their own words while giving the researchers latitude to probe for clarification and examples. The three universities were purposefully chosen for their distinct disciplinary profiles and documented interest in digital learning innovation. For example, Tongji University combines strong engineering and design schools with an institution-wide "AI-Empowered Teaching" initiative. Dalian Maritime University is China's leading maritime-transport institution and has piloted AI-supported simulators for professional training. Central South University has a nationally recognised Big-Data teaching centre and extensive experience with blended-learning platforms. Studying sites with differing cultures and governance structures captures a broader spectrum of organisational opportunities and constraints surrounding generative AI adoption.

2.2. Participant recruitment

We relied on maximum-variation purposive sampling to ensure representation of key stakeholder categories, teaching staff, senior administrators, learning-technology specialists and students. Deans or equivalent gatekeepers circulated an information sheet; interested volunteers contacted the research team directly to minimise coercion. Inclusion criteria were i) active involvement in course design, delivery during 2024-2025 and ii) familiarity, however nascent, with generative AI tools, e.g., ChatGPT, Deeseek. Sample size was guided by information power (Malterud et al., 2016): heterogeneous roles coupled with focused research questions meant 12 interviews were sufficient to achieve analytic saturation; nevertheless, we scheduled two contingency slots that were not ultimately needed.

Table 1. An overview of the in-depth interview participates.

Participant	Position	Major / Disciplinary Area	Gender
P1	Lecturer	Economics	Female
P2	Lecturer	Civil Engineering	Male
P3	Director of Digital Learning (Administrator)	Educational Technology	Female
P4	Undergraduate Student	Sociology	Male
P5	Professor	Maritime Law	Male
P6	Lecturer	Marine Engineering	Female
P7	Learning-Technologies Officer (Administrator)	Information Systems	Male
P8	Undergraduate Student	Logistics & Supply Chain	Male
P9	Lecturer	Accounting	Female
P10	Instructional Designer	Education	Female
P11	Academic Affairs Officer (Administrator)	Higher-Education Management	Male
P12	Undergraduate Student	Computer Science	Female

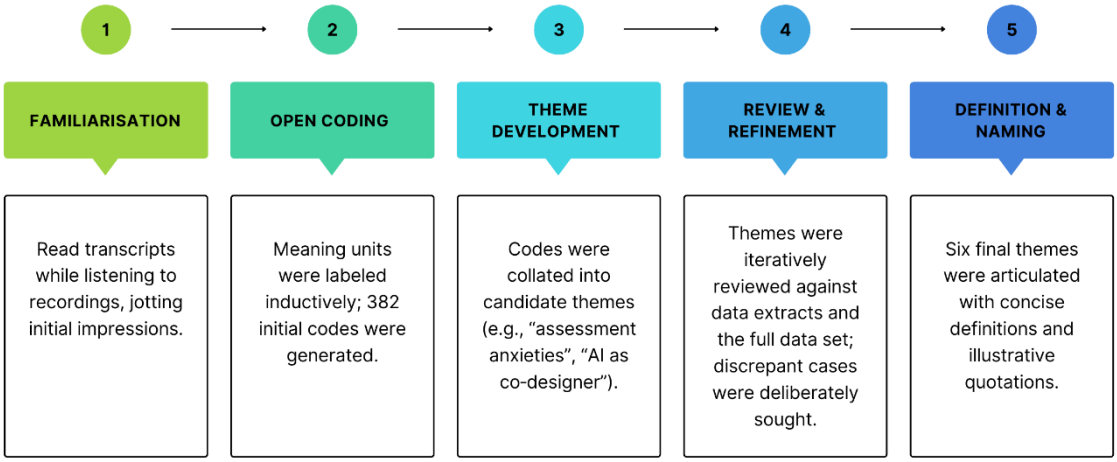
2.3. Data collection procedure

Data were gathered January–April 2025. Owing to geographical dispersion, 12 interviews were conducted via Zoom. Each session lasted 45–70 minutes and followed a semi-structured protocol comprising five thematic blocks: 1) Professional background and current teaching and learning context; 2) Encounters with generative AI, first use, frequency, typical tasks; 3) Perceived benefits, e.g., curriculum design, assessment, student engagement); 4) Perceived risks and challenges, e.g., integrity, bias, workload, policy; 5) Institutional readiness, training, infrastructure, governance, future plans.

2.4. Data analysis

We conducted a reflexive thematic analysis (RTA) (Braun & Clarke, 2023) in NVivo 12, beginning with independent familiarisation as two authors read the Mandarin transcripts while listening to the audio, jotting first impressions. During open coding we inductively assigned labels to meaning units, generating 382 initial codes that were then clustered into provisional themes, e.g., "AI as co-designer," "assessment anxieties". These themes were iteratively reviewed and refined against the full data set, with discrepant cases actively sought, before being precisely defined, named, and illustrated with exemplar quotations; six themes were retained. The procedure of data analysis is summarized in Figure 1.

Figure 1. Procedure of data analysis.



3. Results and discussion

Integrating findings with interpretation, this section presents the six themes that emerged from the reflexive thematic analysis, weaving illustrative quotations with analytical commentary and links to the broader literature.

3.1. Generative AI as a pedagogical *co-designer*

Participants framed GenAI as an assistant that amplifies human creativity rather than a replacement for subject expertise. The technology accelerates the ideation phase, freeing academics to focus on higher-order curation, an enactment of the "co-agency" paradigm (Toiviainen et al., 2022). This shift reconceptualises instructional labour, yet participants emphasised the non-negotiable need for disciplinary vetting, echoing Selwyn's (2019) warning that teacher judgement remains central.

P1: "It used to take me a whole weekend to draft differentiated case studies for three tutorial groups. Now I give ChatGPT my learning outcomes and it spits out first drafts in ten minutes—then I spend the time refining instead of writing from scratch."
P5: "The model generated new maritime-law questions aligned with each competency level. It's like having an invisible teaching assistant who never sleeps."

3.2. Energising student engagement through iterative exploration

GenAI supported a low-stakes, dialogic learning loop that encouraged experimentation and reflection. Students perceived the tool as a non-judgemental interlocutor, aligning with social-constructivist theories emphasising the value of dialogic interaction. Yet two educators cautioned against superficial acceptance of AI outputs, underscoring the need for scaffolded criticality; without such scaffolds, the technology may foster shortcut behaviours rather than deep learning.

P4: "My programming students run draft code through the model, see the error, tweak it, rerun…it's a dialogue. They say it feels less intimidating than asking me in front of 60 peers."
P12: "The AI gave me three visualisations of the same shipping schedule. Comparing them helped me notice patterns I had missed."

3.3. Equity and the digital divide

While GenAI promised levelling effects, hardware disparities and API throttling reproduced pre-existing inequities, echoing findings on technology "amplification (Toyama, 2011)." Participants called for targeted investment in computing resources and subsidised licences to ensure equitable participation, reaffirming argument that digital equity is fundamentally a socio-technical issue (Baskara, 2023).

P2: "Graphic-design students have RTX-GPUs; humanities share an old lab PC. Access shapes ambition."
P9: "Our campus network sometimes blocks the API after midnight. That's when part-time students finally log on."

3.4. Staff capacity and professional development

Professional learning emerged as the linchpin of responsible AI adoption. Tongji's structured micro-credential programme bolstered staff confidence and innovation, whereas Central South's ad-hoc approach left educators feeling "two steps behind" students. The data thus extend existing calls (Tillmanns et al., 2025) for systematic, community-based faculty development in prompt engineering, data ethics, and AI-supported assessment design.

P6: "I'm comfortable asking ChatGPT for quiz stems, but I've no clue how to craft a good prompt for adaptive feedback."
P11: "Our micro-credential on 'Prompt Engineering for Educators' filled in 48 hours—there's huge appetite."

3.5. Governance and ethical frameworks

Stakeholders unanimously demanded clear but agile governance encompassing acceptable use, data privacy, and citation norms. Institutions involving multi-stakeholder committees reported fewer "shadow AI" practices, supporting the notion that governance legitimacy arises from participatory design (Huybrechts et al. 2017). The unresolved question of referencing AI-generated artefacts highlights an urgent agenda for sector-wide standardisation.

P3: "Our draft policy says 'AI output must be cited like any source', but we're still debating how to reference an image Midjourney created."

4. Conclusion

GenAI is rapidly shifting the university education. To identify concrete pathways for responsible adoption, we conducted 12 in-depth interviews with lecturers, students, and senior administrators at three research-intensive Chinese universities. Reflexive thematic analysis uncovered six inter-locking themes: GenAI as a pedagogical co-designer that accelerates content creation; heightened student engagement through low-stakes, iterative exploration; assessment redesign as a more effective integrity strategy than detection-and-deterrence; persistent digital-equity gaps driven by hardware, bandwidth, and licensing costs; staff capacity as the critical bottleneck, with structured "prompt-engineering" micro-credentials proving particularly effective; and the need for agile, participatory governance to keep pace with fast-moving tools. Taken together, the findings show that GenAI's transformative promise materialises only when technological affordances are matched by inclusive infrastructure, professional learning, and transparent policy.

References

Baskara, F. R. (2023). ChatGPT-assisted English language learning: theoretical implications for global mobility and cross-cultural communication. In *International Conference on Language and Language Teaching* (pp. 105-120).

Braun, V., Clarke, V., Hayfield, N., Davey, L., & Jenkinson, E. (2023). Doing reflexive thematic analysis. In *Supporting research in counselling and psychotherapy: Qualitative, quantitative, and mixed methods research* (pp. 19-38). Cham: Springer International Publishing.

Chakraborty, S. (2024). Generative AI in Modern Education Society. *arXiv preprint arXiv:2412.08666*.

Fahlapi, F., Syafitri, K., Ibrahim, S. R. M., & Ilham, F. (2024). Analisis Meta-Sintesis Dampak Artificial Intelegence Terhadap Performa Akademik di Era Digital. *JUTECH: Journal Education and Technology*, *5*(2), 525-536.

Francis, N. J., Jones, S., & Smith, D. P. (2025). Generative AI in higher education: Balancing innovation and integrity. *British Journal of Biomedical Science*, *81*, 14048.

Huybrechts, L., Benesch, H., & Geib, J. (2017). Institutioning: Participatory design, co-design and the public realm. *CoDesign*, *13*(3), 148-159.

Łodzikowski, K., Foltz, P. W., & Behrens, J. T. (2024). Generative AI and its educational implications. In *Trust and Inclusion in AI-Mediated Education: Where Human Learning Meets Learning Machines* (pp. 35-57). Cham: Springer Nature Switzerland.

Maity, S., & Deroy, A. (2024). Generative ai and its impact on personalized intelligent tutoring systems. *arXiv preprint arXiv:2410.10650*.

Malterud, K., Siersma, V. D., & Guassora, A. D. (2016). Sample size in qualitative interview studies: guided by information power. *Qualitative health research*, *26*(13), 1753-1760.

Moore, W., & Tsay, L. S. From Data to Decisions: Leveraging AI for Proactive Education Strategies. In *Proceedings of the International Conference on AI Research*. Academic Conferences and publishing limited.

Morandín-Ahuerma, F. (2024). *UNESCO Proposal for the use of Generative AI in Education: Eight Challenges and Seven Actions*.

Nartey, E. K. (2024). Guiding principles of generative AI for employability and learning in UK universities. *Cogent Education*, *11*(1), 2357898.

Rashid, S. F., Duong-Trung, N., & Pinkwart, N. (2024). Technical Foundations, Applications, and Challenges. *Artificial Intelligence and Education-Shaping the Future of Learning: Shaping the Future of Learning, 33*.

Selwyn, N. (2019). *Should robots replace teachers? AI and the future of education*. John Wiley & Sons.

Singh, P. P. (2024). The Impact of the Development of Artificial Intelligence with Generative Ability on Education. *Journal of Research in Vocational Education*, *6*(6), 46-52.

Tillman, K. (2025). Punitive Inertia: Anti-Blackness and the Policing of Motion. *Social Problems*, spaf007.

Tillmanns, T., Salomão Filho, A., Rudra, S., Weber, P., Dawitz, J., Wiersma, E., ... & Reynolds, S. (2025). Mapping Tomorrow's Teaching and Learning Spaces: A Systematic Review on GenAI in Higher Education. *Trends in Higher Education*, *4*(1), 2.

Toiviainen, S. (2022). Co-agency: reconsidering agency in guidance practice. *British Journal of Guidance & Counselling*, *50*(4), 547-556.

Toyama, K. (2011). Technology as amplifier in international development. In *Proceedings of the 2011 iConference* (pp. 75-82).

GAMIFICATION AS A STRATEGY FOR TEACHING MATERIALS IN ENGINEERING

Daniel Garcia-Garcia, David Garcia-Sanoguera, Mario Miranda-Pinzon, Nestor Montanes, Juan Ivorra-Martinez, & Luis Quiles-Carrillo
Universitat Politècnica de València, Grupo de Innovación de Prácticas Académicas (GIPA) (Spain)

Abstract

Gamification is presented as an effective pedagogical strategy to increase student participation and improve learning in the higher education context. This paper describes a gamified activity implemented in the subject "Taller de Diseño III", belonging to the Bachelor's Degree in Industrial Design and Product Development Engineering at the Universitat Politècnica de València. The experience took place during the didactic unit dedicated to polymeric materials, combining theoretical contents with a practical dynamic based on the identification of polymers from physical samples of different materials. The activity was structured in multiple phases, allowing students to apply the theoretical knowledge acquired with feedback at each stage. The results obtained show an increase in class attendance, a greater student involvement during the classes and an improvement in the understanding of the theoretical contents with respect to previous courses. This experience is proposed as a replicable model in other didactic units of the subject itself, as well as in other similar technical subjects, reinforcing the value of gamification as an educational tool in the field of engineering.

Keywords: *Gamification, polymers, materials, active learning, engineering.*

1. Introduction

The search for more effective methodologies to improve the teaching-learning process in higher education has led in recent years to an increasing incorporation of active and innovative approaches, especially in technical degrees such as engineering (Crisol-Moya, Romero-López, & Caurcel-Cara, 2020). In this context, gamification has been consolidated as an effective educational strategy that allows transforming the traditional classroom dynamics, increasing student motivation, encouraging their participation and favoring a deeper and long-lasting learning process (Aguiar-Castillo, Clavijo-Rodriguez, Hernández-López, De Saa-Pérez, & Pérez-Jiménez, 2021; Subhash & Cudney, 2018).

Gamification consists of the application of game elements (challenges, rewards, level dynamics, immediate feedback, among others) in non-game contexts, with the aim of generating more attractive and effective educational experiences (Carrascosa, Ylardia, Paredes-Velasco, & García-Suelto, 2024). Its implementation at the higher education level has shown benefits both in terms of student commitment and motivation and in the development of key skills, such as critical thinking, teamwork and decision making (Langendahl, Cook, & Mark-Herbert, 2016; Nyahuye & Steyn, 2022).

In the field of engineering, where content tends to be very technical and abstract, these methodologies are especially valuable. They allow complex concepts to be approached in a simpler way, favoring practical learning and the connection between theory and real application. In addition, they promote a student-centered approach, where the student takes an active role in the learning process (Gamarra, Dominguez, Velazquez, & Páez, 2022).

The present experience is developed in the subject "Taller de Diseño III", belonging to the fourth year of the Bachelor's Degree in Industrial Design Engineering and Product Development of the Universitat Politècnica de València. In it, a gamified dynamic has been implemented within the didactic unit dedicated to polymeric materials, with the aim of reinforcing the theoretical contents through a practical activity focused on the identification of materials from physical samples. Through a phased game, students work in teams, apply their prior knowledge, use digital tools and receive progressive feedback that allows them to improve their understanding.

The purpose of this paper is to present the design, development and impact of this activity, assessing its effect on student participation, motivation and performance, as well as its potential for replicability in other technical subjects.

2. Objectives

The main objective of the proposed methodology is to improve students' learning about the most commonly used industrial polymers through a gamification strategy. This strategy seeks to transform a traditional theoretical session into an active and participative experience that combines theoretical contents with a practical application based on the identification of materials. More specifically, the proposal pursues the following objectives:

- Encourage active student participation.
- Develop practical skills, such as tactile and visual identification of materials.
- Promote teamwork and collaboration.
- Promote critical thinking and informed decision making.
- Increase motivation and interest in technical content.
- Promote the use of digital resources and artificial intelligence tools to support autonomous learning.

In summary, the aim of this methodology is not only for students to memorize the properties of the most industrially used polymers, but also to understand, relate, apply and retain this knowledge in a deeper and more lasting way through an active, collaborative and fun learning experience.

3. Methods

3.1. Subject context

In this case, the activity has been implemented in the subject “Taller de Diseño III” a compulsory subject of the Bachelor's Degree in Industrial Design Engineering and Product Development taught at the Escuela Politécnica Superior de Alcoy of the Universitat Politècnica de València. This course is taken in the first semester of the fourth year of the degree and has a total of 6 ECTS credits divided into 3 credits of Classroom Theory and 3 credits of Laboratory Practices.

The teaching structure of the course is divided into three blocks, each of them taught by a different area of knowledge within the Department of Mechanical and Materials Engineering, corresponding to each area 1 ECTS credit of Classroom Theory and 1 ECTS credit of Laboratory Practices. In this case, the experience described has been developed within the block taught by the area of knowledge of Materials and Metallurgical Engineering, specifically in one of the Classroom Theory sessions.

With regard to the number of students enrolled in the course, it should be noted that during the 2024/2025 academic year, the year of implementation of the methodology described, the course had a total of 64 students.

3.2. Implementation of the activity

Within the block taught by the Area of Materials and Metallurgical Engineering, it has been proposed to introduce a gamified dynamic in one of the didactic units taught in Classroom Theory. In this case, the Classroom Theory of the materials block of the subject is divided into four didactic units, which are the following:

- Didactic unit 1: Selection of materials.
- Didactic unit 2: Polymeric materials.
- Didactic unit 3: Metallic materials.
- Didactic unit 4: Wood.

The proposed activity has been implemented in Didactic Unit 2, focused on Polymeric Materials, which is taught in a 2-hour session. Specifically, during this session, a time was initially dedicated where the teacher gave an explanation of what polymers are and how they are classified, according to their structure, into thermoplastic, thermosetting and elastomeric polymers. In the slides used for the explanation of the Didactic Unit, within each family of polymers, those most commonly used at industrial level are shown, including their properties, their main characteristics and their most common applications (Figure 1).

Figure 1. Slides showing the description of one of the polymers seen in the Classroom Theory session of the Didactic Unit of polymeric materials.

After the theoretical explanation, which takes approximately one hour, the game is played. First, students are organized in groups of four people and have 20 minutes to review the slides of the unit, as well as to consult external resources such as the internet or artificial intelligence tools that allow them to go deeper into the characteristics of polymers. During this time, they also have a help sheet to take notes to facilitate the subsequent identification of materials. After this time, the game is explained to the students, which consists of identifying different types of polymers from physical samples of each one of them. Specifically, the game is divided into 3 parts:

Phase 1 - Initial identification:

Each group is given seven samples of different polymers, numbered 1 to 7, along with a sheet listing the names of the available polymers. Students must match each number to the corresponding polymer by observation and touch alone. They have 15 minutes to complete this part. If they get all the materials correct, they receive 3 points on the final exam for the block and are exempt from answering the questions of the polymer unit.

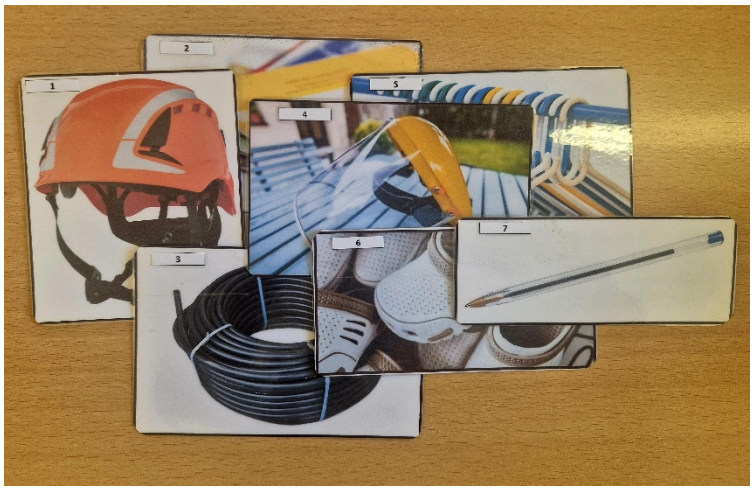
Figure 2. Different polymeric materials samples given to the students.

Phase 2 - Visual clues:

If the group fails to correctly identify all the polymers in the first phase, they are provided with a series of images showing industrial applications of each of the samples. This additional information is intended to facilitate identification. In this phase they have 10 minutes to review the images and correct their sheet. If they achieve complete identification, they receive 2 points on the final exam and can decide whether or not to answer the polymer block questions.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

Figure 3. Visual clues handed out to students in Phase 2 of the game.



Phase 3 - Last chance with feedback:

In case of failing again, the teacher points out on the sheet which answers were correct and wrong. Students have a final 5 minutes to make the necessary adjustments. If in this last opportunity they get all the answers right, they are awarded 1 point on the final exam, having the option of keeping it or answering the block questions on the exam. If there are still errors, no additional points are awarded.

Figure 4. Students during the game proposed in the subject.

4. Discussion

The implementation of a gamified methodology in the Didactic Unit of polymeric materials of the subject has shown significant improvements in different aspects of the teaching-learning process. First of all, a significant increase in attendance was observed in the theoretical session where the game was implemented compared to the rest of the theoretical sessions in which the other didactic units of the block were taught, which are taught using a traditional methodology. This difference is also significant when compared to previous courses, in which participation in the theoretical session of the didactic unit on polymeric materials was notably lower.

In addition to the improvement in attendance, a higher degree of involvement and motivation was detected on the part of the students. The dynamics of the game, together with the possibility of obtaining a bonus in the final exam grade, generated a participatory and collaborative environment. Students were more active in the classroom, working in teams, making use of digital resources and applying their knowledge in a practical way.

Regarding the results of the game, all the groups were able to correctly identify the polymers in some of the phases of the game, which resulted in a better performance in the exam part corresponding to this unit. Even those students who chose to answer the theoretical questions of the unit in the final exam showed, in general, a higher level of understanding than in previous years.

Overall, the results reinforce the value of gamification as an effective pedagogical strategy in the teaching of technical content, not only for its effect on learning, but also for its ability to improve attendance, student engagement and overall classroom dynamics.

5. Conclusions

The introduction of a gamified methodology in the teaching of materials has proven to be an effective tool to promote active learning and improve student engagement in the higher education context. The activity has allowed transforming a traditional theoretical session into a dynamic experience, in which students have been able to practically apply the knowledge acquired, using both tactile and visual analysis of materials and the support of digital tools.

Among the most outstanding benefits are an increase in class attendance, greater student motivation and involvement, and an improvement in the understanding of polymer-related content. The strategy has also favored the development of transversal competencies such as teamwork, effective communication and decision making.

Given the good reception by the students and the results observed, it is proposed to extend this methodology to other didactic units of the subject in future courses. This experience highlights the potential of gamification as a replicable pedagogical strategy in other educational contexts, especially in technical disciplines, where it can contribute significantly to improving both the quality of learning and the students' learning experience.

Acknowledgments

This work has been supported by “Universitat Politècnica de València. Convocatoria A+D. Proyectos de Innovación y Mejora Educativa” through project with reference PIME/24-25/409. The authors would like to thank the Universitat Politècnica de València (UPV) and the Instituto de Ciencias de la Educación (ICE) of the UPV for their help in the formation of the Equipo de Innovación y Calidad Educativa (EICE) called "Grupo de Innovación de Prácticas Académicas (GIPA)".

References

Aguiar-Castillo, L., Clavijo-Rodriguez, A., Hernández-López, L., De Saa-Pérez, P., & Pérez-Jiménez, R. (2021). Gamification and deep learning approaches in higher education. *Journal of Hospitality, Leisure, Sport & Tourism Education, 29*, 100290.

Carrascosa, C. L., Ylardia, I. P., Paredes-Velasco, M., & García-Suelto-Navarro, M. C. (2024). Game-based learning with augmented reality for history education. *IEEE Revista Iberoamericana de Tecnologias del Aprendizaje, 19,* 14-23.

Crisol-Moya, E., Romero-López, M. A., & Caurcel-Cara, M. J. (2020). Active methodologies in higher education: perception and opinion as evaluated by professors and their students in the teaching-learning process. *Frontiers in Psychology, 11*, 1703.

Gamarra, M., Dominguez, A., Velazquez, J., & Páez, H. (2022). A gamification strategy in engineering education—A case study on motivation and engagement. *Computer Applications in Engineering Education, 30*(2), 472-482.

Langendahl, P. A., Cook, M., & Mark-Herbert, C. (2016). Gamification in higher education. *Working Paper Series/Swedish University of Agricultural Sciences, Department of Economics*.

Nyahuye, T., & Steyn, A. A. (2022). *Gamification to increase undergraduate students’ teamwork skills.* Paper presented at the Annual conference of the southern African computer Lecturers' Association.

Subhash, S., & Cudney, E. A. (2018). Gamified learning in higher education: A systematic review of the literature. *Computers in human behavior, 87*, 192-206.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

ARTIFICIAL INTELLIGENCE IN FASHION: A CASE STUDY ON INDUSTRY-ACADEMIC COLLABORATION FOR DIGITAL TRANSFORMATION

Xiaozhu Lin, & Matteo Oreste Ingaramo
Department of Design, Politecnico di Milano (Italy)

Abstract

Since the Industrial Revolution, six essential innovation waves have been widely acknowledged as having significantly transformed the world economy and society. Today, we are experiencing the emergence of the sixth wave, which is characterized by breakthroughs in artificial intelligence (AI) and the shift toward sustainable energy solutions. In the fashion sector, AI has already emerged as a game-changer. It can enhance trend forecasts and design processes, optimize supply chain management, enable the creation of hyper-realistic virtual models, and boost personalized customer engagement. All these innovations collectively lead to significant efficiency, profitability, and sustainability within the sector. The rapid convergence of fashion and technology has created an increasing and pressing need for individuals possessing strong digital skills. Fashion companies must rapidly adjust to this changing environment, while fashion education must simultaneously progress to provide students with essential competencies. This paper delineates a case study of a collaborative workshop between a university and a company aimed at providing students with hands-on experience in advanced AI applications within the fashion sector. This effort enables students to deeply understand the industry's digital transformation while cultivating a passion for upcoming technologies. The authors hope that the ideas and experiences presented in this paper will be a valuable resource for researchers and practitioners investigating the convergence of fashion, design, and technology.

Keywords: *AI fashion, digital fashion, fashion design education, university-company collaboration.*

1. Introduction

Innovation has constantly substantially influenced the global economy throughout contemporary history. Experts have attempted to categorize these cycles of invention using the hypothesis of the "Six Waves of Innovation." This concept originates in the early 20th century, with Austrian economist Joseph Schumpeter establishing the intellectual groundwork in his seminal work *Capitalism, Socialism and Democracy* (1942), wherein he posited that capitalist economies progress through cycles of creative destruction—intervals during which clusters of innovations disrupt existing frameworks and engender new economic paradigms.

As of today, six significant waves have been broadly recognized. The initial wave was propelled by the mechanization of the textile sector and the utilization of hydraulic power in the late 18th century. During the mid-19th century, the second wave was driven by the emergence of steam power and the proliferation of railway networks. The third wave arose in the late 19th and early 20th centuries with the expansion of electricity, steel manufacturing, and chemical industries. The fourth wave emerged in the mid-20th century, characterized by the mass manufacturing of automobiles and airplanes and the extensive utilization of fossil fuels. The fifth wave, starting from the late 20th century, signified the revolution in information and communication technology, encompassing the emergence of computers, the internet, and digital media (Freeman & Louca, 2002). Currently, we are witnessing the emergence of the sixth wave of innovation, defined by the convergence of artificial intelligence (AI), sophisticated robots, the Internet of Things (IoT), and a significant societal transition towards sustainable energy solutions (Silva & Di Serio, 2016).

In the fashion industry, AI has already become a transformative force. It can improve trend predictions and design processes, optimize supply chain operations, and enhance tailored consumer interactions. These advances collectively result in substantial efficiency, profitability, and sustainability within the sector. Transitioning from the prevailing traditional production paradigm to a more streamlined model by embracing digital AI technology has become an urgent requirement and the next normal (Bertola & Teunissen, 2018; Gonzalo et al., 2020).

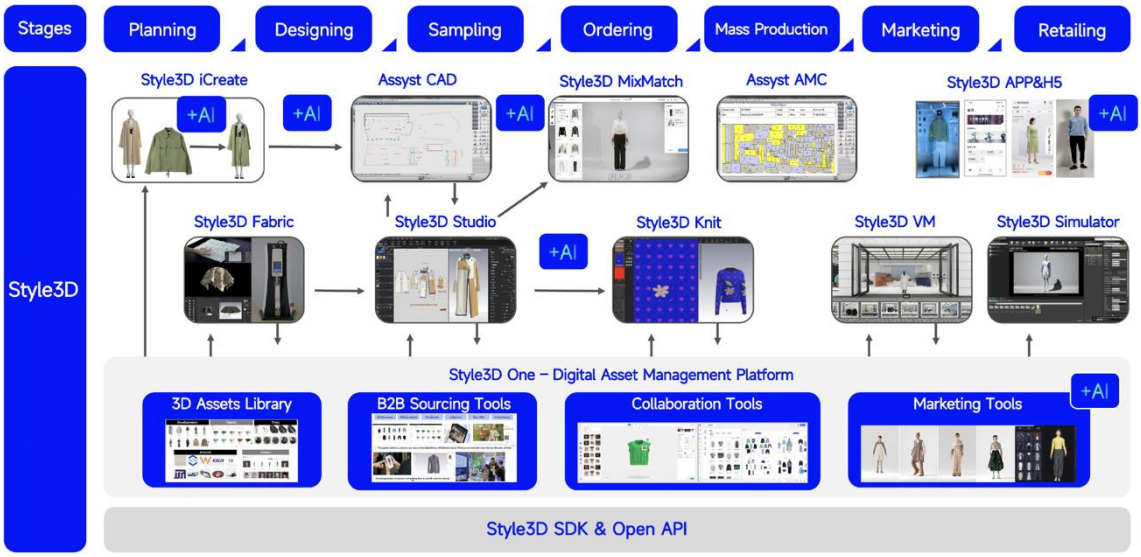
The rapid convergence of fashion and technology has created an urgent need for professionals possessing digital expertise and skills across all fields. A global survey by MOTIF, involving insights from 900 professionals across the value chain, reveals that 57 percent of respondents encounter difficulties in filling positions that necessitate digital skills, especially in digital creation (Alvanon, 2020). The discovery indicates that conventional skill sets are inadequate in this rapidly evolving landscape. It is essential to reconfigure the talent development pipeline and provide upskilling initiatives, particularly in digital competencies, to reconcile the disparity between business demands and existing educational offerings.

Nonetheless, integrating advanced AI technologies into fashion curricula encounters significant challenges, especially for traditional public universities. Unlike private schools, which exhibit superior adaptability and stronger connections with commercial partners, state universities can endure cumbersome and protracted procedures for curriculum updates, making implementing essential technology advancements more challenging. Establishing collaborative educational pathways between private enterprises and public universities may provide a viable and pragmatic solution to this issue (Ingaramo, 2022). This paper presents a case study of a joint workshop activity between Style3D and POLI.design, founded by Politecnico di Milano, examining how university-industry partnerships might leverage AI technology to foster innovation in fashion design education. The authors hope that the insights and experiences detailed in this paper will be a helpful reference point for other researchers exploring digital fashion and design practice in relevant areas.

2. Style3D digitalization ecosystem

Style3D is a science-driven enterprise offering a comprehensive digital infrastructure tailored to the fashion industry. By seamlessly integrating advanced 3D modeling and artificial intelligence (AI) technologies, Style3D facilitates the creation, visualization, and collaboration of digital assets, thereby driving the digital and innovative transformation of the global fashion industry (Figure 1). Its digitalization ecosystem spans three primary domains: 3D tools for fashion (Studio, Fabric, MixMatch, Cloud), AI tools for fashion (iWish, iCreate), and 3D tools for computer graphics (Alelier, Simulator).

Figure 1. Style3D 3D+AI digitalization ecosystem. Source: Style3D.



Their AI tools, Style3D iWish and Style3D iCreate, exemplify the application of AI in accelerating and enhancing fashion design processes. Style3D iWish supports creative efficiency by generating lifelike virtual models with diverse ages and skin tones, enabling AI-powered scene swapping for seamless integration into various contexts and allowing detailed garment refinements for photorealistic output.

Complementing this, Style3D iCreate leverages deep learning to expedite the creation and modification of apparel, accessories, and design concepts. It lets designers quickly visualize garment combinations on digital models, generates high-quality product images from text, sketches, or references, and precisely modifies product components, including color harmonization and graphic detailing.

In the following sections, the authors focus on the functionalities and applications of the Style3D iCreate software. The illustration is framed through a case study of a collaborative workshop designed to offer students hands-on experience with advanced AI applications. By engaging directly with such a tool, students gain practical insights into the digital transformation of the fashion industry while fostering a deeper interest in emerging technologies.

3. Case study: An immersive AI experience

The one-day immersive AI experience workshop in March 2025 is a collaborative activity between Style3D and POLI.design, founded by Politecnico di Milano. This workshop primarily acquainted students with the problems, advancements, and trends currently influencing the fashion industry, as well as how Style3D's innovative AI technologies may enhance the capabilities of designers and marketers in multiple ways. Company representatives presented a comprehensive overview of two newly developed software solutions: Style3D iWish and Style3D iCreate (Figure 2, left).

Students were permitted to investigate and evaluate the various functions of Style3D iCreate beforehand (Figure 2, right). Despite these tools being in development, interaction with cutting-edge technologies in the industry greatly benefits students. The swift progression of technological innovation underscores the imperative for cooperation between corporations and academic entities. These contacts and experiences enable students to stay aware of evolving market demands, equipping them with the attitudes crucial for their future careers. The following part delineates students' immersive experience with Style3D iCreate, offering a comprehensive overview of its capabilities and applications.

Figure 2. Style3D Representatives presented the software, and students tried the functions beforehand.

Style3D iCreate is an inspiration accelerator for designers that utilizes the sophisticated features of Artificial Intelligence Generated Content (AIGC). This program streamlines the development and refinement of design concepts, enabling designers to operate more efficiently (Dong, 2024). The Style3D iCreate functionalities are categorized into two modules: StyleNext (previously called AI Editor) and InnoStyle (previously called AI Creator); each module is specifically designed to address different stages of the design process (Table 1).

Table 1. Two modules of Style3D iCreate: StyleNext and InnoStyle.

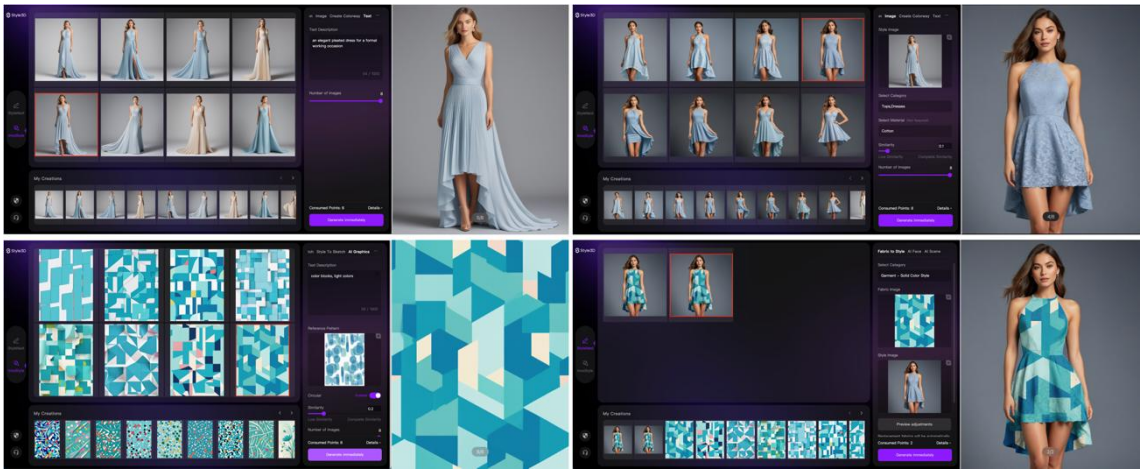
StyleNext	Designers can fine-tune details such as garment features, proportions, ensuring the result aligns with their vision. This iterative editing process enables users to achieve further customization and refinement, facilitates virtual try-ons with suitable virtual models and renders high-quality visual outputs of the pre-defined designs.
InnoStyle	Enables designers to generate initial design concepts rapidly. By inputting textual descriptions as prompts, uploading an image or a design sketch, users can direct the AI to create corresponding designs and partially modefy the designs. This feature simplifies the ideation process, offering designers various options from which to start.

During the workshop, the company experts provided students with hands-on guidance to explore the functionalities of Style3D iCreate. This was achieved through four workflows, each designed to showcase a different entry point for initiating the design process.

- Workflow 1 Starts with a sketch
  Upload a sketch and ask InnoStyle to generate garments accordingly, then partially replace the detail and color.
- Workflow 2 Starts with a textual prompt
  Type a precise textual description as a prompt and ask InnoStyle to generate garments accordingly, then generate a pattern. Finally, back to StyleNext to fabricate the pattern to style.
- Workflow 3 Starts with images
  Upload two garment images and ask InnoStyle to combine and generate a new garment accordingly, then partially replace the details and color.
- Workflow 4 Free creation
  After completing the previous three workflows, students can freely create their own workflow for their designs.

The following illustrates one participant's trial (Workflow 4) during the workshop as an example of how Style3D iCreate AI-assisted design tools were utilized. The participant began by using InnoStyle, where she entered a textual prompt: "an elegant, pleated dress for a formal working occasion." In response, the AI generated a series of proposals aligned with the prompt. From these, the participant selected a preferred option (Figure 3, top left). To further explore stylistic variety, the participant reinserted the initially selected image into InnoStyle, prompting the AI to generate alternative dress designs with low similarity. This iterative process—repeating the image-to-image prompt with modified criteria of similarity—was carried out several times. Eventually, one satisfactory dress was chosen (Figure 3, top right). Thereafter, the participant employed the AI Graphics function in InnoStyle. By uploading a reference pattern and providing a new textual prompt - "light color blocks" - the AI generated a series of custom textile patterns to be chosen from (Figure 3, bottom left). Finally, using the Fabric to Style feature in StyleNext, the participant merged the selected dress silhouette with the chosen generated pattern, creating a final garment design (Figure 3, bottom right). The entire workflow took the participant several dozen minutes to complete. Naturally, these steps can be repeatedly integrated and iterated in practical use to achieve a fully satisfying design outcome.

Figure 3. One example of the workshop outcomes.



4. Conclusion and future directions

Upon trying the software, students were impressed by the efficiency and ease facilitated by today's AI technologies. Company representatives indicate that this software is now undergoing modification; subsequent versions of Style3D software will incorporate an enhanced capability to instantly transform imported photographs into 2D patterns, which may thereafter be effortlessly modified in 3D within the platform. These improvements optimize the design process and augment designers' efficiency.

Nevertheless, this convenience introduces new obstacles. A primary concern is reconciling the use of AI-generated outputs with preserving the designer's creative contributions and conceptual profundity. Although technologies such as Style3D iCreate possess significant potential to transform design workflows, their incorporation into professional and educational settings must be cautiously undertaken. Deliberate tactics are necessary to guarantee that these tools augment creativity rather than serve as substitutes, preserving the distinctive personal and creative vision that characterizes significant design work.

The educational structure must adapt to confront these simultaneous opportunities and difficulties, as this is an inevitable future trend. Students require systematic direction to integrate AI tools while preserving their creative potential. This entails promoting critical thinking, iterative design methodologies, and reflective assessments that guarantee AI-generated ideas only augment their original thoughts. Activities such as brainstorming, concept research, mood board development, and narrative storytelling, carefully overseen by teachers, can guarantee that students possess a distinct and innovative vision for their projects, preventing the AI tool from overshadowing the human design process. The authors hope that the ideas and experiences presented in this paper will be a valuable resource for researchers and practitioners investigating the convergence of fashion, design, and technology.

Acknowledgments

The authors sincerely thank the company Style3D for their engagement and commitment to collaborating with academic institutions. Sincere gratitude also goes to POLI.design, founded by Politecnico di Milano, for their invaluable support and all the students' dedication, and the creative works they developed.

References

Alvanon. (2020). *New global survey identifies knowledge gaps in fashion industry — 57% of respondents struggling to fill skilled roles creating a digital skills gap - Alvanon*. Retrieved April 23, 2025, from https://alvanon.com/new-global-survey-identifies-knowledge-gaps-in-fashion-industry-57-of-respondents-struggling-to-fill-skilled-roles-creating-a-digital-skills-gap/?utm_source=chatgpt.com

Bertola, P., & Teunissen, J. (2018). Fashion 4.0. Innovating fashion industry through digital transformation. *Research Journal of Textile and Apparel*, *22*(4), 352-369. https://www.emerald.com/insight/content/doi/10.1108/rjta-03-2018-0023/full/html

Dong, X. (2019). *Style3D:* Experience the future of digital fashion at an astonishing pace of innovation! Retrieved April 23, 2025, from http://www.taweekly.com/hzdt/202408/t20240829_4355749.html

Freeman, C., & Louca, F. (2002). *As time goes by: From the industrial revolutions to the information revolution*. Oxford University Press.

Gonzalo, A., Harreis, H., Altable, C. S., & Villepelet, C. (2020,). The fashion industry's digital transformation: Now or never. Retrieved April 23, 2025, from https://www.mckinsey.com/industries/retail/our-insights/fashions-digital-transformation-now-or-never

Ingaramo, M. (2022). PREMIUM DESIGN Enhancing Synergies between Design and Business in Education and Practice. *POLITECNICA.* https://doi.org/10.30448/UNI.916.50894

Silva, G., & Di Serio, L. C. (2016). The sixth wave of innovation: are we ready? *RAI Revista de Administração E Inovação*, *13*(2), 128-134. https://doi.org/10.1016/j.rai.2016.03.005

FUTURE EDUCATORS' PERCEPTIONS ABOUT VICARIANCE AS A DESIGN TOOL IN EARLY CHILDHOOD EDUCATION SERVICES IN THE CASE OF THE PRESENCE OF VISUALLY IMPAIRED CHILDREN

Addolorata Amadoro, Umberto Veneruso, & Diana Carmela Di Gennaro
Department of Humanities, Philosophy and Education – University of Salerno (Italy)

Abstract

Neuroscience studies have demonstrated the centrality of the body within cognitive processes, highlighting the deep connection between perception, action and cognition. Vicariance would be configured as a creative capacity of the brain that would allow human beings to find alternative and original solutions to resolve the complexity and unpredictability of reality. Vicariance would therefore represent human beings' adaptive capacity and respond to their need to be available to flexibility and change, which is indispensable for their survival. In the presence of visual impairment, this creative force would allow the body to vicariate the functions of the organ of sight, enhancing the development of the other senses and movement. This evidence can be fully applied in educational research, where biological and cultural elements meet. Within educational processes, and particularly those involving visually impaired children, vicariance can take on a dual perspective. Firstly, it refers to the biological capacity of the visually impaired child's body to identify solutions that compensate for the absence of sight and secondly, to the educator's capacity to identify solutions that respond to the specificity of the child's educational needs, adopting an *Adaptive Decision-Making* perspective. Based on these considerations, a questionnaire was administered to a group of students enrolled in the degree course in Educational Sciences at the University of Salerno during the teaching of "Inclusive design of Early Childhood Services" in the first semester of the current academic year. This questionnaire was aimed at investigating the perceptions of future educators regarding the design of educational activities in early childhood contexts where there were children with visual disabilities. Therefore, the present study aims to analyse whether the scientific evidence regarding the function of vicariance in education is reflected in the results of the questionnaire and how future educators imagine they can use this creative ability as a tool to design educational activities in early childhood contexts with visually impaired children to realise inclusive educational processes, which respond to the needs of all and each one.

Keywords: *Visual impairment, early childhood education services, vicariance, educational design, inclusion.*

1. Introduction

Pedagogical design in early childhood education services represents a fundamental element in constructing quality educational contexts, promoting the well-being, development and learning of children in the 0-3 age group (Bianquin & Bulgarelli, 2022). It is a reflexive, intentional and dynamic process that orients everyday educational practices and ensures consistency with a shared pedagogical vision. Far from being a mere programming of activities, pedagogical design takes on a deeper meaning, expressing a particular image of the child, education, and society. The idea behind the pedagogical work in the nurseries is that of considering the child as a competent person, active in the construction of his or her knowledge, the bearer of rights and the protagonist of his or her growth path, promoting constant exploration and social interaction and encouraging his or her full autonomy (Aiello, 2023). Therefore, the focus is on the specific characteristics of each child to create a place that promotes the well-being of the individual and the entire group (Montessori, 1999). The relationship with the adult and peers is at the heart of design, since learning and personal development are nurtured through interactions. For this reason, pedagogical design becomes an essential tool for creating spaces suitable for developing meaningful relationships, which foster exchanges between peers in a climate of positive affectivity, encouraging social responsibility processes (Amadoro *et al.*, 2024). Furthermore, in the project action, great importance is given to constructing a stimulating environment that supports exploration, learning and growth through numerous activities and play opportunities. For this reason, it is necessary to devote particular care to the arrangement of spaces and furnishings, the choice of materials, the organisation of time, and the design of educational experiences

that can effectively accommodate the different changes the child will try as he or she grows. According to Montessori, the richness of the environment, understood as the presence of stimuli organised according to reasoned educational reflection, is directly proportional to the child's cognitive development. The importance of perception within cognitive processes, nowadays confirmed by studies in the field of neuroscience, has historically been emphasised in education. Indeed, sensory education represents a fundamental cognitive experience that precedes higher intellectual activities for children in the 0-6 age group (Montecchiani & Paolini, 2011). It appears to be further enhanced in the presence of visual disabilities, since in this case stimulation of the senses is necessary to vicariate the absence of sight to allow the child with this type of disability to create the mental images through which to construct his or her knowledge of the world.

From a neuroscientific point of view, vicariance takes the form of a creative capacity of the brain that allows human beings to find alternative and original solutions to solve the complexity and unpredictability of reality, enabling them to adapt and respond to their need for flexibility and openness to change, which are essential for survival (Berthoz, 2015). About visual impairment, vicariousness refers to the extraordinary ability of the human brain to adapt and reorganise its functions when one of the senses is impaired or absent. When one sense, such as sight, is no longer available, the other senses (touch, hearing, smell, taste) play a more critical role in perceiving the environment and gathering information. The deprivation of sight necessarily entails a functional reorganisation expressed through the strategic use of the other senses and specific cognitive functions. Sensory vicariousness determines how pupils with visual impairment interact with the world, learn and develop cognitively. Touch becomes the primary sense used to explore the environment and learn concepts (Caldin, Polato, 2023).

Concerning educational contexts, particularly those that include visually impaired children, vicariousness has a dual meaning. On the one hand, it takes the form of the natural predisposition of the blind child's body to develop alternative mechanisms that compensate for the loss of visual function. On the other hand, it is expressed in the ability of the educational professional to define solutions and design interventions specifically tailored to the child's particular educational needs, implementing an *Adaptive Decision Making* strategy (Caldin, Polato, 2023). In this way, it allows overcoming methodological rigidity and identifying didactic deviations to address the complexity of teaching and learning (Sibilio, 2017).

Starting from these premises, the research aimed to explore future educators' perceptions regarding the design of activities in early childhood contexts in the presence of visually impaired children. In particular, a qualitative-quantitative questionnaire was administered to a group of students enrolled in the third year of the degree course in Educational Sciences, specialising in "Educators in early childhood services", at the University of Salerno (Italy), who attended the course "Inclusive design of early childhood services". The sample was asked to imagine designing an educational activity in a context where at least one visually impaired child was present. The objective was to find out, through the analysis of the answers provided, what the recurrent design elements were, to understand if the outcome of the research confirmed the scientific evidence of the reference literature on the centrality of vicariance understood in its double meaning, that is, as the educator's design ability aimed at developing a capacity that is biologically inherent in every child and necessary for their development.

2. Methodology

2.1. Objective

The present work set out to investigate a twofold objective. Firstly, it aimed to analyse the perceptions of future educators in early childhood services regarding how educational activities are designed in the presence of visually impaired children. Based on the data obtained, the second objective was to verify whether it confirms the evidence of the scientific literature of reference regarding the importance of proximity as a fundamental element in designing educational activities in early childhood contexts where children with visual disabilities are present.

2.2. Sample

The sample analysed consisted of 43 students enrolled in the third year of the degree course in Educational Sciences, specialising in 'Educators in Early Childhood Services', at the University of Salerno (Italy). They attended the course 'Inclusive Design of Early Childhood Services' during the first semester of the 2024-2025 academic year.

2.3. Survey tool and process

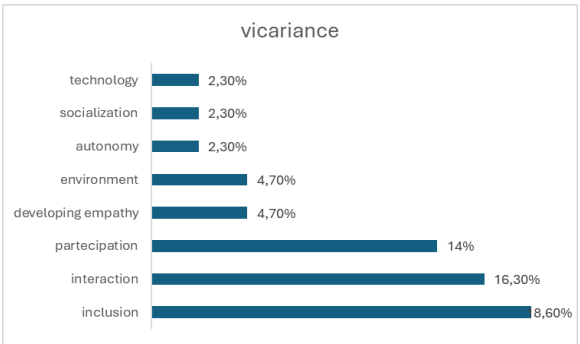
The survey instrument used was a qualitative-quantitative questionnaire with eighteen questions divided into three sections. Section no. 1 (items 1 - 7) was dedicated to gathering socio-demographic information, relating to age, gender, place of origin and course of study. Section no. 2 (items 8 - 16)

collected information on the traineeship experience (activity included in the study pathway). They were asked to indicate the type of facility dedicated to early childhood services where the experience took place (item 9), whether there were children with disabilities (item 12) and, if so, to specify the type of disability (item 13). Finally, it was asked whether the kind of activities designed in contexts where children with disabilities were present had favoured the process of their inclusion within the educational context (item 15). Section no. 3 (items 17 - 18) aimed at gathering information on the perceptions of future educators regarding the design of activities in educational contexts where there were children with disabilities (item 17) and, in particular, with visual disabilities (item 18). More specifically, they were asked to imagine and describe the educational activities designed in the specific contexts outlined above. The questionnaire was administered during the first lesson, so the sample's answers were not influenced by the knowledge gained from attending the course. Still, it expressed personal impressions resulting from direct experience in the field and their sensitivity. The object of the research was to determine the answers to question no. 18 ("If in the imagined educational context there was the presence of one or more visually impaired children, what activities would you plan to respond to their specific educational needs and favour their inclusion process within the educational context?"), for which a thematic type of analysis was chosen. It involved highlighting the key terms, which were then subdivided according to their frequency index and, finally, grouped into macro-categories.

2.4. Data analysis and discussion

As regards the first section of the questionnaire on socio-demographic data, analysis of the data collected shows that the entire sample comes from Campania, the region in southern Italy where the university is located. Most of the sample (72%) comes from Salerno and its province. In comparison, a fair percentage (16%) comes from the city of Naples, the regional capital, and its province. Finally, the remainder of the sample came from the other provinces of the region and their relative provinces (5% respectively from Avellino and Benevento and their relative provinces, and 2% from the city of Caserta and its province). Most of the sample (98%) is female, while 2% claim to be male. Most of the sample (92%) were between 21 and 25 years old, while 6% were under 20, and only 2% were over 25. The second section of the questionnaire, which referred to the training experience carried out (as provided for in the study plan), most of the sample (91%) stated that it took place in nurseries, 7% in pre-schools and 2% in other facilities. To the question concerning the presence of children with disabilities in the facilities where this activity is carried out (item 12), only 16% of the sample answered in the affirmative, and, from the answers given to the next question (item 13), this presence is concentrated exclusively in nurseries. Concerning the third section, which is aimed at investigating how future educators imagine designing activities within early childhood contexts in which there is the presence of children with visual disabilities, the totality of the sample refers to vicariance as a central element of the design activity. The term "vicariance" is associated with "inclusion" (18.6%), "interaction" (16.3%), "participation" (14%) and "motor, cognitive and social development" (9.3%). Further associations emerge with the terms “development of empathy” and “environment” (both 4.7%); “socialisation”, “autonomy” and “technology” (2.3%) [figure 1].

Figure 1.



Through thematic analysis of the answers provided, it emerged that the totality of the sample imagines designing educational activities within early childhood contexts in the presence of visually impaired children using vicariance through sensory education. However, most of the sample considers touch and hearing as vicarious senses of sight, and only a minority also explicitly refers to taste and smell. No one, on the other hand, takes haptic perception, considered the sixth sense and fundamental for people with visual disabilities, into account. A further interesting observation concerns the percentage of the sample convinced that educational design centred on the vicariance favours empathy development.

This idea seems justified by the fact that the vicarious use of the other senses in place of sight would allow a "change of perspective" for children without visual impairment that would bring them closer to the condition of peers with this type of disability. Therefore, sharing the same condition would be functional to understanding it, thus participating in the deconstruction of prejudice against the different. Moreover, sharing the same condition would seem to favour recognition of and attention to the needs of the other. In this sense, this would favour collaboration between peers and the active participation of the visually impaired child, contributing to improving the general class group's inclusion level. According to the answers provided by the sample, sensory education would also be functional to the child's motor, social and cognitive development. This finding seems interesting because it reveals a holistic approach to the dimension of a person that is very close to the biopsychosocial perspective on which the ICF-CY is based. Still, it identifies its justification in the *embodied* dimension of knowledge. It would be sensory education realised through the perception of the senses that vicariate sight that would favour the contextual development of the three dimensions of the person: physical, relational and intellectual. This would confirm the recognition of the centrality of the body (albeit deprived of a sense and of the so-called 'sense of distance' to the advantage of the senses considered 'of proximity' - touch, hearing, taste and smell) within the person's development process. Part of the sample also recognises a central role for the environment, understood as a multifactorial element made up of physical and relational elements, and considers it fundamental to the realisation of a design aimed at enhancing sensorial education by effectively responding to the educational needs of children and children with visual disabilities. Finally, the data relative to the use of technology as a tool to design educational activities centred on the functional use of sensory vicariance leaves one somewhat perplexed. The low percentage recorded by the figure in question seems to be at odds with the figure relating to the average age of the sample, which places it in the generation of digital natives. This contradiction could be justified by the lack of knowledge of the educational potential of technologies that, on the contrary, according to the evidence of the scientific literature in the sector, represent a concrete tool for designing personalised educational paths. For this reason, they would be truly capable of responding to everyone’s educational needs and, therefore, would be highly inclusive.

3. Conclusions

The data that emerged from the research seem to confirm the evidence of the scientific literature in the sector regarding the centrality of vicariance as an indispensable tool for the design of educational activities in early childhood contexts where there is the presence of children with visual disabilities. The most frequent terminological connection is precisely "vicariance-inclusion". However, it should be noted that the property of vicariance can be understood in an ambivalent manner and concern, in this sense, both the organic faculty of the child and the design capacity of the educators to identify solutions that meet the specific educational needs of the children (Caldin, Polato, 2023). In the first case, the design of educational activities that stimulate the development of vicariance, understood as the biological faculty of the human being, would make it possible to foster the development of divergent thinking and creativity in children (Zollo *et al.*, 2015). This would also be consistent with what is indicated by recent European legislation on the subject and, in particular, the *Council Conclusions on the role of early childhood education and primary education in promoting creativity, innovation and digital competence*, which established the importance of fostering creativity from early childhood onwards by making explicit reference to the need for 'modernisation of pedagogical approaches, teaching resources and the learning environment' (2015/C 172/05). In the educational sphere, the acquisition of creative thinking skills could be a valid strategy to promote educational interventions aimed at deciphering complexity and dealing with its pitfalls (Zollo *et al.*, 2015; Amadoro *et al.* 2024b). In the specific case of children with visual disabilities, the design of educational activities that tend to enhance this ability would have the twofold objective of responding to a particular need of the child with this type of disability, since he or she needs to *train* the other senses to compensate for the absence of sight and, at the same time, would respond to the need shared with his or her peers to foster the development of creative ability. Furthermore, designing educational activities centred on vicariance would respond, more generically, to the need common to children in the 0-6 age group to use sensorial exploration as the primary vehicle for knowledge of reality, as confirmed by Montessori's pedagogy (Montessori, 1938).

In conclusion, vicariance, understood as a central component of educational design in early childhood services, even in contexts where there are visually impaired children, is an element that is doubly linked to the theme of inclusion. Responding to needs shared by all and specific to some, vicariance would allow the development of skills necessary for the child in that age group.

References

Aiello, P. (Ed.) (2023) *Pedagogia Speciale, infanzia e servizi educativi inclusivi.* Milano: Francoangeli.

Amadoro, A., & Di Gennaro, D. C. (2024a) Artificial Intelligence and virtual learning environments: limits and opportunities for blind students. *Giornale Italiano di Educazione alla Salute, Sport e Didattica Inclusiva, 8*(2). Edizioni Universitarie Romane.

Amadoro, A., Veneruso, U., & Di Gennaro, D. C. (2024b) Designing childhood inclusive educational spaces to foster the development of creativity in visually impaired children. *ICERI2024 Proceedings* (pp. 7435-7442).

Berthoz, A. (2015) *La vicarianza il nostro cervello creatore di mondi*. Torino: Codice.

Bianquin, N., & Bulgarelli D. (2022). *Nido d'infanzia e progettazione educativa individualizzata, progettare l'inclusione attraverso il PEI su base ICF*. Trento: Erickson.

Bondioli, A., & Savio, D. (2018). *Educare l'infanzia. Temi chiave per i servizi 0-6.* Roma: Carocci Editore.

Bonfigliuoli, C., & Pinelli, S. (2010) *Pedagogia della disabilità visiva*. Trento: Erickson.

Caldin, R., & Polato, F. (2023) T*occare per conoscere: percorsi multisensoriali per l'inclusione scolastica.* Pisa: ETS.

Caldin, R., Polato, L. (2023) Tatto e conoscenza. Percorsi per una didattica multisensoriale nella disabilità visiva. *Pedagogia e Vita, 81*(1).

Chiappetta Cajola, L., & Rizzo, A. L. (2017) Gioco e disabilità: l'ICF-CY nella progettazione didattica inclusiva nel nido e nella scuola dell'infanzia. *Pedagogia più didattica, 3*(1). https://rivistedigitali.erickson.it/pedagogia-piu-didattica/archivio/vol-3-n-1/l-icf-cy-per-la-certificazione-delle-competenze-degli-allievi-con-disabilita-una-proposta-metodologica-nella-prospettiva-dellevidence-based-education/

Conclusioni del Consiglio Europeo sul *ruolo dell'educazione della prima infanzia e dell'istruzione primaria nella promozione della creatività, dell'innovazione e della competenza digitale* (EU 2015/C 172/05).

Goldschmied, E., & Jackson, S. (1997) *Persone da zero a tre anni. Crescere e lavorare nell'ambiente del nido*. Bergamo: Edizioni junior.

Ministero dell'Istruzione. (2021). *Orientamenti per i servizi educativi per l'infanzia*. https://www.miur.gov.it/documents/20182/6735034

Montecchiani, M., Polini, S. (2011) Il Metodo Montessori e la disabilità visiva nella scuola dell'Infanzia. *Tiflologia per l'integrazione, 2*, 98-118.

Montessori, M. (1938). *Il segreto dell'infanzia*. Bellinzona: Istituto Editoriale Ticinese.

Montessori, M. (1999). *La scoperta del bambino*. Milano: Garzanti.

Sibilio, M. (2014). *La didattica semplessa*. Napoli: Liguori.

Sibilio, M. (2017). *Vicarianza e didattica corpo, cognizione e insegnamento*. Brescia: La Scuola.

Zollo, I., Kourkoutas, E., & Sibilio, M. (2015). Creatività, pensiero divergente e pensiero laterale per una didattica semplessa. *Educational Reflective Practices, 1*, 5-17.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

CHATTING WITH THE ASSISTANT: ENABLING STUDENTS TO USE CHATGPT FOR SELF-ASSESSMENT BEFORE ASSIGNMENT SUBMISSION

Ruth Forrest
Dr., Department of Psychology and Education, Longford International College (Ireland)

Abstract

This paper investigates the intentional integration of generative artificial intelligence, specifically ChatGPT—into postgraduate dissertation supervision within online higher education contexts. Nineteen master's students across two disciplines (Sport and Exercise Psychology and Business Administration) participated in a 12-week intervention focused on building custom GPTs for academic support, self-assessment, and improved communication. Drawing from theories of self-regulated learning (Zimmerman), andragogy (Knowles), constructivist pedagogy (Vygotsky, Laurillard), formative assessment (Black & Wiliam), and critical digital pedagogy (Selwyn, Williamson), the study presents qualitative data gathered through semi-structured interviews. Findings suggest enhanced analytical writing, greater confidence among non-native English speakers, and a shift in tutor-student interactions toward independence and critical engagement. Students reported using AI to refine argumentation, clarify structure, and develop professional communication skills. This paper provides a robust model for integrating ethical AI into academic practice, with implications for institutional policy, digital literacy, and future research in technology-enhanced learning.

Keywords: *Artificial Intelligence, dissertation-supervision, self-assessment, digital literacy.*

1. Introduction

The accelerating development and deployment of generative artificial intelligence (AI) in education has sparked considerable debate around the pedagogical, ethical, and cognitive implications of its use. While concerns around plagiarism, academic dishonesty, and over-reliance persist, there is growing evidence that when used transparently and critically, AI can serve as a catalyst for independent learning, especially in online, postgraduate education (Holmes et al., 2022; Selwyn et al., 2023). This study investigates one such application, focusing on how master's degree students in an online university used ChatGPT to enhance their academic writing, structure their dissertations, engage in formative self-assessment, and improve their professional correspondence during supervision. The context of this study is especially pertinent given the global and linguistically diverse student cohorts engaged in distance learning—an environment that requires both technological fluency and self-regulatory learning behaviours.

2. Objectives

This research aimed to investigate how generative AI—specifically ChatGPT—could be pedagogically integrated into the postgraduate research process in ways that encourage independent learning, enhance academic writing, and support students' metacognitive development. The four primary objectives were:

(1) to explore how students used customised GPT-based tools to reflect upon and improve their work;
(2) to assess whether such usage promoted greater critical engagement and analytical writing;
(3) to understand the tutor's shifting role in an AI-supported learning environment; and
(4) to evaluate ethical practices and the challenges of maintaining academic integrity.

These aims were informed by current theory and research on self-regulated learning (Zimmerman, 2002), the ethics of educational AI (Williamson, 2022), and adult education principles (Knowles, 1975).

3. Theoretical framework

This study is grounded in a rich theoretical landscape spanning self-regulated learning, constructivist pedagogy, adult learning theory, formative assessment, and critical digital literacy. These theoretical perspectives informed both the structure of the intervention and the interpretation of results.

Self-regulated Learning (SRL), as defined by Zimmerman (2002), encompasses the metacognitive, motivational, and behavioural processes that learners use to plan, monitor, and evaluate their learning. SRL posits that students are not passive recipients of knowledge but active agents capable of setting goals, selecting strategies, and assessing their progress. In the context of AI-assisted learning, the use of ChatGPT was positioned as a tool to enhance these self-regulatory behaviours—particularly in the planning and drafting phases of dissertation work. Students learned to prompt ChatGPT to challenge their assumptions, simulate opposing viewpoints, and clarify their own arguments, thus reinforcing the SRL cycle.

Complementing SRL is Knowles' (1975) *Theory of Andragogy*, which emphasizes the autonomy and self-direction of adult learners. Knowles argued that adult learners are intrinsically motivated and draw on accumulated experience to make meaning. By providing students with AI tools to independently assess, revise, and organise their academic writing, this study embraced an andragogical model that respected learner agency and promoted a revised partnership approach to research and dissertation supervision.

Constructivist pedagogy, particularly that articulated by Vygotsky (1978), further underpinned the design of this project. The interaction with ChatGPT was conceived as a form of mediated learning, akin to scaffolding in the *Zone of Proximal Development* (ZPD). By asking guiding questions and proposing development strategies, the chatbot served as a quasi-peer with infinite patience and availability, facilitating purposeful and meaningful individualized knowledge construction for and with the student through dialogue.

Formative Assessment Theory, as developed by Sadler (1989) and extended by Black and Wiliam (2009), stresses the importance of timely, constructive feedback in developing student competence. Within this study, students embedded their institution's marking rubric into GPT prompts, effectively transforming the chatbot into a responsive, formative feedback system. This not only familiarized students with assessment criteria but also encouraged them to internalize standards of academic quality and to trust in the consistency of the requirements of the respective universities as aligned with the perceived objectivity of its demands.

Finally, this study was informed by critical digital pedagogy and emerging discourses on AI ethics in education. Selwyn (2016) and Williamson (2022) caution against uncritical adoption of educational technology, noting the risks of bias, surveillance, and data commodification. To mitigate these risks, this study foregrounded digital literacy and ethical use, ensuring students validated all sources, cross-checked references, and used ChatGPT as a thinking companion rather than a source of content to copy.

Together, these frameworks offered a robust and nuanced basis for the intervention, allowing for a pedagogy that was student-centred, digitally aware, ethically sound, and responsive to the diverse needs of learners in an online postgraduate context.

4. Methodology

This study employed a qualitative action research design (McNiff & Whitehead, 2002), characterised by cyclical reflection, iterative feedback, and participatory engagement between the researcher and student participants. Action research was deemed appropriate for this intervention as it enabled the researcher—who was also the students' supervisor and tutor—to adapt teaching strategies in real time while systematically observing the impact of generative AI on learning outcomes and student empowerment.

The intervention involved 19 postgraduate students enrolled in either a Master's in Sport and Exercise Psychology (n=11) or a Master's in Business Administration (n=8) in the online university. Students attended weekly sessions over 12 weeks as part of their Research Methods module. These sessions focused on introducing ChatGPT, principles of prompt engineering, structuring academic writing, alignment with institutional rubrics, ethical considerations, and building custom GPT tools tailored to their individual research.

Ethical approval was granted by the institution following submission of detailed risk assessments and data protection protocols. All participants signed informed consent forms, and confidentiality was preserved in the reporting of findings. Students were reminded continuously of the importance of validating AI-generated content and were encouraged to maintain academic integrity through critical engagement rather than what might have appeared attractive – that is the uncritical adoption of information without verification.

To collect data, the researcher conducted one-on-one semi-structured interviews via *Zoom* at the end of the 12-week period. Each interview lasted between 30 and 45 minutes and was transcribed verbatim for thematic analysis. Braun and Clarke's (2006) six-phase model guided the analytical process: familiarisation, initial coding, theme identification, theme review, theme definition, and write-up. The interviews were designed to elicit rich, reflective data regarding the students' use of ChatGPT, their perceptions of the tool's impact on learning, and their broader reflections on digital support in academic life.

The semi-structured interview guide schedule included the following questions:

1. How did you use ChatGPT in the development of your dissertation or assignment work?
2. What was most useful or effective about using ChatGPT in your academic writing process?
3. Were there any significant limitations or challenges you experienced while using the tool?
4. To what extent did you feel that ChatGPT changed the way you approached learning or research?
5. How did you ensure that AI-generated content you used was accurate and ethically used?
6. Did the use of ChatGPT affect your confidence in writing, particularly in English (if applicable)?
7. In what ways might it have changed the type of support you expected from your supervisor?
8. Would you recommend the use of ChatGPT to other university students? Why or why not?
9. How could this approach to teaching and learning be improved or extended in future teaching?
10. What are your views on using GPT to help you draft professional emails or correspondence with your supervisor?

The final question was particularly valuable in illuminating an emerging theme: that of professional academic communication. Several students began to use ChatGPT to frame their email communications with their tutors, supervisors, and support services. This practice ensured clarity, a consistent academic tone, and a reduction in miscommunication—especially for students working in a second language. One student remarked: "I always struggled with formal tone. The GPT helped me write respectful emails that sounded academic. I feel more confident reaching out." Another commented: "It's not just for writing chapters—it helps with the whole research process, including how I present myself in emails." The researcher recommends this as a further area of development in AI-integrated education: to promote GPT usage not only for drafting and self-assessment but also as a scaffold for developing professional digital literacy in all aspects of academic life.

5. Findings and discussion

The thematic analysis of the interviews yielded *five core findings*, each supported by student testimony and situated within relevant pedagogical theory. These themes demonstrate the multifaceted impact of using generative AI strategically and ethically as a self-assessment and learning-enhancement tool.

These findings included, *Enhanced Confidence in competence in Academic Writing, Improved Analytical and Critical Engagement, Shift in the nature, function and role of the Research Supervisor, Increased Ownership of Assessment Criteria* and the *Development of Professional Communication***

For many students, especially those for whom English was an additional language, ChatGPT served as a confidence-building companion. Students described how the tool supported their grammar, phrasing, and academic tone. One MBA student remarked: "*I used to worry that my writing sounded too basic. ChatGPT helped me reword it more professionally. I now write with more pride*." This aligns with research by Holmes et al. (2022), who suggest that AI can help mitigate language barriers and promote more equitable outcomes.

Far from relying on AI for content creation, students learned to use the tool to ask questions about coherence, evidence, and argument structure. One psychology student explained: "*I would paste a paragraph in and ask the bot if it made sense. Sometimes it would say: 'this point is not supported by evidence' or 'clarify your logic'. That really pushed me to think more deeply."* This type of engagement is closely aligned with Zimmerman's (2002) self-regulated learning theory, wherein students assess their own performance and revise their strategies according to the feedback achieved through engagement with the Bot.

With the chatbot handling lower-order corrections (e.g., grammar, syntax), the supervisor could focus more on higher-order concerns such as conceptual clarity, theoretical alignment, and research ethics. As one student stated: "Before, I would send a rough draft and get it back full of comments on commas and spelling. Now I clean it up first, and we talk about ideas, not grammar." This reflects Laurillard's (2002) view of the educator as a facilitator of conceptual understanding rather than a gatekeeper of correctness.

Many students imported their institution's grading rubric into the chatbot and created prompts to evaluate their drafts against it. This process internalized assessment standards and promoted self-monitoring. One student commented: *"It was like having a personal rubric assistant. I kept checking if I was hitting the criteria."* This self-assessment approach is well-supported by Sadler (1989), who argued that formative feedback should enable learners to understand quality and close the gap between current and desired performance.

An unexpected but positive outcome was the use of GPT for email drafting. Students who previously struggled with formal tone found that GPT helped them write clear, professional messages to their tutors. One noted: *"It saved me time and embarrassment. Now I double-check every email with GPT before I send it."* This reflects Bandura's (2001) social cognitive theory, particularly the concept of self-efficacy: students became more confident not only in writing assignments but in communicating effectively within an academic context and overall professional and business environment.

In addition to these themes, the students themselves recognised the ethical dimensions of their use of AI. Several mentioned using plagiarism-checking tools, double-checking citations, and paraphrasing AI suggestions in their own voice. This awareness suggests that when scaffolded correctly, AI can foster rather than diminish academic integrity—a point echoed in the literature by Selwyn et al. (2023) and OpenAI (2023). The intervention modelled a transparent, critically engaged approach to AI that resonated with the students both in terms of their personal and their professional needs and values aligned with their work.

These findings demonstrate not only the pedagogical promise of generative AI in postgraduate education but also the importance of intentionality, guidance, and ethical reflection in its application.

6. Conclusions and recommendations

This study set out to explore how generative AI—specifically ChatGPT—could be ethically and effectively integrated into postgraduate dissertation supervision to support self-assessment, academic writing, and independent learning. The findings indicate that when students are taught not just how to use AI tools, but how to question, evaluate, and co-construct knowledge with them, the result is a more empowered, critically engaged student and lifelong learner who is well-equipped to deal with the challenges of online learning.

The integration of ChatGPT into academic practice offered several advantages. Students reported greater confidence in their writing, enhanced ability to engage critically with their research, and a deeper understanding of assessment criteria. Notably, students began to view AI as a companion in learning, using it not as a shortcut, but as a space for rehearsal, inquiry, and refinement. This aligns with pedagogical shifts toward learner-centred, dialogic, and constructivist approaches in higher education (Laurillard, 2002; Vygotsky,1978).

Equally significant was the observed shift in the tutor's role. Freed from correcting surface-level errors, the tutor could focus on supporting deeper conceptual development, methodological rigour, and critical thinking. The introduction of AI thus fostered not only student independence but also more meaningful and productive tutor-student dialogue thus introducing a more collaborative approach to the teaching and learning.

One particularly promising outcome was the use of GPT to assist students in drafting professional emails. For many, this was the first time they had considered how language choices impact tone and clarity in academic correspondence. Promoting the use of GPT in this context can support the development of professional digital literacy—a key skill in postgraduate and professional life.

Based on these outcomes, several preliminary recommendations emerge which, when shared, may contribute to this area and approach to learning, particularly in the online domain:

- Institutions should consider embedding AI literacy and ethical AI use into Research Methods curricula.
- Supervisors should receive training on how to support students' use of AI tools constructively.
- Students should be encouraged to use GPT not only for academic drafting but also to refine their professional communication with other stakeholders in the teaching, learning and research process.
- Further research should examine long-term impacts of AI-supported supervision on academic outcomes and student confidence and overall performance in Higher Level education institutions.

In conclusion, ChatGPT has demonstrated real pedagogical value when introduced with clarity, transparency, and purpose. It represents not just a technological shift, but a cultural and pedagogical one—offering new opportunities for co-agency, digital competence, and the reimagining of academic support in online learning environments. With appropriate scaffolding, AI can support the development of not only better writing, but better writers…

References

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology, 52*, 1-26.

Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability, 21*(1), 5-31.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic Motivation and Self-Determination in Human Behavior*. New York: Plenum.

Holmes, W., Bialik, M., & Fadel, C. (2022). *Artificial Intelligence in Education: Promises and Implications for Teaching and Learning. B*oston: Center for Curriculum Redesign.

Jisc. (2023). *Artificial Intelligence in tertiary education: A summary of emerging issues and opportunities.* Retrieved March 18, 2025, from https://www.jisc.ac.uk/reports/artificial-intelligence-in-tertiary-education

King, A. (1993). From Sage on the Stage to Guide on the Side. *College Teaching, 41*(1), 30-35.

Knowles, M. S. (1975). *Self-directed Learning: A Guide for Learners and Teachers*. Chicago: Follett.

Laurillard, D. (2002). *Rethinking University Teaching: A Conversational Framework for the Effective Use of Learning Technologies* (2nd ed.). London: RoutledgeFalmer.

Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016*). Intelligence Unleashed: An Argument for AI in Education*. London: Pearson.

McNiff, J., & Whitehead, J. (2002). *Action Research: Principles and Practice.* London: RoutledgeFalmer.

OpenAI. (2023). *Teaching with AI: Opportunities and Considerations*. Retrieved March 18, 2025, from https://openai.com/education

Sadler, D. R. (1989). Formative assessment and the design of instructional systems. *Instructional Science, 18*, 119-144.

Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education, 36*(1), 111-139.

Selwyn, N., Nemorin, S., & Perrotta, C. (2023). AI and the future of assessment in higher education. *Teaching in Higher Education, 28*(5), 579-593.

Siemens, G. (2005). Connectivism: A learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning*, 2(1).

Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press.

Williamson, B. (2022). The automated university: Digital governance and algorithmic regulation in higher education. In B. Williamson, & R. Hogan (Eds.), *The Politics of Digital Education* (pp. 55-72). London: Routledge.

TECHNOLOGY INTEGRATION CHALLENGES AND ISSUES

Ronald J. Glotzbach
Purdue University / Associate Professor (USA)

Abstract

The integration of technology in education continues to raise important questions regarding its effective use in the classroom. Despite decades of technological adoption, concerns remain about the appropriateness of digital tools, their impact on student learning, and the potential distractions they create. The introduction of new technologies often leads to instructional gaps, ranging from basic skills like reading an analog clock to more complex issues such as understanding the proper context for device use. While technology promises increased efficiency in education, evidence supporting its effectiveness remains limited. In many cases, students become fixated on learning the tools themselves rather than using them to generate innovative ideas. Consequently, technology should be seen as a complement to, rather than the focal point of, the learning process. Additionally, as students' learning styles and social environments evolve, understanding the appropriate use of devices becomes increasingly crucial. Social-emotional learning has become a key factor in understanding how students relate to others and, in turn, how they learn. However, the push to collect data on students' learning patterns raises concerns about privacy and ethical implications. The collection and storage of personal data, whether intentional or not, could lead to future misuse by corporations or governments, raising serious ethical questions. Addressing these concerns requires a critical analysis of the issue, focusing on how devices can enhance learning without infringing on students' privacy. Criteria should be established to evaluate the collection, storage, and use of student data. This investigation should be conducted with an awareness of bias, ensuring that perspectives from diverse stakeholders are considered. By following these principles, potential solutions can be proposed, such as encrypting data to prevent unauthorized access. Ultimately, the goal is to strike a balance between leveraging technology for educational advancement and safeguarding student privacy.

Keywords: *Technology integration, curriculum, technology in teaching and learning*.

1. Introduction

As technology rapidly evolves, the challenge of effectively integrating it into classrooms becomes more complex. Technology is constantly changing, and with artificial intelligence becoming more prevalent in all aspects of life, keeping up with technological changes is more important than ever before. Educators are faced with the task of adapting new tools and platforms in ways that enhance learning, rather than simply adding them for the sake of novelty. Technology integration into educational settings has long been an issue as educators continually investigate and learn how to incorporate digital devices with learning outcomes. The present digital environment demands ever-increasing levels of technical literacy, meaning the ability to comprehend, utilize, and apply technology. As technological advancements sweep across all facets of life and work, those with technical skills are better equipped to handle problems as they arise. The present moment in time is leaving the past far behind and vaulting toward an increasingly bright tech-driven future where learners need to be equipped with the necessary technological skills (Ifinedo & Kankaanranta, 2021).

The swift rate of technological change can inundate educators, many of whom may not have been trained adequately in the effective use of new tools. Programs for professional development always seem to be a step behind the latest innovations and, as a result, teachers have to get along with the new software and hardware despite not having been shown how to use them effectively. This isolation can lead to some grumbling among the ranks, and a fair amount of reality in that a lot of teachers will not use what they are not comfortable with, especially if what they need to be comfortable with has not been taught to them yet.

The integration of technology carries with it a host of ethical and privacy concerns. As colleges and universities embrace new digital tools and platforms, they are encountering serious problems related to student data and its administration. Yet what are these institutions doing with the tremendous amount of personal information gathered about students? We might ask this question with well-founded skepticism because they are not always forthcoming with the answers. And even when they are, the answers we receive tend to raise more questions, even about the prospects for student privacy and data security in the future.

2. Challenges with technology integration

Integrating technology into education does not come without a number of present and future issues. Educators, administrators, and policymakers are responsible for navigating these rough waters to ensure that technology becomes a tool serving educational ends rather than an obstacle. One of the main issues is the varied pace of adoption among educators. Some teachers leap at digital tools and never-before-seen pedagogies, while others adopt at a more glacial pace, if at all. And is it right to assume that those who adopt slowly aren't doing something pedagogically sound that's also benefiting their students?

A substantial challenge lies in the possibility that technology might distract instead of boost learning (Glotzbach, 2024). With countless devices and applications, students can become easily wrapped up in games, social media, or other types of non-educational content. But in what ways does this lifestyle affect study time? Some students lack genuine engagement with the material. Can technology support the kind of distraction-free immersion that makes learning possible? Educators must balance this question and be ever more vigilant in countering the harmful power of distractions that new devices possess. Still, the sword cuts both ways, as there are also superb opportunities for genuine engagement that must not be overlooked.

Additionally, the effectiveness of technology in enhancing student academic performance remains a debatable issue. In spite of the potential of technology for producing much-needed efficiency and engagement, studies frequently show inconsistent results when it comes to the academic performance of students being enhanced through the use of digital devices. These mixed results are causing many to question the value, the appropriateness, and the overall effectiveness of certain digital tools, particularly with regard to how well they are aligned with some very important educational goals. What can be done to resolve this rather large and rather serious issue? More research and more consistent evaluation of what certain digital tools can and cannot do for students is certainly one place to start.

Ensuring equitable access to technology is a big job. It is especially important as our schools move more and more toward a digital future. The only thing worse than an education system that is not equal for all is one that is not equal and is also using digital tools. The digital divide is already bad enough without our making it worse by not attending to the demands of the situation. So we need to work hard to make providing access to technology part of our digital school toolbox, along with the other things digital school leaders know need to be in it.

3. Digital technology impacts on education

Digital technologies have significantly transformed education, prompting worldwide efforts to integrate information and communication technologies into school systems (Timotheou et al., 2023). However, this integration has raised concerns about teaching quality, system adaptation, and alignment with current technological trends. The COVID-19 pandemic further highlighted these challenges, exposing gaps in digital capacity and experience, leading to inequalities and learning losses. As a result, schools must enhance their digital preparedness and capacity to attain successful digital transformation. This process is complex, impacting various stakeholders within the school ecosystem. Studies have shown that the results of technology integration have not been promising and learning outcomes not met (Timotheou et al., 2023).

How profoundly has digital technology changed the educational landscape? It has changed in every conceivable way, from how students learn to how educators instruct and how educational institutions function. The very integration of digital tools in classrooms seems perfectly natural. The most significant repercussion of digital technology on education is access to learning resources. This means not just educational resources, but virtually any kind of books or information that serve as raw material for the knowledge production process. As such, it is access to libraries and yet, here we are today with virtual libraries where online platforms allow access to millions of books and high-quality materials. Furthermore, technology has the potential to facilitate a more personalized experience in the teaching and learning process.

As an example of technology use, the flipped classroom model is a kind of classroom makeover that provides students with direct, clear ways to interact and engage with the teacher in the learning process. Often, an online learning management system is used to facilitate this. It is different from the oftentimes stale and one-dimensional methods of teacher-centered lectures; instead, students are given the appearance of being in the driver's seat of their own education (Bauer & Haynie, 2017). Supporters of the flipped classroom contend that students are better equipped for class and thus learn more effectively. However, an opposing view is that not all students have equal access to the required devices or to a dependable internet service, which can create a digital divide that really harms learning (Schmidt & Ralph, 2016).

Yet, the heavy dependence on digital technology in education brings up the age-old question of the effectiveness of these newest of tools. Certainly, technology can be used in ways that make a decent learning experience better, but a rapidly growing body of evidence and concern suggests that the focus of a growing number of students is on the tools themselves and not on what the tools should be enabling them to do. More and more, students seem to be fixing their gaze on the digital devices they use or the websites they visit when, in fact, they should be using these devices and sites as tools of the mind to enable them to think in creative and critical ways.

Additionally, the implementation of technology in educational environments can craft diversions that impede the learning process. The presence of smartphones and other devices can lead to students multitasking, where they split their attention between academic assignments and social media or gaming (Glotzbach, 2024). This diversion can reduce the quality of learning and have a negative bearing on students' academic performance. Teachers are therefore tasked with finding ways to integrate technology sensibly and amply, ensuring that tech complements the teaching done and does not replace it.

As the landscape of education changes, so too do the social-emotional dynamics among students. Digital technology has flipped how students communicate, with a rapid trend toward virtual spaces over real-life ones. The move to a more digital dialogue necessitates a reexamination of what social-emotional learning (SEL) looks like in a data-driven, tech-heavy world. SEL, at its core, is about learning how to learn alongside others while also recognizing and respecting their differences (Is & Matters, 2019). Historically, the term was used to describe what it looked like inside a classroom. Even in our tech-obsessed culture, there is an inordinate amount of research that points to the importance of face-to-face interactions for both cognitive and social individuals.

4. Technology integration in teacher education

The integration of technology in teacher education is crucial for preparing pre-service teachers for modern classrooms. Data from 214 pre-service teachers showed that website design encouraged the integration of various areas of expertise, meaningful learning, and personal development, better preparing them for the 21st-century classroom (West & Malatji, 2021). However, students faced challenges like limited internet access and difficulties with video recording and uploading. A study determined that the use of Google Sites to help teachers both learn technology as well as integrate it into learning was effective (West & Malatji, 2021).

The infusion of technology into teacher education has become a modern pedagogical practice. As educational institutions adopt digital tools, the impact has been profound and multifaceted, offering future educators both opportunities and challenges. One of the most substantial benefits of technology integration in teacher education is the advancement of instructional techniques. Technology affords access to a plethora of resources and instruments that can stimulate the learning experience. For example, teacher candidates can use multimedia presentations, interactive simulations, and online collaborative tools to interact with their students in diverse and stimulating ways. This kind of exposure enables future educators to develop an arsenal of teaching strategies that accommodate various learning modalities and pushes them toward a more inclusive classroom.

Pre-service teachers are expected to have training in technologies and be proficient enough to both use and teach the use of them. Technology integration fosters the evolution of essential skills in teacher candidates. Digital literacy is a required skill set for all educators in the technology-driven world we live in. Proficiency with not only the tools of technology but also the underlying concepts is critical for doing almost any job in today's and tomorrow's world. By using technology in their own training, teacher education programs equip their students with the model for integrating technology into their own classrooms and with the understanding of how to use the digital tools that their students will encounter in life beyond school.

Furthermore, technology can be a tool for collaborative teamwork and communication among teacher education students. Future educators can share ideas, resources, and personal stories on online discussion forums, social media platforms, and collaborative workspaces. This degree of connectivity between future and current educators fosters an almost palpable sense of community. The enhancement of professional development and lifelong learning in this future educator community is as real as it is in the current educator community.

Even with these benefits, teacher education has a few problems when it comes to using technology. One of the major concerns is distraction. When using digital devices, it is all too easy to be sidetracked by the device itself or, more likely, by what is on the internet (Glotzbach, 2024). As the internet becomes an ever-larger part of our lives, what is on the internet becomes ever-better at grabbing our attention. Of course, being sidetracked is not a good thing. It is bad for content, for context, and for critical thinking. It is bad for just about everything that we might connect with education.

Moreover, technology's introduction can create instructional gaps. For instance, while digital tools are used expertly by some teaching candidates, the very basic skills foundational to the use of such tools may be lacking in some candidates. Skills as elemental as reading an analog clock versus a digital one might be an indicator of how some candidates have become so accustomed to using certain digital devices that they may not fully understand the context in which these devices should be used.

5. Privacy and ethics

A substantial barrier to technology integration comprises privacy and ethical concerns. With the sharp increase in our dependance on data to show how well our students are learning, we face the growing and serious worry about just how secure and properly used these personal treasures of ours are. Schools and educational institutions across the nation are left to make sense of not only innumerable data privacy laws but also an equal number of ethical guidelines. All the while, these schools and institutions are attempting to create a better, personalized educational experience for their students. What is required and what can head toward solving this problem is a deep and clear analysis of data practices themselves along with established criteria for the practices.

As educational institutions gather and study ever more of their students' personal data, it becomes vital to contemplate the possible misuse of that data, especially in light of all the recent publicity surrounding the use and abuse of personal data by some of our biggest tech companies. Much of the debate has centered on the question of whether or not students should be required to use these data-collecting tools, with those in favor arguing that the students will benefit from the analytics and those against it claiming that this is an inappropriate and possibly illegal use of personal data. When colleges and universities gather and retain ever-increasing volumes of information about students, more and more individuals become concerned about the security and privacy of the data being amassed. If these new technologies are not implemented in the right way, using the technologies can expose them to unseen technological risks (Rana et al., 2022).

6. Conclusions

To conclude, the digital revolution in education seems both inevitable and promising. The digital technology that pervades modern life offers not just tools for teaching—more powerful than any we've had before—but also striking new opportunities to engage students in their own learning. The integration of digital technology into the educational environment must be handled with a good deal of caution, though. The potent mix of distraction, inaccessibility, and some very real gaps in our current understanding of both the ethical and pedagogical use of technology makes for a pretty unsafe learning environment. And yet, when done right, the rewards make it all worthwhile.

The amalgamation of technology within teacher education brings with it both good and bad effects. It is true that tech makes for terrific instructional methods, pushes for widespread digital literacy, and makes collaborative opportunities abound. Yet, for every yin, there is a yang, and the distraction potential of tech, the possibility of nonexistent instructional gaps, and the unresolved issues of ethical behavior concerning the use of student data loom large as concerns. If modern educator preparation programs are to prepare the next generation effectively, they must necessarily walk an instructively sound and ethically safe pathway toward the seemingly ever-increasing tech horizon.

References

Bauer, A., & Haynie, A. (2017). How do you foster deeper disciplinary learning with the “flipped” classroom. *New Directions for Teaching and Learning, 151*(1), 31-44.

Glotzbach, R. J. (2024). Distraction and Fragmented Attention in Education: A Literature Review. *Proceedings of the 35th international conference of the Society for Information Technology and Teacher Education (SITE 2024)* (pp. 721-724).

Ifinedo, E., & Kankaanranta, M. (2021). Understanding the influence of context in technology integration from teacher educators’ perspective. *Technology, Pedagogy and education*, *30*(2), 201-215.

Is, W. I., & Matters, W. I. (2019). Social-emotional learning. *USA: Committee for Children*.

Rana, N. P., Chatterjee, S., Dwivedi, Y. K., & Akter, S. (2022). Understanding dark side of artificial intelligence (AI) integrated business analytics: assessing firm’s operational inefficiency and competitiveness. *European Journal of Information Systems*, *31*(3), 364-387.

Schmidt, S. M., & Ralph, D. L. (2016). The flipped classroom: A twist on teaching. *Contemporary Issues in Education Research, 9*(1), 1-6.

Timotheou, S., Miliou, O., Dimitriadis, Y., Sobrino, S. V., Giannoutsou, N., Cachia, R., ... & Ioannou, A. (2023). Impacts of digital technologies on education and factors influencing schools' digital capacity and transformation: A literature review. *Education and information technologies*, *28*(6), 6695-6726.

West, J., & Malatji, M. J. (2021). Technology Integration in Higher Education: The Use of Website Design Pedagogy to Promote Quality Teaching and Learning. *Electronic Journal of E-Learning*, *19*(6), 629-641.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

INTEGRATING GENERATIVE CHATBOTS IN SECONDARY ENGLISH TEACHING: A 2D3S4L MODEL FOR PEDAGOGICAL DESIGN

Wei Zhang, Dzintra Iliško, & Lipolelo Thamae
Educational Science, Daugavpils University (Latvia)

Abstract

This paper presents the 2D3S4L instructional model, designed to embed generative chatbots into secondary English classrooms with pedagogical coherence. The model aligns teaching and learning processes across two dimensions (teachers and students), three stages of instruction (pre-class, in-class, post-class), and four recursive loops (analyze, design, implement, evaluate). Grounded in sociocultural theory and the TPACK framework, the model was implemented in Chinese secondary schools using deep seek and Doubao AI to support writing, speaking, and reflective reading tasks. Findings show chatbots enhanced idea generation, linguistic accuracy, and learner autonomy, while teacher prompts and scaffolded feedback were critical for effective integration. Concrete examples illustrate how chatbots facilitate task execution and deepen reflection. The paper contributes a structured framework and practical guidance for future AI-enhanced language instruction.

Keywords: *Generative AI, secondary English, chatbot pedagogy, instructional design, task-based learning.*

1. Introduction

Generative artificial intelligence (AI) has opened new horizons for English language education. Tools like Deep Seek and Doubao AI offer learners real-time interaction, idea scaffolding, and language refinement. These capabilities reflect a broader trend in language education where AI increasingly supports diverse tasks from vocabulary practice to feedback generation (Zou & Wang, 2023; Wang&Dang, 2024). Despite these affordances, integration into secondary classrooms remains inconsistent, often driven by novelty rather than pedagogy. Without structured guidance, students may misuse chatbots as answer generators rather than dialogic partners. Teachers, in turn, lack frameworks to align chatbot capabilities with instructional goals. This paper responds by introducing the 2D3S4L model—a structured approach to pedagogically embed chatbots into language instruction. The model integrates two key actors (teachers and students), three temporal stages (pre-, in-, and post-class), and four recursive design loops (analyze, design, implement, evaluate). It is grounded in sociocultural theory and the TPACK framework, supporting intentional design and adaptive use of generative AI in classroom practice.

2. Objectives

This study explores how generative chatbots can support task-based English instruction through the 2D3S4L model. Objectives include: (1) to present a theoretically grounded and pedagogically actionable design framework; (2) to illustrate concrete teaching applications across writing, speaking, and reading tasks; and (3) to evaluate the roles chatbots play in supporting learner autonomy, language development, and metacognitive reflection.

3. Methods

To ensure transparency and rigor, the thematic analysis process drew upon Braun and Clarke's (2006) six-phase approach: familiarization, initial coding, theme generation, review, definition, and final reporting. Throughout this process, data from over 60 student artifacts, 18 student interviews, and 6 teacher observation logs were analyzed. All interviews and observation notes were transcribed verbatim. Student artifacts (e.g., written texts, chatbot interactions, annotated drafts) were anonymized and categorized by task type and grade level. We developed an initial coding framework based on Braun and Clarke's (2006) thematic analysis approach, beginning with open coding during familiarization. Two researchers

independently applied this framework to a subset of the data to calibrate consistency, followed by iterative refinement through discussion. Discrepancies were resolved through negotiated agreement. All remaining data were then manually coded using the agreed framework, with emergent themes identified inductively across the three task types. NVivo software was used to organize codes, support constant comparison, and ensure transparency in analytic decisions.

We employed a design-based research (DBR) methodology to develop and refine the 2D3S4L model in authentic classroom settings. Design-based research enables iterative, real-world intervention while maintaining theoretical grounding (Wang & Hannafin, 2005). The study involved three public secondary schools in China, comprising six English teachers and approximately 120 students across Grades 7 to 9. Teachers participated in a pre-study workshop on chatbot tools, prompt design, and pedagogical alignment. Tasks were co-constructed by researchers and teachers to embed chatbot interaction into curriculum-based learning goals. Three task types were implemented: opinion writing, tourist role-play speaking, and reflective reading. Chatbot use occurred during all instructional phases: idea activation, drafting, revision, feedback, and post-task reflection. Data included student texts, chatbot transcripts, classroom observations, and post-task interviews. A thematic analysis approach identified patterns in language outcomes, student attitudes, and pedagogical adaptations.

Two chatbot platforms were utilized with differentiated functions. DeepSeek was employed primarily for writing and reflection tasks, valued for its elaborative and coherent textual output. In contrast, Doubao AI supported spoken interactions, offering real-time pronunciation and fluency feedback suitable for dialogic practice.

While this study did not include a formal control group, learning gains were inferred from pre- and post-task comparisons, supported by triangulated data from student self-reports, teacher observations, and rubric-based assessments.

While both DeepSeek and Doubao AI were employed, they supported different instructional goals. DeepSeek was used primarily for extended writing and reflective discussion due to its elaborative textual responses, whereas Doubao AI's real-time speech feedback was better suited for spoken language practice.

4. The 2D3S4L instructional model

The 2D3S4L model is grounded in two core theoretical frameworks. First, sociocultural theory (Vygotsky, 1978) emphasizes the role of social interaction and mediated tools in learning. In this model, the generative chatbot is viewed as a semiotic tool that scaffolds learners' cognitive and linguistic development through dialogic engagement. Second, the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006; Koehler & Mishra, 2009) provides a structure for integrating AI tools into curriculum design, ensuring that technology use supports both content mastery and pedagogical aims (Mishra, 2023). These two perspectives collectively inform the structure of the model and guide its classroom implementation."

The model consists of three layers. First, the two dimensions: (1) teacher as designer and facilitator; (2) student as autonomous language generator. Second, the three stages: (a) pre-class chatbot priming (e.g., vocabulary activation, brainstorming); (b) in-class AI-supported performance (e.g., speaking drills, writing generation); (c) post-class metacognitive reflection (e.g., annotation, revision logs). Third, the recursive instructional loops—analyze learner needs, design chatbot prompts and activities, implement tasks, and evaluate both learning outcomes and chatbot behavior. Unlike tool-specific methods, 2D3S4L is platform-agnostic. Teachers adapt prompt complexity and chatbot roles to learner levels. The model views chatbots not as replacements for instruction but as dynamic tools that support negotiation of meaning, feedback literacy, and voice development.

5. Classroom implementation and case examples

5.1. Opinion writing task

In this writing task, students used the chatbot to generate outlines and retrieve relevant vocabulary during pre-class preparation. Teachers supported this by crafting guiding prompts and later encouraging students to annotate and reflect on AI-generated feedback. As a result, many students demonstrated improved fluency and coherence in their drafts. However, a common challenge emerged: several learners copied chatbot-generated phrases directly without contextual adaptation, prompting follow-up lessons on paraphrasing and voice development.

Teacher Strategy: Prompted prewriting with deepseek, and assigned reflection post-task.

Outcomes: Improved writing fluency and structure.

Challenges: Overreliance on copied phrases from chatbot.

Grade 7 students were assigned the task 'My Favorite Season.' Pre-class, the teacher crafted a prompt in ChatGPT that helped students generate outlines with reasons, examples, and vocabulary banks. During class, students expanded the outlines into full drafts with AI feedback on transitions, sentence fluency, and paragraph coherence. Post-class, they annotated chatbot edits, justifying revisions or rejections. While writing quality improved, several students copied phrases without contextual adaptation. Teachers responded by guiding discussions around language ownership and added a follow-up activity requiring students to rephrase chatbot suggestions in their own words. The task highlighted the model's reflection phase, encouraging metalinguistic awareness and critical engagement with AI suggestions (Eisenring et al., 2024).

5.2. Tourist role-play speaking task

For the speaking task, students interacted with Doubao AI to simulate tourist dialogues. The AI provided real-time feedback on pronunciation and sentence fluency. Teachers scaffolded these performances by reviewing recordings with students and highlighting moments of linguistic creativity. While the activity boosted learner confidence, it also revealed a tendency to mimic AI-generated structures, especially among less confident speakers.

Grade 8 students used Doubao AI to simulate tourist dialogues. Pre-task vocabulary review was followed by in-class chatbot interactions focused on giving directions and handling questions. Chatbot feedback included pronunciation correction and real-time fluency suggestions. Teachers observed increased confidence, but also noticed mimicry of AI structures. Post-task recordings were reviewed by students to evaluate conversational tone and complexity. In one case, a student modified AI-suggested sentences to include idiomatic expressions, demonstrating linguistic personalization. The teacher emphasized that AI outputs are scaffolds, not scripts, and required students to reflect on what made their version stronger or more authentic.

5.3. Reflective reading task

In the reading task, students engaged with chatbot-generated responses to questions about Mandela's biography. They were then encouraged to critique, modify, or extend the chatbot's answers through journaling and peer review. This led to thoughtful reinterpretations and deeper personal engagement. Still, some students initially accepted the chatbot's optimism uncritically, highlighting the need for explicit instruction in critical reading and stance formation.

Grade 9 students engaged with Mandela's biography and used deepseek to explore questions like 'What would Mandela advise modern leaders?' Students responded by editing, challenging, or extending the chatbot's answer. While most AI-generated responses emphasized optimism, several students critiqued this stance and included more nuanced socio-political contexts. One teacher commented that 'the AI helped launch discussion, but the real depth came from disagreement.' This task illustrated the chatbot's role as a dialogic partner, not an authority. It activated reflective reading and interpretation, with students refining their stances through post-task journaling and peer review.

To provide a clearer picture of how the 2D3S4L model functioned across the implemented tasks, Table 1 summarizes key contrasts in student-AI engagement, instructional strategies, observed learning outcomes, and implementation challenges.

Table 1. Comparative Summary of AI-integrated Tasks.

Task Type	Student Use	Teacher Strategy	Outcome	Challenge
Opinion Writing	Generate outline, vocabulary	Prompt design + revision reflection	Improved fluency	Copying AI phrases
Role-Play Speaking	Dialogue with AI, pronunciation feedback	Scaffold performance + playback	More confidence	Structural mimicry
Reflective Reading	Debate AI interpretation	Journaling + peer review	Stronger critical thinking	Adopting AI views uncritically

5.4. Thematic findings from classroom data

Thematic analysis revealed four recurring themes across the three tasks and grade levels. These themes captured students' cognitive, emotional, and behavioral engagement with chatbot-supported learning. Table 2 summarizes each theme, a brief description, representative evidence, and observed frequency.

Table 2.

Theme	Description	Sample Evidence	Frequency
AI as Confidence Booster	Chatbots lowered students' anxiety and encouraged language risk-taking.	"It doesn't laugh at my mistakes." (G8 student)	Reported by 13 of 18 interviewed students
Surface Dependence on AI Output	Students initially copied AI-generated text without personal adaptation.	Copied 'Spring is the season of rebirth...' from chatbot.	Found in 9 of 20 early writing samples
Importance of Teacher Scaffolding	Structured prompts and modeling led to better AI engagement.	Revised 'Mandela was a great leader' into more nuanced version.	Observed in all 3 classrooms
Reflection Promotes Personalization	Post-task reflection led to critique and deeper understanding.	"The AI missed the political side." (Student journal)	Found in 10+ annotated journals

6. Discussion

Findings suggest the 2D3S4L model supports meaningful chatbot integration in secondary English classes. Across tasks, students were observed to use chatbots for idea generation, draft expansion, and reflective evaluation. This aligns with recent research showing that generative AI enhances writing fluency and accuracy while also posing challenges for voice and authenticity (Wang & Dang, 2024). Teachers served as AI mediators—designing prompts, interpreting outputs, and helping students reframe responses. The cyclical structure promoted feedback literacy and learner agency. Though lacking a control group, progress was gauged via before/after trends and triangulated data.

In addition to qualitative reflections, selected student work was rated using a standardized rubric (adapted from CEFR writing descriptors). Among 24 writing samples, 18 showed improvements of at least one band level in coherence and lexical range, with average writing scores increasing from 3.1 to 4.2 (out of 5). In oral tasks, peer-assessed fluency ratings improved for 72% of participants. Post-task surveys indicated that 86% of students agreed AI feedback helped them notice weaknesses in their argumentation or organization.

Notably, a minority of participants (3 out of 24) demonstrated limited gains despite full access to AI tools. Follow-up interviews revealed contributing factors including digital unfamiliarity, lack of motivation, and passive engagement. This reinforces the need for adaptive onboarding, ongoing teacher monitoring, and personalized scaffolding strategies.

However, success depended on metacognitive scaffolding. Without explicit post-task analysis, students risked copying AI-generated structures. Metacognitive scaffolding is essential to help learners internalize AI suggestions rather than reproduce them mechanically (Mason et al., 2023; Barkley, & Major (2024). Classroom norms and feedback tasks played a vital role in transforming chatbot use from passive assistance to co-construction. The model proved adaptable across language skills and grade levels, affirming its utility in scaffolded language learning environments.

As AI becomes a classroom co-participant, its integration demands thoughtful pedagogical design. Observed classrooms showed students not only used AI output but learned to question and revise it. This triadic engagement—between self, peer, and machine—indicates a shift toward collaborative meaning-making. Institutionally, this evolution requires teacher training, cross-departmental planning, and policy support for sustainable practice.

7. Conclusions

The 2D3S4L model offers a robust framework for integrating chatbots into language instruction with pedagogical coherence. It aligns technology use with student needs and reflective learning cycles. Classroom implementation across three task types demonstrates the model's adaptability and potential to foster fluency, autonomy, and critical thinking. Future work should explore longitudinal impact, student-AI interaction styles, and cross-linguistic applicability. Building teacher capacity through targeted training in prompt design and AI critique remains essential.

8. Limitations and ethical considerations

This study was limited by sample size and geographical scope. Findings may not generalize to schools with different digital access or cultural contexts. In addition, AI novelty may have temporarily boosted student motivation. Ethical considerations also emerged: students occasionally treated chatbot output as truth without question, underscoring the need for AI literacy. Privacy concerns remain, particularly regarding data handling in cloud-based platforms. Ethical frameworks such as those proposed

by UNESCO (2021) and the OECD (2024) emphasize the importance of transparency, informed consent, and digital equity when deploying AI in educational contexts. Educators must critically assess tools before adoption and foster dialogue around AI responsibility and reliability in learning contexts. Additionally, although triangulation of data was applied, the coding process was conducted by researchers immersed in the Chinese education context, which may introduce interpretive bias. Student English proficiency levels varied across classes, potentially influencing the depth of chatbot engagement. These factors limit generalizability and highlight the need for replication in diverse educational settings.

Beyond individual performance, the model encouraged collaborative dialogue about AI. Students often discussed chatbot limitations, such as vague topic development or unnatural phrasing, and collectively improved on them. This positioned AI as a third-party reviewer—neither teacher nor peer—whose presence provoked both critique and creativity. Such interactions reflect emerging AI literacy and emphasize the value of critical digital citizenship in education.

Another significant insight relates to the role of teacher agency. While chatbots provided consistent feedback, it was the teacher's intervention—through prompt design, scaffolding, and feedback interpretation—that transformed AI interaction into genuine learning opportunities. Teachers noted that modeling how to question and negotiate with chatbot output helped students move beyond surface-level dependence. Ultimately, the model empowered teachers to reposition AI not as a replacement, but as a co-facilitator within a carefully orchestrated learning environment.

Acknowledgments

This article was completed during a time of deep emotional difficulty. At a point when finding inner peace seemed impossible, the café Ezīša Kofišops became a place of calm and comfort. I would also like to express heartfelt gratitude to my friend, Tarun. As fellow INFPs, he resonated with everything I expressed. Lastly, thank my supervisor, Dzintra for her encouragement and thoughtful revisions of the thesis, and my dear colleague, Lipolelo Thamae. Cooperating with you is greatly joyful.

References

Chandel, P., & Lim, F. V. (2024). Generative AI and literacy development in the language classroom: A systematic review of literature. *Ubiquitous Learning: An International Journal*, 18(2), 31-49.

Eisenring, M. A., et al. (2024). The use of chatbots in English language teaching to promote modern language learning: A literature review. *International Journal of Indonesian Education and Learning*, 8(1), 127-139.

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education, 9*(1), 60-70.

Wang, H., & Dang, A. (2024). Enhancing L2 writing with generative AI: A systematic review of pedagogical integration and outcomes. *Preprint posted on Research Gate, October 2024.* Retrieved May 30, 2025, from: https://www.researchgate.net/publication/384732061

Mason, J., et al. (2023). Metacognitive strategies to grow students' independent thinking. *Turnitin Blog*. Retrieved April 30, 2025, from https://www.turnitin.com/blog/metacognitive-strategies-to-grow-students-independent-thinking

Mishra, P. (2023). *TPACK in the age of ChatGPT and generative AI*. Retrieved April 20, 2025, from https://punyamishra.com/wp-content/uploads/2023/08/TPACK-in-the-age-of-ChatGPT-and-Generative-AI.pdf

OECD. (2024). *The potential impact of artificial intelligence on equity and inclusion in education*. Retrieved April 30, 2025, from https://www.oecd.org/education/the-potential-impact-of-artificial-intelligence-on-equity-and-inclusion-in-education.pdf

UNESCO. (2021). *Recommendation on the ethics of artificial intelligence*. Retrieved April 30, 2025, from https://www.unesco.org/en/artificial-intelligence/recommendation-ethics

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational Technology Research and Development, 53*(4), 5-23.

Barkley, E. F., & Major, C. H. (2024). Scaffolding AI as a learning collaborator: *Integrating artificial intelligence in college classes.* K. Patricia Cross Academy. Retrieved April 30, 2025, from https://kpcrossacademy.ua.edu/scaffolding-ai-as-a-learning-collaborator-integrating-artificial-intelligence-in-college-classes/

Zou, B., & Wang, D. (2023). Artificial intelligence in language education: A review of recent developments. *Computer Assisted Language Learning, 36*(2), 123-140.

HARNESSING TIKTOK TO ENHANCE GRADE 10 LEARNER ENGAGEMENT IN LIFE SCIENCES CLASSROOMS

Thapelo John Vukeya, Lydia Mavuru,
Lwazi Nsindiso Mkhwebane, & Khanyisile Nolwazi Sethole
Department of Mathematics, Science & Technology Education, University of Johannesburg (South Africa)

Abstract

The integration of modern technologies in the classroom has become a key strategy to enhance learner engagement, particularly in subjects like Life Sciences. TikTok, a popular social media platform, hold significant potential as an educational tool to enhance engagement among Grade 10 Life Sciences learners in South African township schools. However, existing research indicates that while TikTok is widely recognized for its entertainment value, its application in education remains underexplored, particularly in addressing common teaching challenges such as limited classroom time, learner disengagement, and language barriers. As such, the current study sought to investigate how the integration of TikTok by Grade 10 Life Sciences teachers enhances learner engagement. The research was grounded in Cognitive Load Theory (CLT), which elucidates that since learners' working memory has a limited capacity, effective learning requires minimizing extraneous cognitive load, managing the inherent difficulty of the material, and fostering meaningful knowledge construction enhance comprehension and retention, particularly in complex subjects like Life Sciences. A qualitative case study approach was employed, including semi-structured interviews and classroom observations of five Grade 10 Life Sciences teachers from four Soweto township schools. The findings reveal that TikTok's short, visually engaging videos helped simplify complex scientific concepts, making them more accessible to learners, particularly those who are digital natives. Teachers reported that TikTok's concise, visually appealing content aligned well with learners' learning preferences, especially those accustomed to consuming content on social media. The ability to present content in an engaging and easily digestible format contributed to increased learner focus and participation during the lessons. However, the study also identified challenges, including issues of digital accessibility. Some learners lacked smartphones or reliable internet access, which limited their ability to participate in TikTok-based learning activities. Additionally, some teachers noted the potential for distractions, as learners were tempted to create their own TikTok videos during lessons, which could disrupt the classroom environment and undermine educational objectives. Based on these findings, the study recommends more investments in digital infrastructure to bridge the digital divide, ensuring equal access to technology for all learners. It also calls for professional development for teachers in educational technology to maximize the benefits of TikTok in the classroom. Furthermore, the study suggests incorporating digital media literacy into the curriculum to better equip learners for the digital world.

Keywords: *Engagement, grade 10, harnessing, life sciences, TikTok.*

1. Introduction

In recent years, social media platforms such as TikTok have gained immense popularity among learners, shaping how they consume and engage with content. Martin et al. (2018) posit that learners spend significant time interacting with TikTok, primarily for entertainment. Similarly, de Silva (2016) highlights that the current generation of learners is increasingly inclined toward using smartphones, influencing their preferences for digital and interactive learning tools. Given this shift, this study argues that Life Sciences teachers should leverage TikTok as an educational tool to enhance learner engagement, attention, and interest. Life Sciences, as a subject, encompasses abstract and complex scientific concepts, processes, laws, and theories that many learners find abstract and challenging to grasp (Mkhwebane, 2024). This challenge is particularly pronounced in township schools, where learners from marginalized and Indigenous communities often struggle to relate Life Sciences content to their socio-cultural backgrounds (Mavuru, 2022).

A lack of engagement in Life Sciences has led to reluctance among learners to pursue the subject, often due to fear of failure (Nwokocha & Legg-Jack, 2024). Those who enroll in the subject frequently experience low motivation and disengagement when confronted with complex scientific concepts (Mkhwebane, 2024). This issue is exacerbated by Life Sciences teachers' reliance on traditional teaching methods, which fail to stimulate learners' curiosity, interest, and motivation (Nwokocha & Legg-Jack, 2024). According to de Silva et al. (2016), a key factor behind this pedagogical stagnation is the limited professional development opportunities for teachers to integrate social media into their teaching practices. Without adequate training, many teachers continue using outdated traditional approaches, neglecting more innovative and interactive methods that could make learning more engaging.

In response to these challenges, this study explores the potential of TikTok as a tool for demystifying the teaching and learning of Life Sciences, particularly in township schools. TikTok's short-form videos allow teachers to present content in an engaging, audio-visual format that stimulates both visual and auditory processing (Radin & Light, 2022). This multimodal approach fosters inclusivity by accommodating diverse learning preferences and easing cognitive load—an essential consideration given the cognitively demanding nature of Life Sciences (Mkhwebane, 2024). By presenting information in a structured yet visually appealing manner, TikTok helps learners process and conceptualize scientific concepts more effectively while preventing cognitive overload.

Moreover, TikTok allows learners to revisit content at their own pace, facilitating self-directed learning and revision (Hearth, 2020). Research indicates that poor academic performance in Life Sciences is often linked to learners spending excessive time on social media for non-academic purposes (Yélamos-Guerra et al., 2022). Therefore, by integrating TikTok into teaching, teachers can redirect learners' social media engagement toward academic content, potentially improving their performance in Life Sciences.

Beyond improving comprehension and academic outcomes, TikTok also offers Life Sciences teachers an opportunity to create more dynamic, enjoyable, and engaging learning experiences (Ardiana & Ananda, 2022). Traditional teaching pedagogies, still widely implemented in South African township schools, often fail to captivate learners, leading to continued disengagement and declining performance. If this trend persists, the country risks producing fewer science graduates, exacerbating the shortage of skilled professionals needed to address critical sustainability challenges (Mkhwebane, 2024). Despite the potential of TikTok as an educational tool, its integration into Life Sciences teaching in South African township schools remains underexplored. Thus, this study investigates how the integration of TikTok by Grade 10 Life Sciences teachers enhances learner engagement.

2. Theoretical frameworks

This study was informed by Cognitive Load Theory (CLT), conceptualized by Sweller (2004), which posits that learners' working memory has a limited capacity when processing new information. To facilitate effective learning, teachers must present content in ways that reduce cognitive load, a crucial consideration in Life Sciences, where cognitively demanding content often feels disconnected from the lived experiences of township learners (Mkhwebane, 2024; Mavuru, 2022). CLT differentiates between intrinsic load, which pertains to the complexity of the material itself; extraneous load, which refers to the way content is delivered; and germane load, which involves the mental effort dedicated to constructing and organizing knowledge (Sweller, 2020; Van Merrienboer & Ayres, 2005). In alignment with CLT, this study contends that TikTok's short, visually engaging videos can help mitigate cognitive overload by chunking complex scientific concepts into manageable segments. By leveraging TikTok's multimedia features, teachers can minimize extraneous load through concise, interactive content while promoting germane load by encouraging learners to engage with and make sense of the material actively. The platform's engaging format fosters deeper understanding, making abstract Life Sciences concepts more accessible and relevant to learners.

3. Research Methodology

This study employed a qualitative case study design (Creswell & Creswell, 2018) to provide an in-depth understanding of how TikTok influences learner engagement in Grade 10 Life Sciences classrooms. This approach allowed for the exploration of teachers' nuanced experiences and perspectives regarding integrating TikTok into their teaching practices.

The study purposively selected four Grade 10 Life Sciences teachers from four township schools in Soweto, using predefined selection criteria (Cohen et al., 2017). To be eligible for participation, teachers had to (i) be actively involved in teaching Grade 10 Life Sciences, (ii) have a minimum of two years of teaching experience, and (iii) be willing to integrate TikTok as a pedagogical tool in their classrooms.

Data was collected through semi-structured interviews and lesson observations to gain insights into teachers' perceptions and pedagogical practices related to TikTok integration. Each participant participated in one semi-structured interview, which focused on their perceptions regarding using TikTok to enhance learner engagement. This was followed by one lesson observation per teacher, which investigated how they integrated TikTok into their lessons and how learners engaged with the platform during teaching. The Reformed Teaching Observation Protocol (RTOP) by (Sawada et al., 2002) was used to document and analyze lesson episodes, ensuring a structured assessment of teaching practices.

Following Braun and Clarke's (2006) six-step framework, thematic analysis was employed to analyze the data collected systematically. Teachers' interview responses were transcribed verbatim and subjected to coding, categorization, and theme development to identify patterns and key insights. The emerging themes provided a structured interpretation of how TikTok influenced learner engagement in the Life Sciences classrooms.

4. Research findings

Three themes emerged from the analysis of the findings from the analyzed data: Life Sciences teachers' perception of integrating TikTok when teaching to enhance learner engagement and Possible challenges of using TikTok for teaching and learning and Life Sciences teachers use TikTok to enhance learner engagement.

4.1. Life Sciences teacher's perception of integrating TikTok when teaching to enhance learner engagement

The findings of this study reveal that Life Sciences teachers hold positive perceptions toward integrating TikTok as a pedagogical tool. Teachers strongly endorse TikTok as a valuable platform for increasing learner engagement and improving comprehension of complex scientific concepts. Given that Life Sciences contains abstract and cognitively demanding content, teachers recognize the importance of leveraging digital tools that align with learners' interests and technological habits. Mr. Themba stated, *"I feel like in the 21st century, it is very important to include things such as TikTok in teaching because it can encourage learners to engage and grasp the subject matter."* This response highlights teachers' awareness of the necessity to incorporate modern, technology-driven strategies to enhance student participation and conceptual understanding. Furthermore, teachers acknowledge that learner engagement is intrinsically linked to their interests and digital consumption patterns. In today's digital age, learners spend significant time on social media, making platforms like TikTok an effective tool to capture their attention and sustain engagement. The teacher shared the following sentiments:

Ms. Nosipho: These learners are always on their phones, so you might as well use that to your advantage as a teacher.

Mrs. Lerato: Most learners like to create videos for entertainment, so I think if we use this as teachers, we can make their learning more enjoyable.

These responses demonstrate teachers' recognition of the potential of TikTok to transform passive learning into an interactive, learner-driven experience.

Additionally, the findings indicate that teachers are willing to move away from traditional, lecture-based teaching methods in favor of more dynamic, learner-centered approaches that maximize engagement. This shift is evident in the sentiments shared by Mr. Thabo: *"It is important for us as teachers to take advantage of these trends to ensure that we teach well and keep learners engaged."* Similarly, Mrs. Lerato emphasized, *"As teachers, we need to adapt and innovate our teaching practices to maximize learner engagement."* These perspectives suggest that teachers are becoming more open to integrating digital tools into their instructional strategies to align with evolving learner needs and preferences.

Moreover, teachers recognize that relying solely on traditional teaching methods risks disengagement, cognitive overload, and poor academic performance, particularly in Life Sciences, where learners often struggle to grasp abstract concepts. By integrating TikTok, teachers can bridge the gap between traditional teaching and modern digital engagement, ensuring that lessons are both accessible and stimulating. The integration of short, visually engaging videos allows for the chunking of information, which reduces cognitive overload and supports incremental knowledge acquisition. This aligns with the broader need for adaptive and inclusive teaching strategies that cater to diverse learning styles, particularly in under-resourced township schools where learners often lack access to supplementary learning materials outside the classroom.

4.2. Possible challenges of using TikTok for teaching to enhance learner engagement

Although teachers generally viewed the integration of TikTok as a valuable and innovative teaching strategy, they also raised concerns about the challenges associated with its implementation, particularly in under-resourced township schools. One of the primary concerns was the digital divide, as

not all learners have access to smartphones or affordable internet data to engage with TikTok content outside the classroom. This challenge was emphasized by Mr. Themba, who stated, *"Some learners do not afford to buy smartphones, and this may disadvantage those who cannot afford them, and we have plenty of such learners in our school."* Similarly, Ms. Nosipho highlighted the issue of data accessibility, stating, *"Some learners do not afford to buy internet data to access TikTok videos that we will be uploading for them to engage with."*

These statements underscore the inequities in access to digital resources, which could result in the exclusion of many learners who lack the financial means to participate in TikTok-based learning activities. In township schools without free internet access, reliance on personal mobile data to access educational content further exacerbates existing socio-economic disparities. As a result, integrating TikTok into Life Sciences teaching could unintentionally widen the learning gap, disadvantaging learners unable to access the platform while benefiting those with digital resources.

Another critical challenge raised by teachers was the lack of professional development and training on integrating TikTok into teaching. All participating teachers reported never receiving formal training on using TikTok for educational purposes, either during their preservice teacher education or as in-service teachers. While teachers expressed enthusiasm and willingness to incorporate TikTok into their lessons, the absence of training presents a significant barrier to effective implementation. Despite their willingness to integrate TikTok, teachers recognized that without adequate training, they might struggle with its meaningful and structured use in the classroom.

4.3. Life Sciences teachers' use of TikTok to enhance learner engagement

The challenges related to the lack of training, internet access, and smartphone availability were evident during lesson observations, highlighting the practical barriers teachers faced in integrating TikTok into their teaching. For instance, in Mr. Themba's classroom, when he asked learners to take out their smartphones, log in to TikTok, and view the content he had shared, fewer than 20 out of 65 learners had smartphones, and less than half of those had internet data. This significantly disrupted his lesson plan, as the intended interactive experience was no longer feasible. As a result, Mr. Themba was forced to use the interactive whiteboard (IWB) to display pre-recorded TikTok videos on cellular respiration for the entire class. Similarly, all four participating teachers had to adapt their strategies by using IWBs to display videos for learners rather than allowing individual engagement through personal devices. This shift limited the interactive potential of TikTok-based learning, as learners could not actively participate in the creation or personalized exploration of TikTok content. Instead, they became passive consumers of videos pre-recorded and uploaded before class.

Nevertheless, despite these challenges, using TikTok successfully enhanced learner interest, curiosity, and engagement. In Mrs. Lerato's class, learners were heard expressing enthusiasm, with one remark: "Today learning is going to be fun. I really love TikTok content." This response suggests that merely incorporating TikTok into the lesson created excitement among learners, indicating a positive shift in engagement levels. Similarly, after his lesson, Mr. Thabo jokingly commented, "I should use TikTok because you guys were engaged and attentive today." His remark reflects an acknowledgment of the platform's effectiveness in capturing learners' attention, reinforcing its potential as a valuable educational tool.

Additionally, learner body language and focus during the lesson suggested heightened engagement, as students appeared more attentive and responsive than usual. This observation aligns with the notion that TikTok's familiar, visually stimulating format resonates with digital-native learners, making learning more relatable and enjoyable. While the lack of access to individual devices limited the full interactive potential of TikTok-based learning, the platform still demonstrated its ability to generate enthusiasm and sustain learner engagement in Life Sciences classrooms.

5. Discussion, implications and conclusions

The findings of this study reveal that Life Sciences teachers view TikTok as a valuable tool for engaging the current generation of learners. This perspective aligns with de Silva's (2016) assertion that using technologies and social media platforms in teaching increases learner engagement. Additionally, the findings indicate that TikTok enhances learner engagement, curiosity, motivation, and interest, as also noted by Ardiana and Ananda (2022). This was evident in the lessons, where learners became more enthusiastic and eager to learn upon being informed that TikTok would be used as part of the teaching process.

However, contrary to Radin and Light's (2022) finding that TikTok promotes interactivity in lessons, this study found that passive learning could sometimes occur. This was due to the lack of smartphones and internet bundles among learners, which forced teachers to display videos through

interactive whiteboards (IWBs). The study also identified a lack of teacher training, which mirrors de Silva's (2016) claim that teachers often lack the professional development to integrate smart technologies and social media into their teaching effectively. Furthermore, using TikTok helped prevent cognitive overload by providing short, visually appealing videos that allow learners to process new information in manageable chunks (Sweller, 2020). The recommendations of this study include professional development for teachers on technology and social media integration and partnerships to subsidize digital access for disadvantaged learners. This will ensure inclusive, innovative educational practices in resource-constrained settings.

References

Ardiana, E., & Ananda, A. (2022). The Effect of Using the Tiktok Application as a Learning Media on the Activeness and Learning Outcomes of Class XI Social Sciences Students in Sociology Subjects at SMA N 1 Ampek Angkek. *Langgam: International Journal of Social Science Education, Art and Culture*, *1*(02), 22-29.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77-101. https://psycnet.apa.org/doi/10.1191/1478088706qp063oa

Cohen, L., Manion, L., & Morrison, K. (2017). *Research methods in education*. Routledge.

Creswell, J. W., & Creswell. J. D. (2018). *Research design: Qualitative, quantitative and mixed methods approaches.* SAGE.

De Silva, C. R., Chigona, A., & Adendorff, S. A. (2016). Technology integration: Exploring interactive whiteboards as dialogical spaces in foundation phase classrooms. *The Turkish Online Journal of Educational Technology*, *15*(3), 141-150.

Flores, F. A., Maguate, G., Moises, R., Ohoylan, J. G., & Alegre, A. (2024). TikTok Application to the Students' Performance in Science. *International Multidisciplinary Journal of Research for Innovation, Sustainability, and Excellence (IMJRISE)*, *1*(2), 97-106.

Hearth, P. (2020). Impact of TikTok on university Students' academic achievement: A case of UvaWellasa University of Sri Lanka. *The American Journal of Humanities and Social Sciences Research*, *3*(6), 141-146.

Mkhwebane, L. N. (2024). Life sciences teachers' integration of indigenous knowledge: A vision for making science classrooms culturally responsive. *EURASIA Journal of Mathematics, Science and Technology Education*, *20*(8), 1-12. https://doi.org/10.29333/ejmste/14859

Sawada, M., Judson, K., Falcon, A., Benford, G., & Bloom, C. (2002). Measuring reform practices in science and mathematics classrooms: The reformed teaching observation protocol. *School of Science and Mathematics, 102*(6), 245-253. https://doi.org/10. 1111/j.1949-8594.2002.tb17883.

Martin, F., Wang, C., Petty, T., Wang, W., & Wilkins, P. (2018). Middle School Students' Social Media Use. *Educational Technology & Society*, *21*(1), 213-224.

Mawere, M. (2015). Indigenous knowledge and public education in sub-Saharan Africa. *African spectrum*, *50*(2), 57-71. https://doi.org/10.1177/000203971505000203

Nwokocha, G., & Legg-Jack, D. W. (2024). Reimagining STEM education in South Africa: Leveraging indigenous knowledge systems through the M-Show model for curriculum enhancement. *Journal of Social Sciences Research and Review*, *7*(2), 173-189.

Radin, A. G., & Light, C. J. (2022). TikTok: an emergent opportunity for teaching and learning science communication online. *Journal of microbiology & biology education*, *23*(1), e00236-21.

Spence, A., Beasley, K., Gravenkemper, H., Hoefler, A., Ngo, A., Ortiz, D., & Campisi, J. (2020). Social media use while listening to new material negatively affects short-term memory in college students. *Physiology & Behavior*, *227*, 113172.

Sweller, J. (2004). Instructional design consequences of an analogy between evolution by natural selection and human cognitive architecture. *Instructional science*, *32*(1), 9-31.

Sweller, J. (2020). Cognitive load theory and educational technology. *Educational technology research and development*, *68*(1), 1-16.

Van Merrienboer, J. J., & Ayres, P. (2005). Research on Cognitive Load Theory and Its Design Implications for E-Learning. *Educational Technology Research and Developments*, *53*(3), 5-13.

Yélamos-Guerra, M. S., García-Gámez, M., & Moreno-Ortiz, A. J. (2022). The use of Tik Tok in higher education as a motivating source for students. *Porta Linguarum Revista Interuniversitaria de Didáctica de las Lenguas Extranjeras*, *38*, 83-98.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

APPROACHES OF GENDER DIVERSITY IN KINDERGARTEN: A LITERATURE INTERVENTION THROUGH PICTUREBOOKS

Despoina Pechlivanidou, & Christina Kalaitzi
Department of Early Childhood Studies, Institute of Education, Mediterranean College (Greece)

Abstract

The aim of the current research is to explore if it is possible for preschool students to alter their perceptions of gender stereotypes, through a literature intervention. A sample of thirty kindergarten students participated in a semi-structured interview which primarily focused on the impact of gender stereotypes on a) colours, b) clothing, c) toys, d) sports, e) occupations, and f) appearance. Students were equally divided into a Control and an Experimental Group, with the latter participating in a literature intervention. The intervention consisted of five phases with activities based on five different picturebooks. The selection of the picturebooks was based on their depictions and portraits of diversity on gender issues. The findings corroborate the existing literature, indicating that the majority of preschool students have already internalized numerous stereotypes before entering the school environment. A notable deviation in Experimental Group's answers at post-intervention was observed. Their answers and positive attitude to the possibility of change, could be interpreted as the shift in Experimental Group's perceptions regarding gender diversity. This shift in perspective reveals the impact of the intervention, given the lack of any deviation in Control Group's perceptions about gender stereotyped roles. Discussion on findings, highlights the fact that literature interventions using gender diversity-themed picturebooks in the preschool setting can bring about significant changes and prompt students to reconsider their perspectives on gender roles.

Keywords: *Gender diversity-themed picturebooks, literature intervention, gender role perceptions, gender stereotypes, kindergarten.*

1. Introduction

Rooted in societal norms, gender is expressed through various means, shaping behaviors and perceptions from early childhood. Babies and toddlers rapidly form ideas related to gender, influencing their choice of activities, exploration of interests, and pursuit of objectives. In essence, preschoolers already possess firm understandings of gender, which serve as fundamental prior knowledge (Stangor & Ruble, 1987). Leveraging this prior knowledge, our brains efficiently gather and process pertinent information, facilitating quicker and simpler classification learning when presented with stimuli (Paetcher, 2003). Levy and Carter (1989) in their study of gender schema theory emphasized preschoolers' cognitive processes in shaping gender-role stereotype attributions. Contemporary perspectives, drawing from information-processing frameworks, delve into children's acquisition of gender roles, underscoring subconscious motivations to conform to societal norms. While theories may differ, scholars advocate for a nuanced understanding that integrates cognitive processes and sociocultural influences in shaping gender identity (Levy & Carter, 1989; Paetcher, 2003).

2. Literature review

2.1. Gender stereotypes in early childhood

By around age 2, children begin to develop notions of gender, and typically, by age 3, most children can identify themselves as either a boy or a girl. Between the ages of 3 and 5, children begin to form their gender identity and start to understand what it means to be a girl or a boy. As they strive to fully understand themselves, children begin developing stereotypes, which they apply to themselves and others. By the age of 5, gender stereotypes are typically quite established, and they tend to solidify even further between the ages of 5 and 7 (Martin & Ruble, 2004).

A child's perceptions of gender roles may be influenced by family as well as school environment, which are considered the direct factors of socialization. Further parameters that can affect those perceptions are media, religion and cultural norms, which are termed as indirect actors (Stangor & Ruble, 1987). Expanding upon previous critical insights, contemporary perspectives on early gender role development now focus on understanding children's acquisition and application of gender roles, through an information-processing lens (Liben et al. 2002; Martin & Ruble, 2004).

Gender role expectations may vary and include physical characteristics, as well as many activities, skills, interests, and occupations (Liben et al. 2002). Boys and girls obtain different kinds of treatment in various areas, such as academic performance, verbal interaction and acceptable behaviors (Riley, 2014). This pattern is also observed in cultural constructions like toys, books, movies and TV series. Toys, being cultural artifacts, are undeniably shaped by gender stereotypes. Those intended for girls often emphasize nurturing roles, while also focusing on appearance. Conversely, toys targeted at boys tend to emphasize action-oriented themes, as well as activities like sports, construction, and vehicles. Gender-typed toys are linked with distinct pro-social behaviors observed between boys and girls (Blakemore & Centers, 2005). Girls are often expected to exhibit pro-social tendencies through care giving and empathy, whereas boys tend to express theirs through defense and assertion. Moreover, given Disney's extensive marketing and product campaigns, children are regularly presented with opportunities to reinforce the gender stereotypes portrayed in the movies and books. Being exposed in that kind of environment as a kid, teaches young girls that attractiveness is a necessary quality of their biological gender. This also applies to young boys, as the pressure these movies and books exert, when portraying muscular and tough males is equally strong (Sherman & Zurbriggen, 2014).

2.2. Approaching gender stereotypes through picturebooks

Kelly (2013) and Kalaitzi (2024b) discussed how children's books can encourage children to ponder the existence of social justice issues and their thoughts around these by investigating the use of picturebooks to encourage critical thinking and enhance young children's understanding of family diversity. DePalma (2016), also, valued the use of picturebooks in exploring gender and sexuality diversity. She aimed to address sexualities equity in primary schools due to concerns over school-based homophobic bullying. According to Moya-Guijarro and Ventola (2022), children are better able to understand others' perspectives through tools such as picturebooks and this increased awareness can encourage them to act towards social justice and equity. Taking the above into consideration, picturebooks' potential to shape gender attitudes and behaviors among children of early ages is notably highlighted. Nevertheless, in Kalaitzi' s (2024a) recent study regarding factors that affect Kindergarten teachers' use of picturebooks with gender non-conforming fictional characters, findings showed that the specified methodological teaching framework, their own personal beliefs, and parents' influence are crucial influences. As Kalaitzi (2024a) also noted highly qualified teachers -even those with the least working experience- are open to gender diversity, are not discouraged by the parents' influence and take advantage of both the variety of LGBTQ picturebooks and the methodological framework of Early Years Curriculum to deconstruct gender binaries.

2.3. Rational, aim and objectives of the current research

The aim of the study is to explore how to promote kindergarten students' awareness on gender role diversity through the use of gender diversity-themed picturebooks. Although previous research has been conducted on either kindergarten or primary settings regarding approaches of gender stereotypes (Chung & Huang, 2021; Spinner et al. 2021), there is a lack of applied intervention studies within kindergarten utilizing gender diversity-themed picturebooks. Therefore, this study is based on a hypothesis that a literature intervention could impact kindergarten students' perceptions regarding gender stereotypes. Specifically, the study aims to address the following research questions:

• *To what extent gender diversity-themed picturebooks affect kindergarten students' perception of gender-typed appearance, objects, behavior and roles?*

• *To which level is it feasible for a literature intervention to produce measurable results, which could subsequently be used for comparisons between groups of preschool age?*

3. Methodology

3.1. Sample

Two groups of children of balanced mixed gender between the age of 5 and 6 years old (1 group/ kindergarten classroom) participated in the study (15 participants/ group) with a total number of 30 participants. The participants were not previously exposed to gender-diversity or gender-inclusive picturebooks. The groups were randomly differentiated to Experimental Group (E.G.), which participated in the intervention, and to Control Group (C.G.), which followed the curriculum and functioned as a weighing tool for the data evaluation (Kallio et al. 2016). Written consent was acquired from the parents (or legal guardians) of the children in both groups. A separate written consent was acquired from E.G.'s parents prior to conducting the intervention. This research was approved by the Ethics Board of the University of Derby (UK), collaborative partner of the Mediterranean College.

3.2. Data collection tool

Previous research by Spinner et al. (2021) used as framework for designing the semi-structured interview. The interview tool was composed by 12 questions (2 questions for each of the 6 categories: 1A&1B_colours, 2A&2B_clothes, 3A&3B_toys, 4A&4B_sports, 5A&5B_occupations, 6A&6B_appearance). Each question had two parts. In the first part of each question participants were asked to identify the indicator of each category (e.g., 1A_Colour for boys), while in the second part of the question they were asked to state if their choice can change.

3.3. Framework: A literature intervention on gender roles diversity

The framework of the intervention was based on prior intervention studies (Chung & Huang, 2021; Spinner et al. 2021). The intervention was conducted within a five-week period with an average of six class hours per week (3 days/week, 2 hours/day). When devising the activities, objectives, concepts, and methodological recommendations regarding the learning fields, the Greek curriculum for preschool education (Curriculum for preschool education, 2022) was considered. The procedural practices were divided into five phases, each focusing on a different gender-typed category using a picturebook addressing to this specific gender diverse portrayal. All picturebooks were selected from lists including gender-inclusive picturebooks in terms of their scopes (Moya-Guijarro & Ventola, 2022). Table 1 below outlines the content of all five intervention phases.

Table 1. The literature intervention phases.

PHASE 1	PICTUREBOOK: ***William's doll*** **(Charlotte Zolotow, 1972)**	**OBJECTIVES**	- To distinguish gender-typed toys. - To acknowledge that all toys can be played by both genders.		
LEARNING AREAS – INTERDISCIPLINARY CONNECTIONS	• Personal & Social Development/ Collaboration • Language/ Production of oral speech • Art & Culture/ Drama			**METHODOLOGICAL APPROACHES**	• Questions & answers • Working in groups • KWLH chart
DESCRIPTI	-Picturebook read aloud - questions & answers on 'What is my favourite toy?'. -Two-entrance table depicting students' favourite toys and classroom's play corners. -Play-Pairs: students are divided into pairs matching with a peer with a different favoured toy. Each pair plays for an equal amount of time both toys in turns. -Given that every student tries their pair's toy, students refill the two-entrance table adding to or changing their new favourite toys (if any) and classroom's play corners (if any). -Questions & answers on 'What toys do I like to play with?', 'Do I have only one favourite toy, or do I have more?				
PHASE 2	PICTUREBOOK: ***Piggybook*** **(Anthony Browne, 1986).**	**OBJECTIVES**	- To distinguish gender-typed occupations & activities. - To acknowledge that all occupations & activities can be performed by both genders.		
LEARNING AREAS – INTERDISCIPLINARY CONNECTIONS	• Personal & Social Development/ Personal identity • Language/ Production of oral speech • Social Sciences/ Culture			**METHODOLOGICAL APPROACHES**	• Brainstorming • Role play • Discussion
DESCRIPTI	-Picturebook read aloud - predictions on narrative's ending. -Open ended discussion on parents/ guardians' occupations. -Distinguish pictures depicting individuals performing various occupations (firefighter, doctor, teacher, cleaner, car mechanic, police officer, etc.) with their heads covered into female occupations and male occupations & justify their decisions. -Revealing of figures' heads. Discussion on misconceptions and relocating any photos (if necessary). -Discussion on the roles of women and men in the past compared to the changes seen today. -Drawing on the subject: 'What I want to be/become when I grow up'.				
PHASE 3	PICTUREBOOK: ***Pink is for boys*** **(Robb Pearlman, 2018)**	**OBJECTIVES**	- To distinguish gender-typed colours. - To acknowledge that all colours can be used by both genders.		
LEARNING AREAS – INTERDISCIPLINARY CONNECTIONS	• Personal & Social Development/ Collaboration • Language/ Production of oral speech • Art & Culture/ Arts & Crafts			**METHODOLOGICAL APPROACHES**	• Brainstorming • Working in groups • Discussion
DESCRIPTI	-Picturebook read aloud without showing the pictures that reveal the protagonists' gender. -Predictions on two figures' gender according to the length of their hair. -Divided into two groups (boys and girls) they colour the protagonist figures with pink or blue acrylics based on their assumption of the figures' gender. -Revealing of the protagonist figures true gender (the long hair figure is the boy while the short hair figure is the girl). -Recolouring the figures in mixed groups with a variety of colours. -Drawing themselves using their favourite colours.				
PHASE 4	PICTUREBOOK: ***Princess Smartypants*** **(Babette Cole, 1986)**	**OBJECTIVES**	- To distinguish gender-typed sports & activities-hobbies. - To acknowledge that all sports & activities-hobbies can be performed by both genders.		
LEARNING AREAS – INTERDISCIPLINARY CONNECTIONS	• Personal & Social Development/ Self awareness • Language/ Production of oral speech • Physical education/ Gross motor skills			**METHODOLOGICAL APPROACHES**	• Discussion • KWLH chart • Role play

<table>
<tr><td>DESCRIPTI</td><td colspan="5">-Picturebook read aloud without revealing the ending - predictions on the protagonist’s choice.
-Open ended discussion on princesses/ princes’ appearance, hobbies, and activities.
-Displaying a clip from the animation movie ‘Shrek’ showcasing a different type of princesses and princes
-Drawing of princesses or princes of their choice attributing to them gender non-conforming appearance and hobbies.
-Role playing of fictional or movie heroes/heroines who display gender non-conforming behaviours (i.e, Brave, Shrek, Fiona, Bob SpongeBob, Mulan, etc.)</td></tr>
<tr><td colspan="2">PHASE 5</td><td>PICTUREBOOK:
My Shadow is Pink (Scott Stuart, 2020)</td><td>OBJECTIVES</td><td colspan="2">- To distinguish gender-typed clothing materials & accessories.
- To acknowledge that all kinds of clothing materials & accessories can be worn by both genders.</td></tr>
<tr><td colspan="2">LEARNING AREAS – INTERDISCIPLINARY CONNECTIONS</td><td colspan="2">• Personal & Social Development/ Self-image - Empathy
• Language/ Production of oral speech
• Art & Culture/ Drama</td><td>METHODOL O-GICAL APPROACH ES</td><td>• Discussion
• Role play
• Questions & answers</td></tr>
<tr><td>DESCRIPTI</td><td colspan="5">-Watching the picturebook adaptation in YouTube [animation sans mots (no words)] - open ended discussion on protagonist’s feelings.
-Picturebook read aloud - revealing of protagonist’s feelings.
-Hidden treasure hunt to find a variety accessories and clothing materials.
-‘Dress up like your shadow’: Disguising using clothing pieces and accessories of their choice. Present themselves in front of class.
-Questions & answers on the subject: ‘What makes you happy?’, ‘What colour is your shadow?’
-Drawing of their shadow attributing to it any colour, clothes, behaviour, occupation, appearance they choose.</td></tr>
</table>

4. Results

Participants’ answers at pre-intervention level, do not reveal any deviation between groups. Most participants (83,3%) from both groups answered that blue is the colour for boys and pink is the colour for girls. All participants, from both groups, mentioned that boys wear pants and shirts and girls wear skirts or dresses. The 60% from both groups, chose superhero figures as the toy suitable for boys, while 80% from both groups, chose dolls as the toy most suitable for girls. The 56,6% from both groups, stated that basketball is the boys sport, and volleyball is the girls sport. The 60% from both groups, stated that boys would follow the driver profession, while 63,3% from both groups stated that girls would work as teachers. As the appearance is concerned, both groups answered that boys are distinguished by their short hair, while girls for their long hair. The most intriguing part of the interview was the second part of every question, regarding the possibility of change. Most of both groups (64,3%) answered negatively, meaning that colours, clothes, toys, sports, occupations and appearance attributed with each gender could not be changed.

Proceeding to the analysis of findings after the intervention, Control Group’s answers reveal no difference compared with pre-intervention and their perceptions regarding the impotence of change remained unaffected. However, a notable deviation in Experimental Group’s choices at post-intervention was observed. In their range of answers new ones were added: all colours, all clothes, all toys, all sports, all professions, both types of hair, meaning that colours, clothes, toys, sports, occupations, and appearance that attributed with each gender could be changed. More specifically, 40% declared that all toys are for everyone and 53,3% were flexible to the change. The 33,3% answered that both girls and boys can participate in all sports and do all kinds of jobs. The 33,3% stated that all colours are for everyone, while the rest, who mentioned specific colours were positive to change. The 66,7% stated that a boy and a girl can have both long and short hair. The 20% responded that clothes are for everyone, and the 33,3% stated that a boy can wear dresses or anything they desire.

5. Discussion, limitations & prospects

The results aligned with the literature confirming that kindergarten students have already adopted gender role constructions and are driven from gender role expectations that include physical characteristics, activities, skills, interests, and occupations (Liben et al. 2002). Students’ answers revealed embodied perceptions for gender-typed behaviours and objects (Blakemore & Centers, 2005; Sherman & Zurbriggen, 2014; Riley, 2014). Both groups pre-intervention performance corroborated previous findings of Martin and Ruble (2004) stating children's stereotypical acquisition and application of gender roles. The notable deviation in groups’ post-intervention performance agrees with Paetcher’s (2003) point that by leveraging from prior knowledge children’s brains efficiently gather and process pertinent information, facilitating quicker and simpler classification learning when presented with stimuli.

In case that the literature intervention presented in this study could be considered as stimulus, the results, also confirmed, the gender diversity-themed picturebooks’ impact on kindergarten students’ perceptions regarding gender roles. This study contributes to all previous studies highlighting the use of picturebooks to enhance, enrich, and strengthen the approach of gender diversity in early childhood education (DePalma, 2016; Kalaitzi, 2024a/2024b; Kelly, 2013; Moya-Guijarro & Ventola, 2022).

Some future implications of the current research could involve conducting separate analyses for the views of girls and boys to examine whether there are differences in their level of shaping alternative attitudes. Additionally, a larger sample size, or a diverse sample in terms of ethnicity or socio-economic status would provide more reliable and safe results. Furthermore, it would be interesting to explore additional factors in multiple levels that influence children’s perspectives (i.e. demographic background,

cultural context, etc.) (Frenzel, Pekrun, & Goetz, 2007). Also, a comparison of the literature intervention with other forms such as role-playing could identify the effective aspects of this strategy for challenging gender stereotypes in early childhood.

To conclude, given that educators are willing to create an inclusive and gender-sensitive classroom teaching, and exploiting the dynamics of gender issued picturebooks, kindergarten students' perceptions of gender roles could be challenged and reshaped. Thus, the early childhood field needs applied interventions to approach gender norms as they raise critical questions regarding gender.

References

Blakemore, J. E. O., & Centers, R. E. (2005). Characteristics of boys' and girls' toys. *Sex Roles 53*, 619-633. https://doi.org/10.1007/s11199-005-7729-0.

Chung, Y., & Huang, H. (2021). Cognitive-Based Interventions Break Gender Stereotypes in Kindergarten Children. *International Journal of Environmental Research and Public Health, 18*(24), 13052.

Curriculum for preschool education (extended version). (2022). *Act "Upgrading the Curriculum and Creating Educational Materials for Primary and Secondary Education" - MIS: 5035542*. Athens: Institute of Education Policy.

DePalma, R. (2016). Gay penguins, sissy ducklings... and beyond? Exploring gender and sexuality diversity through children's literature. *Discourse: Studies in the Cultural Politics of Education, 37*(6), 828-845.

Frenzel, A. C., Pekrun, R., & Goetz, T. (2007). Perceived Learning Environment and Students' Emotional Experiences: A Multilevel Analysis of Mathematics Classrooms. *Learning and Instruction, 17*(5), 478-493. https://doi.org/10.1016/j.learninstruc.2007.09.001

Kalaitzi, C. (2024a). Exploring factors that affect Kindergarten teachers' use of picturebooks with gender non-conforming fictional characters. *Journal of Psychological Perspective, 6*(1).

Kalaitzi, C. (2024b). Framing family diversity in early years: an inquiry-based intervention on approaching same-sex parenting through picturebooks. *Education and New Developments 2024 – Volume 2*, 361-365. https://doi.org/10.36315/2024v2end082

Kallio, H., Pietilä, A. M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: Developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing, 72*(12), 2954-2965. https://doi.org/10.1111/jan.13031

Kelly, J. (2013). Supporting diversity: Picture books featuring same-gender parented families. *Early Childhood Folio, 17*(1), 24-29.

Levy, G. D., & Carter, D. B. (1989). Gender schema, gender constancy, and gender-role knowledge: The roles of cognitive factors in preschoolers' gender-role stereotype attributions. *Developmental Psychology, 25*(3), 444-449. https://doi.org/10.1037/0012-1649.25.3.444

Liben, L., Bigler, R., Ruble, D., Martin, C., & Powlishta, K. (2002). The developmental course of gender differentiation: Conceptualizing, measuring, and evaluating constructs and pathways. *Monographs of the Society for Research in Child Development, 67*(2), 1-185.

Martin, C., & Ruble, D. (2004). Children's search for gender cues: Cognitive perspectives on gender development. *Current Directions in Psychological Science, 13*(2), 67-70.

Moya-Guijarro, A. J., & Ventola E. (2022). Picture Books, Gender and Multimodality. An Introduction. In A. Jesús Moya- Guijarro, & Eija Ventola (Eds.), *A Multimodal Approach to Challenging Gender Stereotypes in Children's Picture Books* (pp.1-19). New York, London: Routledge. https://doi.org/10.4324/ 9781003145875-1

Paechter, C. (2003). Masculinities and Femininities as Communities of Practice. *Women's Studies International Forum, 26*(1), 69-77. https://doi.org/10.1016/S0277-5395(02)00356-2

Riley, T. (2014). Boys are like puppies, girls aim to please: How teachers' gender stereotypes may influence student placement decisions and classroom teaching. *Alberta Journal of Educational Research, 60*(1), 1-21.

Sherman, A. M., & Zurbriggen, E. L. (2014). "Boys can be anything": Effect of barbie play on girls' career cognitions. *Sex Roles, 70*, 195-208. https://doi.org/10.1007/s11199-014-0347-y

Stangor, C. S., & Ruble, D. N. (1987). Development of gender role knowledge and gender constancy. In L. S. Liben & M. L. Signorella (Eds.), *Children's Gender Schemata: New Directions in Child Development* (pp. 5-22). San Francisco: Jossey-Bass. https://doi.org/10.1002/cd.23219873803

Spinner, L., Tenenbaum, H. R., Cameron, L., & Wallinheimo, A.-S. (2021). A school-based intervention to reduce gender-stereotyping. *School Psychology International, 42*(4), 422-449. https://doi.org/10.1177/01430343211009944

DRAMATIC ARTS IN INCLUSIVE EDUCATION: A CASE STUDY OF ONE HIGH SCHOOL

Limkani Sincuba, & Buka Andrea Mqondisi*
Faculty of Education, Walter Sisulu University (South Africa)

Abstract

Incorporating dramatic arts into the curriculum offers essential emotional and social development opportunities in an inclusive educational environment. The qualitative case study examined the role of dramatic arts in inclusive education at a high school in the O.R. Tambo Inland District, using a purposive sample of 20 grade 10 learners. The study was grounded in Vygotsky's social constructivist theory, and the framework incorporated the principles of Universal Design for Learning to advocate flexible teaching methods. The research examined how dramatic arts facilitate social interaction and emotional expression among diverse learners. Data was collected using structured interview questions. The collected data was coded and patterns drawn. Thematic analysis was employed to identify key themes from structured interviews. Significant findings emerged from the study. Graphs and tables were drawn and interpreted. Findings reveal that dramatic arts significantly enhanced students' communication skills, allowing them to express themselves more freely and confidently. Another finding was that participation in drama activities fostered stronger peer relationships, promoting a sense of belonging and inclusion among students with varying abilities. The findings highlighted the importance of creative expression in enhancing educational experiences for all learners if included in most schools. To further support the integration of dramatic arts in schools, it is recommended that schools invest in professional development for teachers focused on drama education and allocate resources specifically for dramatic arts programs. Also, fostering partnerships with local arts organizations could enrich the curriculum and provide students with diverse artistic experiences.

Keywords: *Creativity, curriculum, dramatic arts, education, inclusivity.*

1. Introduction

Dramatic arts foster inclusive education by enhancing social interaction, emotional intelligence, and academic engagement among diverse high school students (Landsman & Lewis, 2023). A case study revealed that drama-based activities promote collaboration, communication, empathy, and teamwork while building students' confidence and sense of belonging (Peppler et al., 2022). This approach equips students with essential life skills and creates inclusive educational environments that value all voices. The research emphasised the importance of inclusive practices in education, advocating for incorporating artistic methodologies to support all learners effectively.

These research questions guided the study:

1. How do dramatic arts activities facilitate social interaction and emotional development among students with diverse learning needs in a high school?

2. What are the perceived impacts of integrating dramatic arts into the curriculum on academic engagement and performance for students in an inclusive education environment?

2. Literature review

2.1. The role of dramatic arts in inclusive education

Dramatic arts advance inclusive education by fostering collaboration, creativity, and social interaction (Peppler et al., 2022). Research shows drama activities enhance emotional and social skills, benefiting students with diverse needs. For instance, interventions improve social acceptance and reduce rejection among students with ADHD (Gerber et al., 2024). By encouraging self-expression through performance, drama creates safe spaces for exploration and belonging, promoting inclusion, and understanding in educational settings (Peppler et al., 2022).

*Correspondence: leesincuba@gmail.com / lsincuba@wsu.ac.za ; mbuka@wsu.ac.za

2.2. Benefits of drama for students with disabilities

Integrating dramatic arts into education benefits students with disabilities (Landsman & Lewis, 2023). Arts participation boosts motivation, engagement, and learning outcomes (Wong, 2021). Drama fosters peer interaction and vital life skills through shared experiences (Gerber et al., 2024). Adaptable activities ensure inclusive participation, creating meaningful learning environments for diverse abilities (Peppler et al., 2022).

2.3. Drama as a tool for social inclusion

Dramatic arts enhance learning and foster social inclusion in diverse classrooms (Landsman & Lewis, 2023). Ensemble activities teach role negotiation and creative collaboration, promoting democratic values and mutual respect (Peppler et al., 2022). This collaborative environment builds empathy, understanding, and stronger peer relationships, creating a sense of community and breaking barriers between students of differing abilities (Wong, 2021).

2.4. Challenges and considerations in implementation

Implementing dramatic arts in inclusive education faces challenges (Landsman & Lewis, 2023). Teachers need training and resources to deliver curricula suited to diverse needs (Peppler et al., 2022). Ensuring all students feel comfortable, especially those with confidence issues, is difficult (Landsman & Lewis, 2023). Institutions must support educators through professional development to foster inclusive environments for thriving through the arts (Gerber et al., 2024).

2.5. Empirical literature

2.5.1. The impact of drama on social skills development. Empirical studies show dramatic arts enhance social skills, especially for students with disabilities (Landsman & Lewis, 2023). A drama intervention for middle schoolers, including those with ADHD, increased peer acceptance and reduced rejection rates (Gerber et al., 2024; Peppler et al., 2022). It fostered friendships and belonging in classrooms (Wong, 2021). These findings underscore drama's transformative role in promoting inclusion and interpersonal relationships in diverse educational settings (Landsman & Lewis, 2023).

2.5.2. Enhancing emotional intelligence through drama. Dramatic arts foster emotional intelligence through role-playing and improvisation, helping students recognise and express emotions while building empathy (Gerber et al., 2024; Landsman & Lewis, 2023). Drama improves emotional regulation and resilience, especially for students facing social challenges (Peppler et al., 2022). Programs integrating drama report growth in navigating complex emotions, creating supportive school environments, and enhancing overall student well-being (Wong, 2021; Peppler et al., 2022).

2.5.3. Drama as a pedagogical strategy for inclusion. Integrating dramatic arts into education promotes inclusion (Landsman & Lewis, 2023). Drama-based learning supports differentiated instruction, accommodating diverse learning styles and abilities (Gerber et al., 2024). Collaborative projects foster teamwork, creativity, and inclusive spaces where all voices are valued (Peppler et al., 2022). This approach enhances academic achievement and builds community, enabling educators to adapt lessons for diverse learners (Wong, 2021; Landsman & Lewis, 2023).

2.5.4. Challenges in implementing drama in inclusive settings. Despite its benefits, implementing dramatic arts in inclusive education faces challenges (Landsman & Lewis, 2023). Teachers often lack training, resources, and time to integrate drama effectively (Gerber et al., 2024). Some students may feel anxious or uncomfortable participating, limiting engagement (Peppler et al., 2022). Addressing these issues requires professional development and supportive environments that encourage creativity and risk-taking, maximizing drama's potential for inclusion (Wong, 2021; Peppler et al., 2022).

3. Theoretical framework

The study's framework emphasised creativity, collaboration, and social interaction (Glaveanu et al., 2020). Vygotsky's social constructivism highlighted learning through peer engagement (Shah, 2022). Drama encouraged self-expression, empathy, and role negotiation, while Universal Design for Learning ensured inclusive participation (Glaveanu et al., 2020). This approach fostered meaningful involvement, valuing every student's voice within an inclusive educational environment (Glaveanu et al., 2020).

4. Methodology

4.1. Research design

The study employed a qualitative research design to explore the role of dramatic arts in promoting inclusive education within a high school setting (Rudduck, 2020). By focusing on the lived experiences of students and educators, the research aimed to understand how dramatic arts activities influenced social skills, emotional development, and overall academic engagement among diverse students (Glaveanu et al., 2020).

4.1.1. Population. The selected population for the study included 20 Grade 10 learners from a single high school (Creswell, 2021). The specific group was chosen to explore how dramatic arts could enhance social skills, creativity, and collaboration among students, particularly in an inclusive educational environment (Levitt, 2021). The students represented a diverse mix of backgrounds, abilities, and learning needs, which was essential for understanding the impact of dramatic arts on inclusivity (Gill, 2020).

4.1.2. Sampling Method. A non-probability sampling technique of 20 grade 10 students was employed for the case study, specifically purposive sampling (Stratton, 2021). The method allowed for selecting participants likely to provide rich and relevant information about the subject under investigation (Levitt, 2021). By focusing on students who have engaged with dramatic arts in an inclusive setting, the research aims to gather data that reflects their experiences and perceptions (Gill, 2020).

4.3. Data collection

4.3.1. Structured interviews. Data collection for the study of dramatic arts in inclusive education was primarily conducted through structured interviews (Stratton, 2021). The method was chosen to gather specific, comparable information from participants while allowing for a focused exploration of their experiences and perspectives (Gill, 2020). Structured interviews involved a predetermined set of questions designed to elicit detailed responses regarding the impact of dramatic arts on social skills, emotional development, and academic engagement (Levitt, 2021).

4.3.2. Interview process. Individual interviews were conducted with 20 grade 10 students in a dramatic arts program, lasting 30–45 minutes in a secluded setting to encourage openness (Stratton, 2021). Participants were informed of their rights, including confidentiality and withdrawal options (Levitt, 2021). Carefully crafted questions elicited descriptive responses, providing insights into students' experiences with dramatic arts (Gill, 2020).

4.3.3. Recording and transcription. All interviews were audio-recorded with participants' consent to ensure accurate data capture (Levitt, 2021). Following the interviews, recordings were transcribed verbatim for analysis (Gill, 2020). The process allowed for thoroughly examining participants' responses, ensuring their voices were accurately represented in the findings (Stratton, 2021).

4.3.4. Rationale for using structured interviews. Structured interviews facilitated consistency across data collection, enabling comparisons between participants' responses (Stratton, 2021). The method also allowed for efficient data collection while focusing on specific research questions (Gill, 2020). By employing structured interviews, the study aimed to gather comprehensive insights into how dramatic arts contribute to inclusive education within the high school context, enriching the understanding of the educational practice (Levitt, 2021).

4.3.5. Data treatment and analysis. Thematic analysis was utilised to Analyse the qualitative data collected from structured interviews (Stratton, 2021). Transcripts were coded to identify key themes and patterns related to the benefits and challenges of integrating dramatic arts into inclusive education (Gill, 2020). The iterative process involved reviewing the data multiple times to ensure that emerging themes accurately represented participants' experiences (Levitt, 2021). The findings were then organized into coherent categories that highlighted the transformative potential of dramatic arts in fostering an inclusive learning environment (Gill, 2020).

4.3.6. Ethical considerations. Ethical approval was obtained from the relevant institutional review board before conducting the study (Stratton, 2021). Informed consent was secured from all participants, ensuring they understood the purpose of the research and their right to withdraw at any time (Gill, 2020). Confidentiality was maintained throughout the study by anonymizing participant data and securely storing

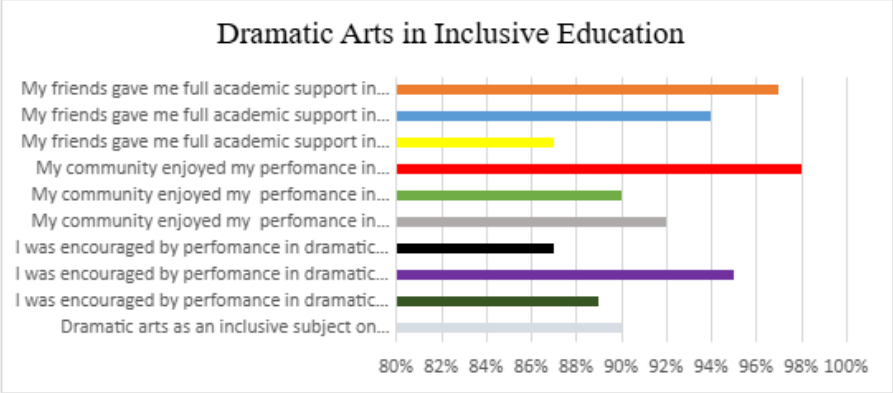
all research materials. These ethical considerations ensured that the research adhered to best practices while respecting participants' rights and well-being (Levitt, 2021).

5. Findings

Figure 1. Dramatic arts and themes.

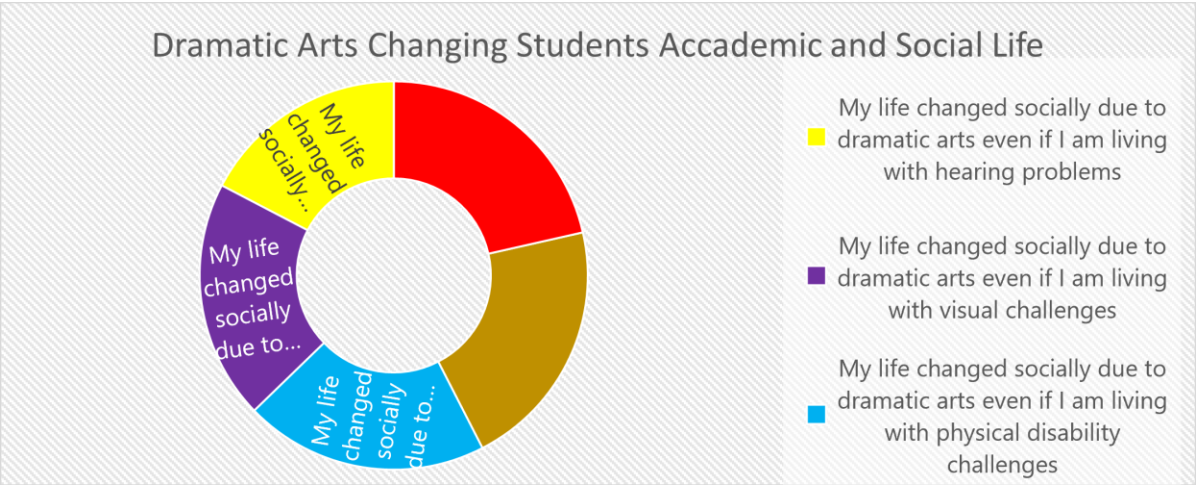
	Research Question	Theme
1	How do dramatic arts activities facilitate social interaction and emotional development among students with diverse learning needs in high school?	Dramatic arts and social interaction in diverse learning needs.
2	What are the perceived impacts of integrating dramatic arts into the curriculum on academic engagement and performance for students in an inclusive education environment?	Integrating dramatic arts into an inclusive curriculum.

Figure 2. Positive Aspects of Dramatic Arts in Inclusive Education.



From Figure 2, participants reported that: My friends gave me full academic support in dramatic arts even if I am living with hearing challenges 97%, My friends gave me full academic support in dramatic arts even if I am living with visual challenges 94%, My friends gave me full academic support in dramatic arts even if I am living with physical disability 89%, My community enjoyed my performance in dramatic arts performance even if I am living with hearing challenges 90%, My community enjoyed my performance in dramatic arts performance even if I am living with visual challenges 92%, I was encouraged by performance in dramatic arts even if I am living with hearing challenges 89%, I was encouraged by performance in dramatic arts even if I am living with visual challenges 95%, I was encouraged by performance in dramatic arts even if I am living with physical disability 89%, Dramatic arts as an inclusive subject for hearing, visual changing and physical disability 90%.

Figure 3. Positive Academic and Social Change Due to Inclusivity of Dramatic Arts



My life changed socially due to dramatic arts even if I am living with hearing problems 80%; My life changed socially due to dramatic arts even if I am living with visual challenges 92%; my life changed socially due to dramatic arts even if I am living with physical disability challenges 94%, I gained confidence in my studies due to dramatic arts even if I am living with hearing problems 97%, I gained confidence in my studies due to dramatic arts even if I am living with visual issues 99%.

6. Discussion of the findings

The study highlights the dramatic arts' role in fostering inclusivity and improving outcomes for students with disabilities. Peer support was noted by 97% of students with hearing challenges and 94% with visual challenges. Engagement boosted confidence, with 99% of visually impaired participants reporting increased self-assurance. These findings align with Creswell's (2021) mixed-methods research and Glaveanu et al.'s (2020) socio-cultural perspective, emphasising creativity's role in personal growth and community belonging (Gerber et al., 2024). Performances also enhanced social integration.

7. Conclusion

The study highlights the transformative impact of dramatic arts in inclusive education for students with disabilities. The findings reveal that participation in dramatic arts fosters academic support, enhances self-confidence, and promotes social integration among peers and the community. The positive experiences reported by participants highlight the necessity of incorporating artistic discipline into educational frameworks to create equitable learning environments. By embracing the diverse abilities of all students, academic institutions can cultivate a more inclusive atmosphere that values creativity and empowers individuals to thrive academically and socially.

8. Recommendations

Based on the findings of this study, several practical recommendations were made. Educational institutions may need to integrate dramatic arts into the curriculum from grade 10 to grade 12 as a core subject to promote inclusivity and support diverse students. Training for dramatic arts teachers on inclusive teaching strategies in the arts may be essential to ensure all students receive equitable support. Also, fostering partnerships with local arts organisations may provide resources and opportunities for students with disabilities to engage in dramatic arts practical performances. Schools may need to create awareness campaigns to highlight the benefits of dramatic arts, encouraging community involvement and support for inclusive artistic initiatives in dramatic arts.

References

Creswell, J. W. (2021). *A concise introduction to mixed methods research*: SAGE publications.

Gerber, B. L., Guay, D. M., & Burnette, J. (2024). *Reaching and teaching students with special needs through art*. Taylor & Francis.

Gill, S. L. (2020). Qualitative sampling methods. *Journal of Human Lactation, 36*(4), 579-581.

Glaveanu, V. P., Hanchett Hanson, M., Baer, J., Barbot, B., Clapp, E. P., Corazza, G. E., ... Lubart, T. (2020). Advancing creativity theory and research: A socio-cultural manifesto. *The Journal of Creative Behavior, 54*(3), 741-745.

Landsman, J., & Lewis, C. W. (2023). *White teachers/diverse classrooms: Creating inclusive schools, building on students' diversity, and providing accurate educational equity*. Taylor & Francis.

Levitt, H. M. (2021). Qualitative generalisation, not to the population but to the phenomenon: Reconceptualizing variation in qualitative research. *Qualitative psychology, 8*(1), 95-110.

Peppler, K., Dahn, M., & Ito, M. (2022). Connected arts learning: Cultivating equity through connected and creative educational experiences. *Review of research in education, 46*(1), 264-287.

Rudduck, J. (2020). The theatre of daylight: Qualitative research and school profile studies. In *Qualitative voices in educational research* (pp. 8-22). Routledge.

Shah, M. A. (2022). Teachers as reflective practitioners: From individualism to Vygotskian social constructivism. *Alberta Journal of Educational Research, 68*(3), 297-307.

Stratton, S. J. (2021). Population research: convenience sampling strategies. *Prehospital and disaster Medicine, 36*(4), 373-374.

Wong, M. W.-y. (2021). Fostering musical creativity of students with intellectual disabilities: Strategies, gamification and re-framing creativity. *Music Education Research, 23*(1), 1-13.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

EDUCATION STUDENTS' PERCEPTIONS OF SUSTAINABILITY TRAINING AND THE USE OF ACTIVE METHODOLOGIES: AN EXPLORATORY STUDY

Elena Mª Díaz-Pareja, Juana Mª Ortega-Tudela, & Mercedes Llorent-Vaquero
Department of Pedagogy, University of Jaén/Professor (Spain)

Abstract

Today, it is imperative to prepare committed and competent professionals to address the most pressing global environmental, economic and social challenges. Education for Sustainable Development (ESD) is a priority to transform society, fostering competencies such as systems thinking, anticipation, collaboration, critical thinking, strategic action and responsibility. In this process, university students, graduates in the near future, become key actors and must play an active role as agents of change, contributing to the construction of a more sustainable future. Therefore, the aim of this study is to analyse the perception of university students on the training they have received on issues related to sustainability and its relationship with the use of active methodologies in their respective degrees. For this purpose, a descriptive and analysis of variance and post-hoc comparisons were carried out, with a quantitative design, applied to a sample of 460 students enrolled in the degrees of Education at the University of Jaén. The instrument used was a questionnaire, designed ad hoc, with Likert-type questions on a scale ranging from strongly agree (5) to strongly disagree (1). The data collected were analysed using the SPSS programme. The findings showed that the majority of students are aware of the SDGs and understand what they consist of (82.6%); they consider that active methodologies facilitate the development of sustainability competences (83.1%); and they value positively the role of teachers in the implementation of education for sustainable development (80.6%). ESD should be promoted and opportunities should be provided for students to get involved in ESD-related projects so that they can become agents of change to ensure a more sustainable future.

Keywords: *Active methodologies, sustainability, SDG, education, students.*

1. Introduction

The Sustainable Development Goals (SDGs) are presented as an opportunity to act on the environmental, economic and social challenges of greatest global concern, becoming a roadmap for a more just and prosperous future for all (UN, 2015). University students play a fundamental role in achieving these goals, contributing significantly, with their knowledge and skills, to the construction of a more sustainable society (Maoela et al., 2024). It is therefore essential to develop a comprehensive education in which the SDGs provide a frame of reference that goes beyond the strictly academic, fostering critical thinking and global awareness.

The inclusion of the SDGs in university curricula plays a crucial role in increasing student knowledge and awareness (Fošner, 2025). The presence of subjects or modules dedicated to sustainability and the SDGs is crucial, as by engaging in SDG-related projects, students develop key skills such as teamwork, problem solving, creativity and leadership (Seva-Larrosa et al., 2021). Access to clear and concise information on the SDGs, both inside and outside the university, is also considered key, and extracurricular activities, participation in projects, volunteering and student organisations related to sustainability, among others, can help increase knowledge, interest and motivation (SDSN, 2020).

Likewise, the interest and motivation of teachers in conveying the importance of the SDGs influences student learning. Therefore, university institutions should focus their efforts on making the goals of the 2030 Agenda visible and including them in teaching guides and programmes, so that progress is considered as evidence for the assessment of the level of implementation and adequacy of the goals (CRUE, 2019). In this line, the need to use active and experiential methodologies, such as service-learning projects, case studies or simulations, which allow students to apply their knowledge in real situations and develop practical skills for sustainability, is highlighted (Lozano & Figueredo, 2021). Using more innovative methodologies helps students to achieve curricular competences related to sustainability, fosters their personal and social engagement, connects learning experiences with real practice and improves the use of teaching materials and resources (Martín et al., 2021).

2. Design

This study has used a quantitative design, employing a descriptive method through surveys to collect data on the knowledge of the Sustainable Development Goals (SDGs) among university students of Education, and the way in which this knowledge is linked to the use of teaching methodologies that encourage active participation. The instrument used was an ad hoc questionnaire with Likert-scale questions, applied at two time points (pre-posttest) to identify changes in the variables. For the design of the questionnaire, a review of the literature on the subject was carried out in order to prepare a first draft which was reviewed by expert judges. Once the proposed modifications had been made, the online form was sent to the students using the Google Form tool. Students were informed of the purpose of the research, and informed consents were obtained. The final instrument was structured in five dimensions:

1. Sociological data of the students (10 items). **2.** Knowledge about the SDGs (6 items). **3.** Information channels to learn about the SDGs (5 items). **4.** Knowledge and experience of active methodologies and sustainability in undergraduate studies (11 items). **5.** Assessment of the teaching staff's work in the development of Education for Sustainable Development (5 items).

3. Methods

The aim of this study was to analyse the degree of knowledge and assessment of university students towards the use of active methodologies that promote Education for Sustainable Development (ESD). The sample consisted of 460 students of the Education degrees of the University of Jaén. This purposive sample is mainly composed of women (82.6%), comprising the 18-25 age group (96.9%). Access to the respective degrees is almost equally divided between Baccalaureate (54.2%) and Vocational Training (44.5%). In this study, the Bachelor's Degree in Early Childhood Education (EChildEd) is the most represented (62.7%), followed by Primary Education (PrimEd) (21.9%) and Social Education (SocEd) (15.4%). The first (53.4%) and second (43.8%) years are those with the highest number of participants.

4. Results

4.1. Knowledge about the SDGs

Students in Education degrees at the University of Jaén show moderate awareness of the 2030 Agenda ($M=2.9$; $SD=1.336$), with significant differences across degrees ($F(2, 458) = 3.424$, $p = .033$). Post-hoc comparisons indicate that PrimEd students ($M=3.61$, $SD=0.96$) have significantly lower awareness than EChildEd students ($M=3.99$, $SD=0.99$; $p=0.036$).

Regarding SDG understanding, 81.3% of students grasp their role in education ($M=3.507$; $SD=1.104$). SocEd students ($M=3.760$) exhibit greater comprehension than EChildEd ($M=3.278$; $p=0.003$) and PrimEd students ($M=3.502$; $p<.001$). However, only 50.5% identify sustainability-related values, with PrimEd students ($M=3.123$) showing a lower capacity than EChildEd students ($M=3.381$; $p=0.040$).

Notably, 93.7% of students recognize sustainability's multidimensional nature ($M=4.043$; $SD=0.931$). Significant differences emerge ($F(2, 458) = 6.091$, $p=0.002$), with SocEd students ($M=4.214$) perceiving sustainability more broadly than EChildEd students ($M=3.789$; $p=0.002$). Additionally, SocEd students ($M=4.405$) acknowledge sustainability's influence on personal lifestyle more than EChildEd students ($M=4.206$; $p=0.016$).

Regarding professional practice, 80% of students agree that SDGs should shape their careers ($M=4.144$; $SD=0.86$). EChildEd students ($M=3.868$) show lower agreement compared to SocEd students ($M=4.144$; $p=0.047$).

4.2. Information channels to learn about the SDGs

Education students report receiving more SDG-related training during their university studies ($M=3.527$; $SD=1.15$) than in compulsory education ($M=2.95$; $SD=1.36$) or through mass media ($M=2.854$; $SD=1.13$). ANOVA reveals significant differences ($F(2, 458) = 15.469$, $p<.001$). EChildEd ($M=3.557$) and PrimEd ($M=3.871$) students receive significantly more sustainability training than SocEd students ($M=2.915$; $p<.001$).

4.3. Knowledge and experience of active methodologies and sustainability in undergraduate studies

Students show a solid understanding of active methodologies, with high participation rates in cooperative learning (90-95%), critical thinking (87-93%), and play-based learning (85-96%). They associate these methods with meaningful and motivating learning, quality education, and enhanced student engagement. SocEd students rate active methodologies higher than PrimEd students, particularly regarding personal development ($p=0.021$), ICT integration ($p=0.025$), and research skills ($p=0.043$).

4.4. Assessment of the teaching staff's work in the development of Education for Sustainable Development

Students recognize faculty as agents of social change ($F(2, 458) = 3.952$, $p=0.020$), with SocEd students ($M=4.22$; $SD=0.59$) scoring higher than EChildEd students ($M=3.94$; $SD=0.73$; $p=0.023$). Significant differences also emerge in the perception of faculty fostering sustainability-related active methodologies ($F(2, 458) = 6.131$, $p=0.002$), with SocEd students ($M=3.86$; $SD=0.85$) scoring higher than PrimEd students ($M=3.50$; $SD=0.84$; $p=0.025$).

Although no significant differences are found in overall satisfaction with sustainability training, PrimEd students report slightly higher satisfaction ($M=3.90$; $SD=0.866$) than EChildEd ($M=3.76$; $SD=0.930$) and SocEd ($M=3.19$; $SD=0.950$). However, SocEd students express greater satisfaction with the use of active methodologies ($M=4.17$; $SD=0.74$) compared to PrimEd students ($M=3.84$; $SD=0.92$; $p<0.001$).

5. Discussion and conclusions

Awareness of the Sustainable Development Goals (SDGs) among university students is a topic of growing interest. As sustainability becomes a global priority, future generations, largely represented by university students, are expected to be familiar with these goals and be willing to contribute to their achievement. Several research studies have explored the level of knowledge and perceptions of university students about the SDGs, showing that students from Social Sciences and Education-related majors tend to be more knowledgeable about the SDGs compared to those from more technical majors, and also more engaged (Zamora-Polo et al., 2019).

In our study, students in Education degrees are familiar with the SDGs, with variability in their knowledge of the SDGs (Cachero et al., 2023). Despite not having in-depth knowledge, students perceive the importance of the SDGs and their influence on their lives, indicating a positive attitude towards the SDGs and their importance for their future careers (Leiva-Brondo et al., 2022). Furthermore, this positive attitude towards the SDGs is related to a strong motivation to contribute to their development and a high willingness to participate in related activities (Nusrat & Zul, 2020).

On the other hand, we highlight that the majority of students have a global vision of the areas covered by sustainability, beyond environmental issues, taking into consideration the social, economic and cultural dimension. Likewise, most of them state that they have received training on the SDGs in their respective degree studies, with the following sources of information being social networks and the media (López et al., 2024).

As in other studies (Gutiérrez-Fresneda & Verdú-Llorca, 2018), students value active methodologies positively, perceive them as facilitators for the achievement of the SDGs (Aparicio et al., 2021) and consider that teachers play a fundamental role as agents of social change and drivers of ESD (Gómez-Gómez & García-Lázaro, 2023).

We must educate global citizens who can take on the challenges facing humanity, developing knowledge and skills in sustainability, fostering social responsibility and critical thinking, offering meaningful learning experiences and implementing university policies that promote these approaches.

Acknowledgments

This work was supported by the Operational Plan for Research Support of the University of Jaén (HUM427_2023; Action 1b); and the Vice-rectorate for Coordination and Quality of Education of the University of Jaén, PID2024_011 (PIMED-UJA Plan 2019-2023).

References

Albu, R. (2022). Knowledge of SDGs among Students and Determination of their Interest in Building a Career in the Field of Sustainable Development. *Bulletin of the Transilvania University of Brasov. Series V Economic Sciences, 15*(64), 2, 59-68. https://doi.org/10.31926/but.es.2022.15.64.2.7

Aparicio, L., Bohorques, L., De Paredes, C., Escamilla C., Giménez, E., & Quilez, J. M. (2021). Los ODS como instrumento de aprendizaje: una experiencia multidisciplinar en los estudios universitarios. *Revista Educación y Derecho, 1,* 307-332. Retrieved from https://revistes.ub.edu/index.php/RED/article/view/37706/36994

Cachero, C., Grao-Gil, O., Pérez-del Hoyo, R., Ordóñez-García, M.C., Andújar-Montoya, M.D., Lillo-Ródenas, M. A., & Torres, R. (2023). Perception of the Sustainable Development Goals among university students: A multidisciplinary perspective. *Journal of Cleaner Production*, *429*. https://doi.org/10.1016/j.jclepro.2023.139682

CRUE. (2019). Manifiesto XXVIII Jornadas de Crue-Sostenibilidad: "Las Universidades en la transición social de la Agenda 2030". Retrieved from https://www.crue.org/Boletin_SG/Manifiesto%20Crue-Sostenibilidad%20Mieres.pdf

Fošner, A. (2025). Sustainability Literacy as a Key to a Better Future: A Look at Higher Education. *Sustainability*, *17*(3), 987. https://doi.org/10.3390/su17030987

Gómez-Gómez, M., & García-Lázaro, D. (2023). Concienciación y conocimientos sobre los Objetivos de Desarrollo Sostenible en la formación del profesorado. *Profesorado, Revista de Currículum y Formación del Profesorado, 27*(3), 243-264. https://doi.org/10.30827/profesorado.v27i3.27948

Gutiérrez-Fresneda, R., & Verdú-Llorca, V. (2018). Aprendizaje individual, colaborativo y cooperativo, ¿cómo valoran los estudiantes estas metodologías?. En R. Roig-Vila (Ed.). *El compromiso académico y social a través de la investigación e innovación educativas en la Enseñanza Superior*, (pp. 951-957). Alicante: Octaedro. Retrieved from https://rua.ua.es/dspace/bitstream/10045/87911/1/2018-El-compromiso-academico-social-94.pdf

Leiva-Brondo, M., Lajara-Camilleri, N., Vidal-Meló, A., Atarés, A., & Lull, C. (2022) Spanish University Students' Awareness and Perception of Sustainable Development Goals and Sustainability Literacy. *Sustainability*, *14*, 4552. https://doi.org/10.3390/su14084552

López, I., López, E., & Rinovell-Rico, S. (2024). Estudiantes del máster de Profesorado como agentes de cambio: percepción y conocimiento sobre los ODS. *Educar, 60*(1), 83-101. https://doi.org/10.5565/rev/educar.1876

Lozano, A., & Figueredo, V. (2021). Los objetivos de desarrollo sostenible en la formación de los futuros maestros: uso de metodologías activas. *Campo Abierto, 40*(2), 245-257. https://doi.org/10.17398/0213-9529.40.2.245

Maoela, M. A., Chapungu, L., & Nhamo, G. (2024). Students' awareness, knowledge and attitudes towards the sustainable development goals at the University of South Africa. *International Journal of Sustainability in Higher Education*, *25*(9), 455-473. https://doi.org/10.1108/IJSHE-11-2023-0518

Martín, M. L., Díaz, E., & García, C. (2021). Puesta en Práctica de ODS en Educación Superior a través de la competencia "Sensibilidad hacia temas Medioambientales y Sociales". En M. L. Sein-Echaluce, A. Fidalgo, & F. J. García (Eds.). *Innovaciones docentes en tiempos de pandemia*. *VI Congreso Internacional sobre Aprendizaje, Innovación y Cooperación (CINAIC 2021)* (pp.48-52). Zaragoza: Universidad de Zaragoza. https://doi.org/10.26754/CINAIC.2021.0010

Nusrat, A., & Zul, I. (2020). Assessment of Knowledge, Attitude and Practice of University Students towards Sustainable Development Goals (SDGs). *The Journal of Indonesia Sustainable Development Planning*, *1*(1), 31-44. https://doi.org/10.46456/jisdep.v1i1.12

ONU (2015). *Transformar nuestro mundo: La agenda 2030 para el desarrollo sostenible*. Retrieved from http://unctad.org/meetings/es/SessionalDocuments/ares70d1_es.pdf

Seva-Larrosa, P., Marco-Lajara, B., Úbeda-García, M., García-Lillo, F., Rienda, L., Zaragoza-Sáez, P. C., Andreu-Guerrero, R., Manresa-Marhuenda, E., RuizFernández, L., Sánchez-García, E., Poveda-Pareja, E., & Martínez-Falcó, J. (2021). Conocimiento y percepción de los alumnos en el ámbito universitario sobre los Objetivos de Desarrollo Sostenible (ODS). En R. Satorre (Coord.). *Redes de Investigación e Innovación en Docencia Universitaria. Volumen 2021* (pp. 161-170). Institut de Ciències de l'Educació (ICE) de la Universitat d'Alacant. Retrieved from https://rua.ua.es/dspace/bitstream/10045/119458/1/Redes-Investigacion-Innovacion-Docencia-Universitaria-2021_14.pdf

Zamora-Polo, F., Sánchez-Martín, J., Corrales-Serrano, M., & Espejo-Antúnez, L. (2019). What Do University Students Know about Sustainable Development Goals? A Realistic Approach to the Reception of this UN Program Amongst the Youth Population. *Sustainability*, *11*(13), 3533. https://doi.org/10.3390/su11133533

SDSN (2020). *Accelerating Education for the SDGs in Universities: A guide for universities, colleges, and tertiary and higher education institutions*. New York: Sustainable Development Solutions Network (SDSN). https://files.unsdsn.org/accelerating-education-for-the-sdgs-in-unis-ES-web.pdf

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

AN ESCAPE ROOM ACTIVITY IN ANALYTICAL CHEMISTRY

Roberto Sáez-Hernández[1], Inés Adam-Cervera[2,3], Paula García-Balaguer[4], Ángel Morales-Rubio[1], Adela R. Mauri-Aucejo[1], & M. Luisa Cervera[1]
[1]Department of Analytical Chemistry, University of Valencia (Spain)
[2]Department of Physical Chemistry, University of Valencia (Spain)
[3]Institute of Material Science, University of Valencia (Spain)
[4]Department of Optics, Optometry and Vision Sciences, University of Valencia (Spain)

Abstract

This proposal outlines an escape room activity that integrates key concepts from courses offered by the Department of Analytical Chemistry at the University of Valencia. Designed as an interactive learning experience, the activity encourages students to develop hypotheses, ask questions, and make decisions based on clues and experimental results obtained through analytical instrumentation. By engaging in this hands-on approach, students can apply the theoretical knowledge gained during their academic studies. Escape room-style activities are rooted in active learning, placing students at the center of the experience while fostering the development of theoretical, practical, and behavioral skills. Research supports their effectiveness in complementing traditional teaching methods, aiding exam preparation, and enhancing laboratory practice. Additionally, these activities boost student motivation through engaging challenges and promote teamwork in problem-solving scenarios. In this case, the proposed escape room takes place in a laboratory setting designed to simulate the workspace of a missing scientist. Students must complete a series of analytical tests to progress toward their ultimate goal: retrieving a code to unlock the scientist's laptop and uncover the mystery behind their disappearance. The challenges include fluorescence spectroscopy for analyzing tonic drinks, infrared spectroscopy for organic substance identification, and X-ray fluorescence for examining inorganic salts. Each test provides analytical results that lead to the next stage, ultimately guiding students toward the final solution. This initiative makes use of the available facilities and resources at the University of Valencia's Faculty of Chemistry. The required equipment and materials are readily accessible and easily adaptable. The activity is tailored for laboratory courses with an instrumental focus, such as the Analytical Chemistry II Laboratory and the Applied Instrumental Analysis Laboratory, typically taken in the third and fourth years of the Chemistry Degree program.

Keywords: *Analytical chemistry, escape room, instrumental analysis, laboratory modules, undergraduate students.*

1. Introduction

Escape rooms are usually ludic activities that consist of a series of puzzles to be solved in a logical sequence to finally reach a point of conclusion. These have gained interest not only as leisure activities, but also in educational research, with multiple examples having being published in the literature.

Among the most interesting advantages of scape rooms in education, the literature shows that it helps promote critical thinking and increases motivation among students (Veldkamp et al., 2020). Additionally, escape rooms are closely related to Active Learning, a perspective of education that focuses on the participation of students in their learning process, becoming the main character, instead of passive information recipients. As escape rooms make students interact with different items and objects, students are forced to participate in the process and make evidence-based decisions (Zhang et al., 2018).

More specifically, in the field of Chemistry Education, escape rooms can help settle on the theoretical content often taught in theoretical lessons to specific practical cases to be solved. This is especially interesting as experimental and laboratory teaching is a key part of the Chemistry syllabus, so Escape Rooms applied to the laboratory can become an innovative approach to innovate and face students with problems that need to be solved by them using their Chemistry theoretical and practical knowledge.

2. Activity description

2.1. Educational context

This activity has been designed for the module "Applied Instrumental Analysis Laboratory", a fourth-year subject in the Degree of Chemistry at the University. This context is especially relevant as it allows one to have a grasp on the expected *a priori* knowledge that students are supposed to have at this point. In this regard, at this point of their studies, students have already gone through all the compulsory theory modules, so they should be proficient in describing the theoretical foundations of analytical instruments. Also, given their stage within the degree syllabus, they have gone through several laboratory modules (not only focused on Analytical Chemistry, but also in other areas of Chemistry), so their performance in the laboratory is expected to be independent and adequate.

Finally, it must be considered that this module has been designed for an optional subject, which should mean that students are more motivated towards it as they have chosen it themselves.

2.2. Activity

The activity consists of three different tests, which are planned sequentially, so that solving one of them would path the way to undertake the next one. Each one of these tests or challenges applies a different analytical technique. The idea is that students find some prompts or hints that they should integrate along with their prior knowledge to carry out analytical measurements and, subsequently, analyze the results.

The activity should be carried out in small groups, between two or three students, as it is intended that all of them actively participate in solving the challenges. Bigger groups could end up with a leader who rules and some students who lean on them with minimal to no participation whatsoever. When it comes to time investment, the whole practice is set up to last around two or three hours, as the laboratory sessions of this module are three and a half hours.

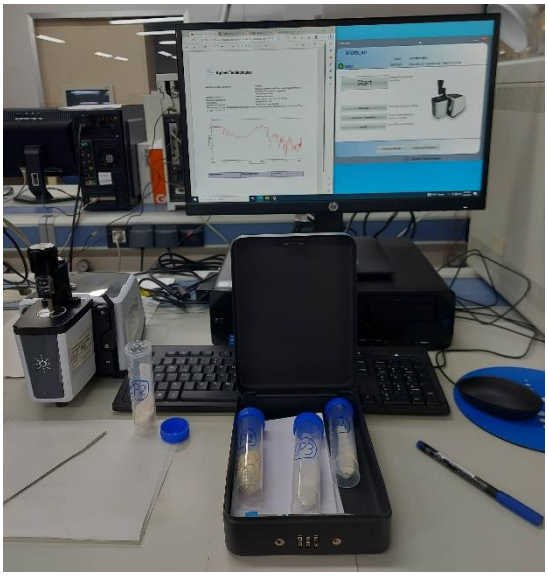
Challenge number one is based on fluorescence analysis, and it is the starting point of the whole activity. First, students are presented with some basic instructions indicating that they will find in the lab some objects, instruments (which should be already on to help them spot them), two locked boxes, and a blocked laptop that needs a password to unlock. Next to those instructions, students will find a tonic beverage bottle and a cup with liquid in it. All this material will be placed close to a spectrofluorometer, so students are expected to read the instructions first and start finding out their way through the activity. The logical first step is to spot that the bottle contains tonic, and the label indicates that there is quinine present in it. Thus, based on their prior knowledge and the information at their disposal, students are expected to measure an aliquot of the liquid in the spectrofluorometer.

They will be able to obtain the excitation spectra first, and this could lead them to a first potential result: the excitation maximum of quinine. They might try this value in the first locked box, with no result. Then, they are expected to measure the liquid to obtain the emission spectra, spot the wavelength of maximum emission, and try again in the box. Now, introducing the value of 450 nm will open the box that will take them to the next challenge.

When they open the first box, they will find four labelled tubes containing known organic substances, and a firth tube labelled as "unknown sample". Also, some instructions as to how to use an FTIR spectrometer will be included. Thus, at this point, students are expected to join the dots and interpret that the unknown substance must be one of the compounds present in the standards, and that upon their IR measurement, they will be able to stop which one is it. Hence, after having measured all five solids in the instrument, they will have the spectra of four standard compounds and a sample. A visual inspection of all five spectra will lead to the spot which substance is contained in the unknown sample vial. In order to open the next box, they will need to introduce the subindexes of the molecular formula of the unknown compound. For example, if they find that the spectrum of the sample is the same as the tartaric acid standard (whose molecular formula is $C_4H_6O_6$), they will need to introduce 466 in the second locked box to open it. In Figure 1, the set up for challenge 2.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

Figure 1. Challenge number 2: Standard and sample tubes within the first box, being measured in the FTIR instrument. The obtained spectra for the sample is compared with the reference spectra.



If they are able to thrive through challenge number 2, they will be able to gain access to the second and last locked box. This one also contains some other tubes with different solids in them. However, in this case, these are inorganic solids. As was the case before, they will find some instructions about the portable X-ray fluorescence spectrometer and (**important!**) some safety instructions that must be followed.

These solids are different inorganic salts with only one metallic element, and they will be contained in tubes labelled as "1", "2", "3" … For example, $FeCl_3$, $MnCl_2$, $CoCl_3$… can be chosen. It is positive if the different compounds present different colors, as students are always attracted to visually eye-catching substances. The rationale behind this challenge is that students measure the samples in the indicated order (first, substance contained in tube "1"; second, substance contained in tube "2" …), and the instrument will provide them with a list of the elements present in each solid. At the top of the list, they will have the most abundant element of each salt (this is why it is important that these are simple salts, to avoid potential confusions). Students will need to take note of which element is the most important one in each tube, as their concatenation will be the passcode to unlock the final laptop. In this way, for instance, if tube "1" has Mn as the main element, tube "2" has Fe, "3" has Cu, and "4" has Co, the final password will be "MnFeCuCo". All this is shown in Figure 2.

Figure 2. Challenge number 3: tubes with different salts in them are measured by the portable X-ray fluorescence spectrometer, and the concentration of main metals is shown in the screen.

It is crucial that this challenge is carried out under close surveillance of the laboratory instructor, as the portable X-ray fluorescence spectrometer emits ionizing radiation. Hence, some safety precautions must be followed:

- The potential leakage of radiation must be controlled by the presence of a dosimeter close to the instrument.
- The samples must be measured using the instrument's protective cover, ensuring that no radiation leaves the measuring apparatus.
- Students must keep a distance from the instrument while it is measuring, at least one meter is advised.

Finally, to bring the activity to an end, once students have unlocked the laptop with the password, they will be presented with a spreadsheet to include their personal information and results obtained.

3. Conclusions and future perspectives

The activity presented in this contribution is a new escape room designed for a laboratory module within the degree of Chemistry at the University of Valencia. This activity makes use of three different analytical instruments as examples for students to be faced with different challenges that they will need to address. The challenges have been designed so that the solution of one of them leads to the start of the next one, in a logical sequence that guides them through the whole activity.

The main objective of this activity is to present an innovative idea to be implemented in instrumental analysis laboratories. In general, laboratory modules are taught in a very routinary manner, usually consisting of a practice preparation, laboratory experimentation, and data analysis. This process, most probably legit and adequate, can also benefit from eventual innovative practices like the one presented here. In this way, we intend to motivate students to be more involved in the practice, as they usually value positively some different methodologies that leave the usual path.

As briefly described in the introduction, educational escape rooms have proven themselves as efficient teaching tools as they promote transversal skills, and not only theoretical knowledge. For example, for the case presented here, students combine different aspects to thrive and succeed in the activity:

- They require prior theoretical knowledge. For example, they need to know that quinine is a fluorescent molecule, the differences between excitation and emission spectra, how to use IR spectra to identify substance…
- They require to have practical skills in the laboratory. In this activity, they do not receive assistance from the laboratory instructor (unless strictly necessary), so they need to work independently to apply the analytical instrumentation.
- They need to work collaboratively in small groups, working transversal skills like team work or communication. This kind of activity promotes more fluent communication, as they are not so used to working in the lab in this way.

Regarding the evaluation of the activity, it is recommended that the laboratory instructor focuses more on the experimental aspects while students are carrying out the challenges. For example, a rubric would be an appropriate tool to guide the observance process. In this rubric, instructors should focus on aspects like skill when using instrumentation, reasoning processes to extract and interpret analytical data, lateral thinking to link that analytical information with the elements of the escape room, or active participation and involvement in the group.

Finally, this escape room is presented as a potential starting point for other instructors willing to innovate in their laboratory teaching. We have adapted it to our facilities and instrumentation, but other analytical techniques and/or solids can be included, sophisticating or simplifying the activity according to the necessities of each particular case.

Acknowledgments

Authors thank the University of Valencia for an educational research project (UV-SFPIE_PIEC-3330106) and Inés Adam-Cervera thanks the University of Valencia for a predoctoral position "Atracció de Talent".

References

Veldkamp, A., van de Grint, L., Knippels, M. C. P., & van Joolingen, W. R. (2020). Escape education: A systematic review on escape rooms in education. *Educational Research Review*, *31*, 100364.

Zhang, X. C., Lee, H., Rodriguez, C., Rudner, J., Chan, T. M., & Papanagnou, D. (2018). Trapped as a group, escape as a team: applying gamification to incorporate team-building skills through an 'escape room'experience. *Cureus*, *10*(3).

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

BIBLIOTHERAPY IN BULGARIA: A STUDY OF PERCEPTIONS, APPLICATION AND EDUCATIONAL PERSPECTIVES

Sabina Eftimova, & Teodora Genova
Department of Library Sciences,
University of Library Studies and Information Technologies - ULSIT (Bulgaria)

Abstract

This report summarizes the activities and results implemented during the second phase of the project "Study of Attitudes towards the Therapeutic Potential of Reading in Atypical Situations for the Individual". The main focus of this phase is the conduct of an empirical study among library professionals in Bulgaria, aimed at investigating the level of knowledge, understanding and practical application of bibliotherapy in a library environment, as well as the development and popularization of bibliographic and educational resources focused on bibliotherapy. The project demonstrates a significant contribution to increasing the information provision and systematization of knowledge about bibliotherapy, strengthening the connection between science, academic education and practice, as well as popularizing the therapeutic potential of reading among library professionals and the general public. The results of this project are of key importance for the development of library science and practice, providing new knowledge and solutions in the service of society.

Keywords: *Bibliotherapy, Bulgaria, project, ULSIT.*

1. Introduction

The project launched in 2020 entitled "Study of Attitudes towards the Therapeutic Potential of Reading in Atypical Situations for the Individual" financed by the National Science Fund of the Ministry of Education and Science of the Republic of Bulgaria with Contract No. КП-06-Н45/2 from 30.11.2020, led by Chief Assist. Prof. S. Eftimova–Ilieva, PhD is innovative for Bulgaria for the following reasons:

- Focus on atypical situations – most research on the therapeutic effect of reading has focused on standard contexts such as psychotherapy or educational settings. This project explores how reading can affect an individual in circumstances that are unusual for them (e.g. isolation, social change, crises, stressful events).
- Individual attitudes – while existing research analyzes the general benefits of reading, this project delves into people's personal perceptions and emotional responses in specific situations.
- Interdisciplinary approach – combines psychology, literary studies, and cognitive science to offer a more complete picture of the impact of reading on mental health.

The relevance of the implemented project is related to:

- The dynamic and uncertain world – in the conditions of global changes (pandemics, wars, economic crises), people increasingly find themselves in unforeseen life situations. The project can offer new coping strategies through reading.
- Growing interest in bibliotherapy – reading is now seen as a therapeutic tool, but its potential in extreme and atypical circumstances has been little explored.
- Mental health and prevention – the topic of mental health is becoming increasingly important, and reading can be a cheap and accessible way to improve emotional well-being.

Contribution in the future:

- Developing new therapeutic approaches – the study may provide guidance for using reading as a psychological tool in crisis situations.
- Personalized strategies – the results can help individualize the reading process according to the emotional and cognitive state of the individual.
- Education and social policy – it can influence the way schools, hospitals and institutions use reading to support people in vulnerable situations.

This project will not only contribute to expanding knowledge about the therapeutic effects of reading, but will also provide practical guidance for improving mental health through literature.

2. Results

In the first stage of the project, a nationally representative study was conducted with an author's survey instrument aimed at analyzing the perception and use of the therapeutic functions of reading in atypical situations among the population in Bulgaria.

The results of the study unequivocally confirmed that reading performs a significant adaptive and regulatory function in dealing with atypical and crisis situations, such as the COVID-19 pandemic. The data showed that books are not only a source of information and emotional support, but also a means of psychological stabilization, reducing anxiety and maintaining cognitive and emotional resilience. Among the main conclusions of the study are:

- Increased frequency of reading during periods of crisis – a significant share of respondents reported an increase in time spent reading during the pandemic as a form of coping with stress and uncertainty.
- Diversity in preferred genres – while some respondents seek comforting and inspiring literature, others turn to popular science or fiction that helps them escape from the disturbing reality.
- Reading as a mechanism for emotional regulation – books have been found to help reduce psychological distress and support the processes of self-reflection and emotional adaptation.

These results not only confirm the therapeutic potential of reading, but also highlight its role as an accessible and effective tool for mental health in conditions of social isolation, crises, and other atypical life circumstances. In the future, individual differences in the perception of reading as a therapeutic practice, as well as the factors that determine its effectiveness in different demographic and psychological profiles, can be actively worked on.

In connection with the project's assessment of library professionals' knowledge and application of bibliotherapy, an empirical study was conducted to assess the level of awareness, understanding and application of bibliotherapy among library professionals in Bulgaria. The study included a survey method, interviews and analysis of practices in various libraries – public, school, university and specialized. The survey was conducted among a wide range of library professionals from all regions of the country in order to ensure a nationally representative sample. Additionally, qualitative interviews were conducted with librarians who have experience or are interested in bibliotherapy programs.

Main results and conclusions reached:

- Limited awareness of bibliotherapy – a significant percentage of respondents are not familiar with the theoretical foundations and methods of bibliotherapy. A small number of specialists have participated in training or have used bibliotherapy purposefully in their practice;
- Lack of systematic implementation – although some librarians intuitively use reading as a form of support for readers (for example, in working with children with learning difficulties, the elderly or people in social isolation), these practices are not structured and are not perceived as bibliotherapy in the classical sense. The main obstacles to the implementation of bibliotherapy include insufficient training, lack of specialized materials and limited resources for training;
- Positive attitudes and interest in additional training – the majority of respondents express interest in additional training in bibliotherapy, especially regarding its practical applications in different social contexts. A need has been identified for the development of methodological guidelines and specialized training for librarians to prepare them for the effective use of bibliotherapy in their practice.

There is a need for systematic training and awareness raising, and the development of training programs for library professionals will be a key factor in integrating bibliotherapy into libraries. It is necessary to develop methodological resources - the creation of manuals, online courses, and specialized literature that will help promote and implement bibliotherapy in practice.

Pilot programs in libraries – it is advisable to implement experimental projects in several libraries to implement bibliotherapy practices and share experience and good practices. Based on these results, it is planned to expand the research and create practical models for implementing bibliotherapy in libraries, with the aim of establishing it as a sustainable practice in support of readers.

In addition to these two studies, a number of other surveys were conducted related to various elements of bibliotherapy: Audio and E-Books: Alternative in Time of Pandemic; Educational Initiatives to Stimulate Reading among Young People; Educational Role of the Children's Illustrated Book through the Child's View; Examination of Good Practices in Teaching Bibliotherapy in a University Environment; How Books Help Children Understand and Find Their Way in This New Reality; Reading as a Key Factor for Personality Development of Adolescents; Study of Attitudes towards Bibliotherapy among Students of Library and Information Studies in Bulgaria; Study of the Attitudes and Interest in Listening To Audiobooks among Students at Elementary And Secondary Education Levels In Bulgaria in English Language Learning; The Healing Books - through the Eyes of the Writer; The Place of Bibliotherapy in the Field of Continuing Vocational Education and Training in Bulgaria; The Place of the Library in a Period of Crisis; The Possibilities and Role of Audiobooks as A Medium in Learning English as A Foreign

Language; Using Books to Support the Processes Associated with the Perception of Loss in Children (Garvanova, 2021; Genova, 2022; Mincheva, 2021; Mukanova, 2022; Parijkova, 2021).

Improving the quality of information provision and systematization of knowledge on bibliotherapy issues were also among the goals of the project. Within the framework of the project, targeted work was carried out to improve access to scientific and applied information in the field of bibliotherapy, which led to significant results in several areas:

- **Creation of a national bibliography on bibliotherapy.** A detailed bibliographic study of scientific, popular and specialized publications related to bibliotherapy in Bulgaria has been carried out. The first systematized bibliography of Bulgarian publications on the topic has been prepared, which includes articles, monographs, scientific conference reports and dissertations. The bibliography has been published online on the project website, which will facilitate access for researchers, librarians, psychologists and other interested specialists.
- **Preparation of an international bibliography.** A systematic review of the scientific literature published by leading international authors in the field of bibliotherapy has been conducted. The bibliographic resources include key studies and monographs by established scholars, which provides access to the latest trends and research paradigms in this field. This resource creates a basis for comparative analysis between the Bulgarian and international scientific contexts.
- **Popularization of bibliotherapy as a scientific and practical discipline.** Online and face-to-face discussions have been held on the application of bibliotherapy in various social and clinical contexts. Publications and reports presented at scientific conferences have been prepared, which contribute to the establishment of bibliotherapy as an important field in the science of reading and psychology.

Through the collected bibliographic resources and the activities carried out, interest in bibliotherapy has been increased in academic and professional circles. The creation of accessible bibliographic resources represents an important step towards the institutionalization of bibliotherapy as a scientific and practical discipline in Bulgaria. The scientific base provided will facilitate future research, training and applied activities in the field. In the long term, this resource can be expanded and updated, which will support the development of bibliotherapy as an important tool for psychological support and personal development. These results demonstrate the sustainability of the project and its contribution to the building of a scientific infrastructure in the field of bibliotherapy in our country.

The project implemented targeted activities to integrate bibliotherapy and related disciplines into academic education, focusing on the preparation of students for Bachelor's and Master's degrees in library and information sciences. The process included updating the curriculum, developing new academic materials, and promoting research in this area:

- **Updating and integrating bibliotherapy into academic disciplines.** New learning modules and topics were developed that broaden and deepen the understanding of bibliotherapy, library psychology, and pedagogy. Existing curricula were updated, introducing interdisciplinary approaches linking library science with psychology, pedagogy, social sciences, and medical humanities. The courses were enriched in:

Bibliotherapy - expanded learning content with an emphasis on methods for bibliotherapy work in various institutional and social contexts.

Library Psychology - including topics about the impact of reading on cognitive and emotional development.

Library pedagogy - integrating bibliotherapy approaches in working with children and adults.

Accessibility to information for people with specific needs - inclusion of bibliotherapy techniques to support people with disabilities and social difficulties.

Policies to stimulate reading - an analysis of bibliotherapy strategies as a tool for promoting reading.

Bibliophilism – expanding topics related to the cultural and aesthetic role of books in a therapeutic context (Eftimova, 2021).

- **Introduction of new academic resources and practical training.** New teaching materials have been developed, which include bibliotherapy case studies, methodological guidelines, and practical guidelines. Interactive teaching methods have been introduced, with students participating in bibliotherapy work scenarios, analyzing real cases, and developing projects related to the application of reading in a therapeutic environment. Practical seminars and workshops with students have been organized, demonstrating bibliotherapy techniques and analyzing its application in various social groups. Pilot practical classes have been carried out in libraries, where students have the opportunity to apply bibliotherapy methods in a real environment.
- **Promoting scientific research and publication activity.** Course and thesis papers have been developed with a focus on bibliotherapy and its applications. Doctoral students and undergraduates are involved in scientific research aimed at analyzing bibliotherapy approaches and their impact on various reader groups. Publication activity is stimulated, with students and young scientists being encouraged to participate in scientific conferences and publish in specialized journals. The

development of young scientists and doctoral students who continue to work on topics related to bibliotherapy and its interdisciplinary dimensions is supported.

- **Continuing education opportunities for library professionals.** Professional development training programs have been created for librarians who want to integrate bibliotherapy into their practice. An online training platform is in the process of being prepared that will offer courses on bibliotherapy and related topics for the continuing professional development of library professionals. The realization of this sub-goal led to a significant enrichment of the academic content, creating conditions for building a new generation of library professionals who have broader competencies and are prepared to use bibliotherapy as an effective tool in their practice.

In the future it is planned to:

Expand curricula by introducing specialized modules and electives in bibliotherapy. Develop new research projects in the field of bibliotherapy, involving doctoral students and undergraduates. Collaborate with libraries and social institutions for the practical application of bibliotherapy techniques. This initiative strengthens the connection between science, education and practice, ensuring sustainable development of bibliotherapy in Bulgaria and creating opportunities for future research and innovation in the field.

The last element of the project was the popularization of bibliotherapy in Bulgaria. The popularization of bibliotherapy in Bulgaria was carried out through a wide range of scientific and practical initiatives, including participation in conferences, organization of scientific forums, publication activity and digital presentation of the project. The goal was to disseminate knowledge about bibliotherapy, both among the scientific and professional community, and among the general public.

- **Participation in scientific conferences and presentation of the project.** Members of the team presented reports and scientific research at national and international conferences focused on bibliotherapy, reading as a therapeutic tool and the role of libraries in social support. Emphasis was placed on: the theoretical foundations and development of bibliotherapy in Bulgaria; the empirical results of the national representative survey on the perception of the therapeutic functions of reading; analysis of good bibliotherapy practices from international experience, etc.
- **Organization of scientific forums and events.** Roundtable on Bibliotherapy; National Scientific Conference with International Participation "Bibliotherapy in Bulgaria - Opportunities and Prospects" - research and good practices from Bulgaria was presented with the aim of stimulating the development of bibliotherapy in our country. A scientific collection of conference reports was published, which serves as a valuable source of information for specialists and researchers.
- **Publication activity: scientific publications and methodological resources.** An important part of the popularization of bibliotherapy was the publication of scientific research, methodological materials and educational resources. A monograph on bibliotherapy summarizes the results of the project, presents the theoretical aspects of bibliotherapy and analyzes its application in library practice. A teaching aid, intended for students and library professionals, includes practical guidelines and examples for the use of bibliotherapy.
- **Scientific articles and reports** – published in specialized Bulgarian and international publications, which contributes to the wider dissemination of the topic and its establishment in academic circles. The project established bibliotherapy as a relevant and promising field in library and social sciences in Bulgaria. Thanks to scientific forums, publications and digital presence, the topic received deserved attention and laid the foundations for future initiatives, research and practical applications in the library environment.

3. Conclusion

The main hypothesis of the project was that bibliotherapy is poorly interpreted in a scientific-theoretical and practical-applied aspect in Bulgaria, that it is not widely known and used in the library environment, and that it is necessary to stimulate the application of the therapeutic potential of reading in atypical situations. In the course of the study, empirical studies were conducted, scientific and practical initiatives were organized, which allowed to analyze the real situation and confirm the validity of the hypothesis.

1. *Lack of systematic research and low awareness*

- The nationally representative study showed that although reading is intuitively used as a form of coping with crisis situations, the conscious application of bibliotherapy is poorly known among both librarians and the general public.
- There is a lack of structured methodologies and systematized resources for bibliotherapy in Bulgarian library practice, which proves that the topic has so far been episodically researched and applied.
- The results of surveys with library professionals showed a low rate of professional training in bibliotherapy issues and insufficient integration of bibliotherapy programs into library services.

2. Significant potential for the application of bibliotherapy in the library environment

- The results of the study showed that the population perceives reading as a coping mechanism for stress, social isolation, and personal crises (for example, during the COVID-19 pandemic). This supports the idea that bibliotherapy has the potential to be purposefully implemented, but an expert framework for this is lacking.
- Training activities conducted with librarians and students showed that with appropriate training, librarians can effectively apply bibliotherapy methods in their work.

3. Successfully laid foundations for the popularization and future development of bibliotherapy

- The organization of the national scientific conference and the roundtable with the participation of experts, librarians and researchers created conditions for a broader discussion of the topic and helped integrate it into the scientific and professional discourse.
- The creation of a website and the publication of scientific works (monograph, collection of reports, teaching aids) provided librarians and researchers with access to scientifically based information and methodological guidelines, which will facilitate the future development of bibliotherapy in Bulgaria.
- The inclusion of bibliotherapy in the curricula for library and information science students ensures its long-term development and integration into library practice.

The main hypothesis was confirmed, as it was found that bibliotherapy is poorly developed in Bulgaria, but has significant potential for development. The project laid a solid foundation for future research, popularized bibliotherapy and created practical mechanisms for its implementation in the library environment. In the long term, the project created prerequisites for new fundamental scientific research that will contribute to the deeper theoretical and practical application of bibliotherapy in Bulgaria. The present project has proven that bibliotherapy is a valuable but underdeveloped resource in Bulgaria, which has serious potential for application in library practice, social work and psychology. The study found that although reading is intuitively used as a means of coping in difficult life situations, the targeted and systematized application of bibliotherapy is poorly known and developed both at the theoretical and practical level.

In the modern world, marked by stress, social challenges and global crises, bibliotherapy provides an accessible, effective and long-term means of emotional and psychological support. Its development in library practice and education will contribute to improving the quality of life, social inclusion and cultural development of society. Thus, the project not only proves the importance of bibliotherapy, but also sets a direction for its future establishment as an integral part of library and social activities in Bulgaria.

Acknowledgements

This paper is supported by the project entitled "Study of Attitudes towards the Therapeutic Potential of Reading in Atypical Situations for the Individual" financed by the National Science Fund of the Ministry of Education and Science of the Republic of Bulgaria with Contract No. КП-06-Н45/2 from 30.11.2020, led by Chief Assist. Prof. S. Eftimova-Ilieva, PhD.

References

Eftimova, S., Todorova, T., Parijkova, L., Mincheva, K., & Mukanova, P. (2021). Bibliotherapy – Academic Education – Librarians. *INTED21*, 6758-6762. doi: 10.21125/inted.2021.1345

Garvanova, M., & Eftimova, S. (2021). Educational Initiatives to Stimulate Reading Among Young People. *EDULEARN21*, 3812-3816. doi: 10.21125/edulearn.2021.0803

Genova, T., Eftimova, S., Garvanova, M., Atanasov, H., & Todorova, T. (2022). Application of Research under a Bibliotherapy Project in Training of Students from the Specialties of Library and Information Management. *INTED2022*, 10404-10409. doi: 10.21125/inted.2022.2745

Mincheva, K. (2021). Educational Role of the Children's Illustrated Book Through the Child's View: Results of a Study. *EDULEARN21*, 3998-4004. doi: doi.org/10.21125/edulearn.2021

Mukanova, P., Eftimova, S. Popova, E., & Damianova, I. (2022). The Power of Words and the Ones Using the Power of Words during a Pandemic. *INTED2022*, 2822-2826. doi: 10.21125/inted.2022.0816

Parijkova, L. (2021). "Read – So You Never Feel Alone" – Initiatives Born During the Pandemic and Related to the Healing Power of Books. *EDULEARN21*, 4767-4771. doi: doi.org/10.21125/edulearn.2021

MATH AND MAKING IN AFTERSCHOOL - A PEDAGOGIC INNOVATION WITH LATINX MIDDLE SCHOOL YOUTH

Nuria Jaumot-Pascual, Teresa Lara-Meloy, & Ken Rafanan
TERC (USA)

Abstract

Amped 4 Making (A4M) is an afterschool program co-developed by TERC and the Cesar Chavez Foundation (CCF) that integrates mathematics-oriented design and making with the community values of civil rights leader Cesar Chavez. The program engaged Latinx middle school youth across the U.S. Southwest in community-focused maker projects, aiming to broaden participation in STEM through culturally responsive practices. A4M consists of four semester-long modules designed to support rural Latinx youth's mathematical identity and agency. Materials include student and facilitator resources in multiple media and accompanying training. Youth aged 10–14 engaged in co-designed, locally adaptable making projects that connected mathematics learning, community, and cultural strengths. A4M's design/making framework integrates the mindset of design thinking with hands-on making through an iterative cycle. This structure supported both youth and facilitators in recognizing and leveraging embedded mathematics. Through this approach, A4M provides a model for transforming how Latinx youth engage with informal math learning, and how they see themselves as mathematical thinkers—solving problems rooted in their communities through making.

Keywords: *Math and making, pedagogic innovation, giving back, design cycle, Latinx youth.*

1. Literature review

AMPED 4 Making (A4M) developed and piloted an afterschool program of mathematics-oriented design and making that was infused with the community-oriented core values of civil rights leader Cesar Chavez. The making focus was animated through activities that align with a broader view of making espoused by Leah Buechley as well as Clapp, Ross, Ryan, and Tishman in their book, *Maker-Centered Learning* (2016). In this exclusivity-eschewing view, a maker is a person who makes things. Our participants (and the facilitators) are makers by engaging in the making activity and their maker identities are developed through their engagement in making. Clapp and colleagues provide a useful "symptoms-based" framing for considering whether a learning experience is maker-centered by considering characteristics touching on aspects of community, process, and the environment. In its development, the co-designers of A4M considered multiple community, process and environmental aspects to ensure that the learning experience centered around the participants' making experiences.

Existing research has found that giving back—which encompasses "behaviors associated with improving an individual's community and helping others" (Page, 2010, p. 10)—are important for underrepresented groups among whom communal values are important. Furthermore, the literature shows that even though STEM disciplines are seen as individualistic and competitive (Diekman et al., 2017), engaging in giving back, community-oriented activities support students' persistence in STEM (Jaumot-Pascual et al., 2023; Silva et al., 2021). Jaumot-Pascual et al. (2023) found that Native students in computer science did not have difficulty in finding ways to use their technology skills give back to their communities on and off campus through activities such as teaching, mentoring, conducting outreach, and using technology to preserve cultural artifacts and Tribal documentation.

2. Context of the program

2.1. Description of the program

A collaboration of the Cesar Chavez Foundation (CCF) and TERC, (funded by the National Science Foundation (award #2215382) before being prematurely terminated), A4M is a middle school afterschool program of mathematics-oriented design and making infused with the core values of civil rights leader Cesar Chavez. Thus, the program has a strong focus on caring for community, as exemplified by this quote.

> *"We cannot seek achievement for ourselves and forget about progress and prosperity for our community … Our ambitions must be broad enough to include the aspirations and needs of others, for their sakes and for our own."—Cesar Chavez, 1991*

A4M's goals are to engage youth in a blend of design and making in and for the community—consequential making (Barton & Tan, 2018)—to enhance and develop youth's:

- agency and positive identity, as makers, mathematical doers and users, and community members,
- understanding of mathematics, such as geometric principles or linear measurements, within the context of informal learning projects, and
- perceptions of how they can use mathematics, design, and making in their future lives and work.

As a two-year after school program, youth sign up at their schools each semester. Semesters are composed of mini-maker projects which lead up to a larger project focused on making something for youths' own communities—the afterschool program, their family and the school. For example, in Semester 1 youth build skills with 3D modeling and printing and cardboard construction, culminating in making a storage system for program participants to store projects in progress, which they can use in following semesters. Sessions also integrate select Cesar Chavez values.

2.2. Participants

CCF recruited seven middle school sites in California to run the A4M afterschool club. A majority of the over 200 enrolled youth participants are Latinx (about 80%), ages 10–14 years, multilingual, and receive free or reduced-priced lunch. At some sites, A4M was part of the school's existing afterschool offerings, so only youth already in an ongoing program either chose or were guided to participate in A4M. At other sites, there was no ongoing afterschool program, so any youth in the school could join.

2.3. Facilitators

This kind of complex project with many "moving parts" requires special skills and awareness on the part of the afterschool facilitators who facilitate it (NRC, 2015). We take inspiration from Vossoughi, et al. (2013), studying how afterschool maker programs can foster equity. Centrally, facilitators must be able to recognize the mathematics in its many forms: the mathematics that youth use in making, school mathematics, and community mathematical know-how. Just as important, staff must attend to youth's identity development. This is no small feat. Both topics, (and how they fit together) were addressed in professional development (PD) workshops. Research suggests that facilitators need at least three kinds of skills: in making, in pedagogy, and in youth development (Vossoughi & Bevan, 2014). In A4M PD, facilitators wore two hats: as learners (participating in mathematics and making), and as facilitators (e.g., learning how to make norms or mathematics explicit). During the academic year, facilitators had opportunities to reflect on their own practice, anchored in artifacts or videos from afterschool sessions.

3. Curriculum design

Middle school youth in AMPED 4 Making engaged in design-and-making projects that addressed community goals based on Cesar Chavez's values. These values were integrated across the curriculum in several ways, such as through the integration of the distinctive "Sí se puede" cheer at the beginning of sessions, the use of community-centered topics emphasized in the making projects, and the emphasis on peer support. This project aimed for changes in youth's relationship with mathematics. Youth had opportunities to engage with important mathematics while drawing on community and cultural strengths, particularly in community mathematical know-how.

The project used a co-design framework to develop an equity-focused making program. The A4M team co-designed lesson plans for four semesters that introduce a series of mini-making projects, such as an LED lantern, a 3D-printed bookmark, an LED patch, stuffies, and cubbies. During the first year and before each session, the team would meet to review the lesson plan and practice the relevant making skills.

After each session, the team would meet to review feedback from youth and facilitators on how the session went and propose any changes to be applied to the past lesson and future ones, as relevant. These piloted sessions formed the cornerstones of projects in future years.

The focus of A4M projects progressively moved from the smallest circles of community, most proximal to youth (e.g., family and the afterschool program) to the largest circles of community (e.g., school, neighborhood). For example, in the program's first semester, youth reflected on their families through making a luminary that integrated elements that represented something important about them. Youth used images that represented their families in different ways, such as showing activities that their families enjoyed doing together (e.g., making arepas; riding horses, caring for pets), or using an abstract square to represent four members of their family. In later semesters, the program focused on making projects that represented or that were designed to either represent or be helpful for the larger community, such as designing and 3D printing a wall mosaic representing their neighborhood community or building wooden planters for the school. Each of the projects also required that the youth engage in foundational mathematics for a successful build. The most mathematical topics were measurement, volume, rigid transformations, and proportionality. By focusing projects on making for the community, the A4M curriculum engaged youth not only in consequential making but also consequential use of mathematics.

4. Research design and methods

This project's research followed a mixed methods convergent parallel design (Creswell, 2021), where quantitative and qualitative data collection and analysis occurred simultaneously. The research took place in two stages (co-design and implementation).

The project implemented a multi-method approach to collect data to ensure triangulation, including pre/post surveys, pre/post math assessments, facilitator reflection forms, facilitator interviews, and youth object elicitation interviews. The methods were chosen for their appropriateness to the informal education setting, their participatory nature, and their precision. Research activities were integrated into the co-design process for a more naturalistic understanding of the phenomena. TERC and CCF staff were co-researchers and collaborated in the development and implementation of the data collection instruments, the analysis of the data, and the development of findings.

This description of the pedagogical innovation of A4M is mainly based on the data and analysis of object elicitation and facilitator interviews and focus groups. Object elicitation is a data collection method that centers the youth interview around an object that youth made in the program (Levin-Güracar et al., 2024). Since the objects were created by the youth, the objects embody the youth's knowledge, skills, and attitudes and make interviews easier by shifting the focus of attention from the interviewer-interviewee dyad to the object. This type of interview elicits richer information than regular interviews because images and objects facilitate recalling processes and memories in more detail (Harper, 2002).

We analyzed the transcripts of object elicitation interviews and focus groups using deductive coding by starting with the main ideas in the research questions as the main codes (Fereday & Muir-Cochrane, 2006). Then, codes were consolidated into broader themes, which we present in the findings.

5. Implementation results

This paper shows that the integration of consequential making and the Cesar Chavez values in the A4M program is a pedagogical innovation that supported participating youths' community orientation. We divided the concept of community orientation into two main themes: youth's community orientation by encouraging their interest in giving back and their engagement in teamwork.

5.1. Giving back

Participants kept family, friends, and their school community in mind when considering how they were going to use their new making skills. Participants talked about using their new making skills to engage in reciprocity and gifting with people in their lives, making things that they would find useful or would enjoy and to show them gratitude and love. In the first year, when the youth were asked to make a stuffy representing their families, four youth made their stuffies to give to their siblings (horses, football, frog), four made stuffies related to activities that they do with their families, such as cooking and baking, one made an item that connects with their family business (arcade machine), and one made a religious symbol because their family is religious. Additionally, three participants made stuffies that represented an activity that they personally enjoyed (riding horses and motorcycles, playing PacMan). The quote below shows how Leo thought about the development of his stuffy, from the original idea to the making process and the math involved to the motivation for making it.

Leo: I made a stuffy, it felt pretty good because it didn't come out that bad and it was my first time making one, it's a horse. I really like riding horses. I've been having horses since I was four.

Interviewer: How did you make it?

Leo: I just turned it from a 2D to a 3D. I just folded it, and I cut it, and I did the same with the hair with the body shape, and then I sewed the shape together, and I left a little hole right here so I could stuff it in, and I didn't get to finish. I will finish at home. It is for my little brother. He is 5 and likes horses too.

In year 2, youth built wooden planters for their school community. When youth were asked in an object elicitation focus group what they would plant, they talked about planting flowers as something nice for the school to make it prettier. They also talked about having useful plants such that they can be used for medicinal purposes, like mint or aloe vera. Rose explained, "[aloe vera] could be used if a student has a burn or something". The youth were thinking about using their new making skills for the benefit of their greater school community by considering what to plant that would be beneficial.

5.2. Supporting teamwork

Facilitators worked to develop positive relationships with the youth and create supportive environments where youth were able to come together as a group. They used the program's routines, such as starting sessions with the "Sí se puede" cheer, as a way to bring the group together and create a sense of belonging in the program. During interviews and in weekly feedback forms, facilitators explained that they encouraged the youth to work together and help each other, particularly when one of them finished early or if another had difficulty figuring out how to do something. A facilitator commented,

At first, they weren't really talking to each other … If they didn't know how to do something, I'd encourage them to team up with someone and they would be like 'Oh, OK! I get this now!'"

In the weekly feedback forms, facilitators talked about students working together and learning from each other with more frequency as the weeks went on to the extent that "some students would become teachers to other students," as one of the facilitators shared. They reported that youth interacted with each other in positive terms, using language that described motivation, enjoyment, collaboration, leadership, teaching each other, mutual encouragement, and even safety, as shown in this example:

The students were using tools safely, which is an important skill, and it was great to see the students helping each other out. I kept encouraging them to work collaboratively and develop their skills, and they'll no doubt continue to thrive.

Youth also shared how supporting each other became part of how the program run. In the following quote, Stephen shared how he received help from a peer when he ran into difficulties while working on his stuffie, which included a circuit with an LED light:

My friend helped me out with the [LED] light because I didn't really remember how to do it. So, they helped me out with the light, and they also help me out with cutting the shapes.

6. Conclusions and recommendations

A4M integration of the community goals based on Cesar Chavez's values created a supportive environment that promoted teamwork and collaboration. These values also opened up opportunities for relational making, which was taken up by learners, who found ways to engage in consequential making that integrated math and giving back. We recommend the implementation of programs that engage youth in solving problems in the communities they care about, drawing on their connections to the people living near them to promote consequential making, giving back, and the development of a positive math identity.

Acknowledgments

This material is partially based upon work supported by the National Science Foundation. AMPED 4 Making was funded through the AISL Program (award #2215382) until it was prematurely terminated. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

References

Barton, A. C., & Tan, E. (2018). *STEM-rich maker learning: Designing for equity with youth of color*. Teachers College Press.

Chavez, C. (1991). *Remarks from Dedication Ceremony of Cesar Chavez Elementary School in Coachella, CA*.

Clapp, E. P., Ross, J., Ryan, J. O., & Tishman, S. (2016). *Maker-centered learning: Empowering young people to shape their worlds.* John Wiley & Sons.

Creswell, J. W. (2021). *A concise introduction to mixed methods research*. SAGE publications.

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International journal of qualitative methods, 5*(1), 80-92.

Harper, D. (2002). Talking about pictures: A case for photo elicitation. *Visual studies, 17*(1), 13-26.

Jaumot-Pascual, N., DeerInWater, K., Ong, M., & Silva, C. B. (2023). "I can do data for my people": experiences of giving back for Native undergraduates in computing. *Cultural Studies of Science Education, 18*(3), 879-909.

Knudsen, J., Shechtman, N., Lara-Meloy, T., Stevens, H., & Rutstein, D. (2015). *A professional development program for mathematical argumentation: Bridging from workshop to classroom* (SRI Technical Report). https://bridgingmath.wpengine.com/wp-content/uploads/2020/01/bridging-pd-for-math-argumentation.pdf

Knudsen, J., Stevens, H., Lara-Meloy, T., Kim, H. J., & Shechtman, N. (2017). *Mathematical argumentation in middle school: The what, why and how*. Corwin.

Levin-Güracar, E., Jaumot-Pascual, N., Rafanan, K., Lara-Meloy, T., Eways, J., & Mitchell, I. (2024, September 28–October 1). *Object elicitation interviews: Engaging youth in conversations about their STEM learning through making* [Conference presentation]. ASTC Annual Conference, Chicago, IL, United States.

National Research Council. (2009). *Learning science in informal environments: People, places, and pursuits*. The National Academies Press.

Page, J. D. (2010). *Activism and leadership development: Examining the relationship between college student activism involvement and socially responsible leadership capacity* [Unpublished doctoral dissertation]. College Park, MD: University of Maryland.

Silva, C. B., Jaumot-Pascual, N., Ong, M., & DeerInWater, K. (2021, Spring). What Motivates Native Computer Science Students? A New Study Looks at How Giving Back Helps Undergraduates Stick with a Challenging Major. *Winds of Change*. https://read.nxtbook.com/aises/winds_of_change/spring_2021/what_motivates_native_compute.html

Taylor, E. V. (2012). Supporting children's mathematical understanding: professional development focused on out-of-school practices. *Journal of Mathematics Teacher Education, 15*, 271-291.

Vossoughi, S., & Bevan, B. (2014). Making and tinkering: A review of the literature. *National Research Council Committee on out of school time STEM, 67*, 1-55.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

DEVELOPMENT OF AN E-EXERCISES APPLICATION FOR AN INTRODUCTORY STATISTICS COURSE AT UNIVERSITY LEVEL

Janne Engblom[1], Kaisa Saastamoinen[1], & Erkki Kaila[2]
[1]*Turku School of Economics (Finland)*
[2]*University of Turku (Finland)*

Abstract

This study describes the development and content of an e-exercises application for an introductory statistics course targeted at bachelor students of a business school. The course is offered in blended-learning format. The development was based on success factors in blended learning and it involved the customization of an already existing software to specific educational needs. The primary goal was to enhance learning by offering a web-based and easy-to-use exercises environment that gives students an opportunity to work at their own pace and to receive instant feedback. The purpose was also to lighten the workload of an instructor with large number of students on the course and to provide learning analytics data for teaching development and research purposes. The course instructor designed and coded the application using a learning environment with already existing features of course setup and maintenance (ViLLE). Exercises included probability theory and statistical inference. The application allowed for personalization of assignments and the system was set to be simulation-based with random starting values for each student. Statistical inference exercises included phases of verbal multiple-choice questions. This enabled interpretation of numeric results of hypothesis testing and confidence interval estimation, which simulated real-world statistical decision-making. A survey (n = 98) showed that the students were satisfied with the application. The large majority of respondents (more than 80%) considered the application to be simple, easy to navigate with and overall, a successful system. A majority of students saw the system as a good way to promote independent working. The system is currently in use in Turku School of Economics, Finland and approximately 400 students use it every year.

Keywords: *e-Learning, software development, higher education.*

1. Introduction

The use of educational software has spread rapidly during the past few years as the digitalization of society has intensified due to the COVID-19 pandemic. Universities all over the world promote studies independent of place and time, supported by the availability of a multitude of devices that enable both learners and instructors to exploit the possibilities of digitalization (Basak et al 2018). Digitalization has also profoundly changed the methods of interaction and working (Kurvinen et al 2020).

This article describes the development of an e-Exercises application for an introductory statistics course targeted at bachelor students at a business school. The application was introduced within the context of a massive blended course, and developed following software development life-cycle phases of planning and analysis, design with implementation and maintenance (see e.g., Davis, Bersoff & Comer 1988 for a review of such models). The development work aimed, firstly, to enhance learning by offering an easy-to-use environment that gives students an opportunity to work at their own pace and to receive instant feedback. Secondly, the purpose was to lighten the workload of an instructor, and to provide learning analytics data. The organization of the article is as follows: We first discuss the critical success factors which are the basis of the development process of the application. Secondly, we discuss content of the system with feedback received from the students. We conclude by acknowledging the challenges of the development and the need for an ongoing development process.

2. Success factors in blended learning

Blended or hybrid learning is a pedagogical approach that combines face-to-face and online teaching with the aim of enhancing the effectiveness of learning (Hockly 2018). Prior literature suggests that hybrid courses are more student-centred, promote active learning and student collaboration, and

increase student interaction with course content. The blended format is seen as supporting different learning styles by offering instructional material in diverse formats, and allowing students to work at their own pace with the online material. Hybrid courses add flexibility to students' schedules by allowing them to control when and where they work during the online part of a course (Marquis & Ghosh 2017; Bokolo et al 2022; Min & Yu 2023). However, as the number of face-to-face lessons is reduced with the insertion of online segments, negative effects caused by reduced social interaction and collaborative learning, are possible (Jazayeri & Li 2021). From the instructor's point of view, the blended format offers several advantages, such as improved availability of teaching material, convenience of communication and flexibility of homework distribution. However, the creation of suitable online elements combined with a larger number of students may increase instructor workload (Haughton & Kelly, 2015; Jazayeri & Li, 2021).

Min and Yu (2023) reviewed critical success factors for blended learning and identified six categories of factors (learner, instructor, course, design, technology and environment). These factors provide a general framework for our discussion on the development of an e-Exercise application. The critical success factors pertaining to learners include their learning speed, commitment, attitude, motivation, cognition, computer efficacy and experience (Min & Yu 2023). Instructors' substantive knowledge, pedagogical characteristics, course management skills, knowledge of computer systems and instructional implementation of technology have been identified as critical in blended learning (Ozkan & Koseler 2009; Min & Yu 2023).

The course-related success factors include course objectives, content and materials, course design, assessment and grading. As students on introductory statistics courses have to deal with subject information that is often novel and complex, it is recommended that the online learning environment and materials are designed to minimize extraneous cognitive load caused by the way information is presented and what students are required to do (Sweller et al 2019; Flores et al. 2023).

The critical pedagogical features of a blended course relate to design, such as the clarity of the learning objectives, teaching methods and learning strategies (Min & Yu 2023). Collaborative and active learning approaches, using real data that are directly relevant to students' fields of interest, solving genuine research problems and analyzing data from real studies have been proposed as means to engage and motivate students with statistics (Bromage et al., 2022).

The technology-related critical success factors cover the ICT system available and its accessibility, ease of use, quality, reliability, efficiency and privacy, as well as on information and the use of software. A related, but distinct category in Min and Yu's conceptualization is environment, which refers to the learning environment and learning management system adopted. The central features of the learning management system in a blended course are interactivity, diversity in assessment and evaluation methods, accessibility, ease of navigation and other features facilitating its use (Sun et al., 2008; Min & Yu 2023). Hence, issues such as the availability of statistical software and their suitability for building learning activities, and students' access to the software and computing resources needed for completing statistics assignments are at stake here (Biehler 1997; Bromage et al. 2022; Flores et al. 2023).

3. The development of the application

We begin by noting that the development of the application involved the customization of an already existing software to specific educational needs (Tchounikine 2011). A web-based learning environment, ViLLE (VisuaL Learning Environment), developed by the Department of Information Technology of the University of Turku, Finland, was readily available. ViLLE is an exercise-based learning environment, designed along constructivist views of learning (Laakso, Kaila & Rajala 2018).

A critical question to address when designing and considering the adoption of educational software is whether the new setting is expected to enhance learning. In this respect, the ViLLE environment offered several important features that could be incorporated in the application to bring added value to the blended course and to satisfy user requirements. Firstly, the automatic assessment of submissions with instant feedback in a massive course was possible. From the students' viewpoint, these features added time and place flexibility as the submission of assignments and receiving feedback is no longer tied to the weekly schedule of the course. The instant feedback provided by the application not only notifies whether submissions are correct or not, but also provides additional feedback on how the correct solution could be reached. Additionally, as students can retake assignments as many times as they want, they can study at their own pace. The number of points earned gave students information on their learning levels.

A very important value-adding feature of the ViLLE environment is its adaptability, i.e., an instructor can code and update the system as well as create exercises to account for changes in course content or teaching. The exercise code can be embedded into ViLLE user interface (exercise set-up, evaluation and feedback). Multiple sections can be used, for example, for mathematical calculations and verbal interpretations based on numeric results.

The application, hence, allowed for the personalization of assignments, i.e. the system could be set to be simulation-based with random starting values for an exercise. This feature also counteracts the problems of free-riding efficiently, making course management easier. At the same time, the application makes it possible to design similar exercise "stories" to enable teamwork and account for the social dimension of learning. From the instructor's perspective, these features enable the automation of working processes, leading to a lighter workload and freeing up time for other activities.

Many features of the application that relate to the technological and environmental factors in Min and Yu's (2023) framework were already implemented in the current system. The current system runs on a standard web browser with no additional plug-ins required, is device independent and an easy-access system. These features were set to be implemented in the new system as well. Ease of access means that students are able to log in using their own usernames and passwords to the university network without additional login information. Simple user interface entails that the new system can be utilized without any commands, but is menu-driven with a structure similar to the course.

The system's method for answering is either a numeric answer to an exercise or a choice out of several alternatives. The latter is the method in the final exam. Therefore, this helps students familiarize themselves with the method used in the final exam. Preparing for the exam is naturally the most important outcome of exercises from the students' perspective.

Four types of e-Exercises were set up in the application:

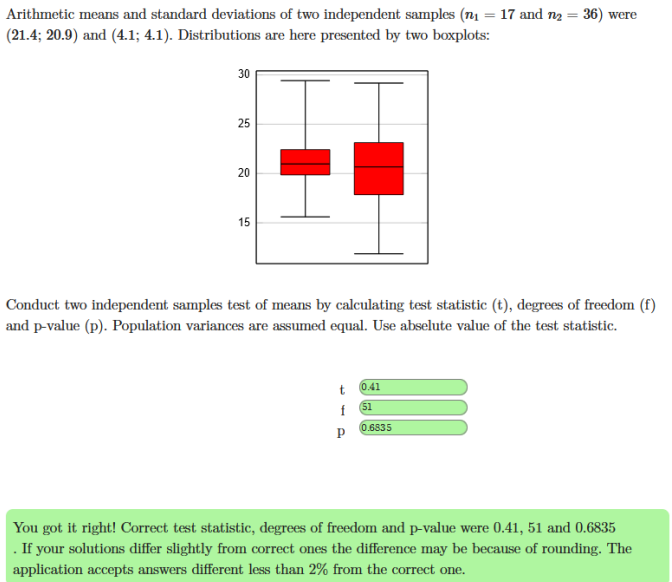
- Numeric: Random parameter value and/or data was generated. User-input and system-defined numeric answers are automatically compared (≤2% difference is allowed).
- Numeric: Random parameter value and/or data is generated, selection out of four numeric alternatives, one correct choice.
- Verbal: questions of substance, selection out of four alternatives, one fixed correct choice.
- Numeric and verbal: Exercise has two phases. First, numeric results are calculated and evaluated similar to items 1) or 2). In the second phase, the correct choice from several alternatives is defined based on numeric results.

4. Results and discussion

The e-Exercise application was developed within the context of an introductory statistics course given at Turku School of Economics, Finland. The course is a compulsory, three-credit undergraduate course, lasting for six weeks and given in Finnish. It is usually taken during the second year of studies, and approximately 400 students attend annually. Students have different major subjects (accounting and finance, marketing, business management, information systems science, etc.) or none yet. The course is a recommended prerequisite for an advanced-level statistics course in the curriculum.

The main level user interface of the system was built with the blocks corresponding to the six weeks of teaching in the course. Figure 1 (translated from Finnish) gives an example of two independent samples test of mean. In this example, the user gave correct answers, which are indicated by the green feedback colour together with a positive feedback text.

Figure. 1. Example of a Problem Solution (Math).



In Figure 2a (translated from Finnish), first a false choice was selected. The correct choice was defined by numeric results presented in Figure 1. In this case, the null hypothesis was accepted because the p-value was greater than 0.05 (see Figure 2b).

Figure 2a. Example of a Problem Solution (Verbal), false choice.

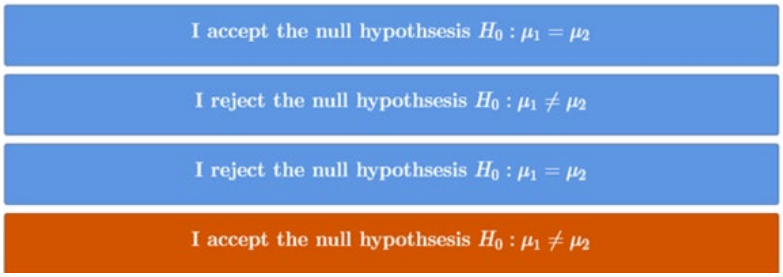
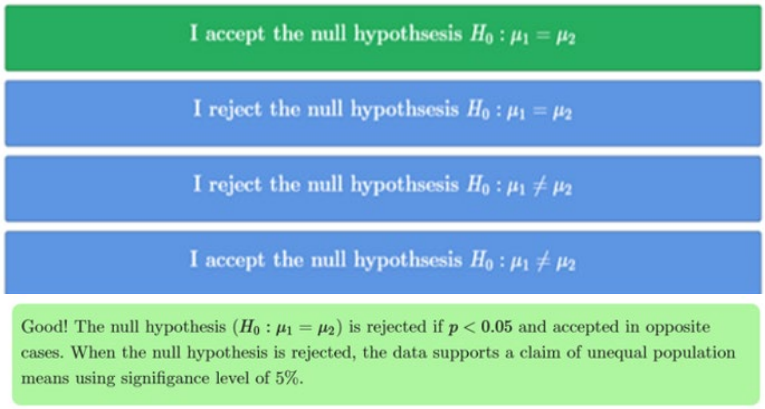


Figure 2b. Example of a Problem Solution (Verbal), correct choice.



A brief survey (n = 98) was conducted in spring 2024, and the results showed that the students were quite satisfied with the application (named as eTKMY3). In the survey, the statements were assessed using a psychometric scale of "Strongly agree", "Somewhat agree", "Neither agree nor disagree", "Somewhat disagree" or "Strongly disagree". The majority of respondents (80.6% and 87.0%) disagreed (strongly or somewhat) with the statements "Starting eTKMY3 was difficult" and "eTKMY3 was complex". Again, more than 80% of the students either agreed or strongly agreed with "eTKMY3 is a successful system", "I can manage my studying and exercises easily", "Navigation was easy". Interestingly, most considered individual starting values of most exercises as a good way to promote independent working (61.3% agreed with the statement somewhat or strongly). From the instructor's point of view, the weekly workload was lightened by several hours because the system gave students automated and instant feedback.

The limitation of the study is concentration on student experiences only. The analysis of eTKMY3's effect on course outcome (grade) requires different type of data which is to be collected in 2025. The data to be collected includes information on attitudes on statistics, course experience together with students' background. What comes to the limitations of the system itself a further question pertains to the lifespan of the ViLLE system, as the application developed is dependent on the maintenance of the system. What will happen to the coded applications after ViLLE is not supported is not clear. However, since ViLLE is currently maintained and supported by the University of Turku, and has more than 100,000 active users, it is unlikely that the lifespan of the system would end anytime soon. Another issue are the challenges created by the limited flexibility of the environment. For example, if a student gives a false answer, the application gives only one fixed type of feedback instead of allowing for different types of feedback after each false answer. On the other hand, because ViLLE is a ready-made environment, several functions supporting course management and implementation already existed.

References

Basak, S. K., Wotto, M., & Bélanger, P. (2018). E-Learning, M-Learning and D Learning: Conceptual Definition and Comparative Analysis. *E-Learning and Digital Media, 15*(4), 191-216. doi: 10.1177/204275301878518.

Biehler, R. (1997). Software for Learning and for Doing Statistics. *International Statistical Review, 65*(2), 167-189. doi: 10.1111/j.1751-5823.1997.tb00399.x

Bokolo, A., Jr., Kamaludin, A., Romli, A., Raffei, A. F. M., Phon, D. N. A. L. E., Abdullah, A., & Ming, G. L. (2022). Blended Learning Adoption and Implementation in Higher Education: A Theoretical and Systematic Review. *Technology, Knowledge, and Learning, 27*, 531-578. doi: 10.1007/s10758-020-09477-z

Bromage, A., Pierce, S., Reader, T., & Compton, L. (2022). Teaching Statistics to Non-Specialists: Challenges and Strategies for Success. *Journal of Further and Higher Education, 46*(1), 46-61. doi: 10.1080/0309877X.2021.1879744

Davis, A. M., Bersoff, E. H., & Comer, E. R. (1988). A Strategy for Comparing Alternative Software Development Life Cycle Models. *IEEE Transactions on Software Engineering, 14*(10), 1453-1461. doi: 10.1109/32.6190

Flores, A., Parker Cappiello, L., & Quintanilla Salinas, I. (2023). Challenges and Successes of Emergency Online Teaching in Statistics Courses. *Journal of Statistics and Data Science Education, 32*(2), 122-128. doi: 10.1080/26939169.2023.2231036

Haughton, J., & Kelly, A. (2015). Student Performance in an Introductory Business Statistics Course: Does Delivery Mode Matter? *Journal of Education for Business, 90*(1), 31-43. doi: 10.1080/08832323.2014.968518

Hockly, N. (2018). Blended Learning. *ELT Journal, 72*(1), 97-101. doi: 10.1093/elt/ccx058

Jazayeri, M., & Li, X. (2021). Examining the Effect of Blended Instructional Method on Students' Grades in an Introductory Statistics Course. *International Journal of Mathematical Education in Science and Technology, 52*(8), 1240-1249. doi: 10.1080/0020739X.2020.1775319

Kurvinen, E., Kaila, E., Laakso, M. J., & Salakoski, T. (2020). Long Term Effects on Technology Enhanced Learning: The Use of Weekly Digital Lessons in Mathematics. Informatics in Education, 19(1), 51-75. doi: 10.15388/infedu.2020.04

Laakso, M. J., Kaila, E., & Rajala, T. (2018). ViLLE – Collaborative Education Tool: Designing and Utilizing an Exercise-Based Learning Environment. *Education and Information Technologies, 23*, 1655-1676. DOI: 10.1007/s10639-017-9659-1

Marquis, G. P., & Ghosh, S. (2017). Student Preferences for a Hybrid Course. *Journal of Education for Business, 92*(3), 105-113. doi: 10.1080/08832323.2017.1289886

Min, W., & Yu, Z. (2023). A Systematic Review of Critical Success Factors in Blended Learning. *Education Sciences, 13*(5). doi: 10.3390/educsci13050469

Ozkan, S., & Koseler, R. (2009). Multi-dimensional Students' Evaluation of E-Learning Systems in the Higher Education Context: An Empirical Investigation. *Computers & Education, 53*(4), 1285-1296. doi: 10.1016/j.compedu.2009.06.011

Sun, P. C., Tsai, R. J., Finger, G., Chen, Y. Y., & Yeh, D. (2008). What Drives a Successful E-Learning? An Empirical Investigation of the Critical Factors Influencing Learner Satisfaction. *Computers & Education, 50*, 1183-1202. doi: 10.1016/j.compedu.2006.11.007

Sweller, J., van Merriënboer, J. J. G., & Paas, F. (2019). Cognitive Architecture and Instructional Design: 20 Years Later. *Educational Psychology Review, 31*(2), 261-292. doi: 10.1007/s10648-019-09465-5

Tchounikine, P. (2011). *Computer Science and Educational Software Design: A Resource for Multidisciplinary Work in Technology Enhanced Learning*. Springer-Verlag. Doi: 10.1007/978-3-642-20003-8

A 2D3S4L MODEL: DOES GENERATIVE AI ENHANCE ENGLISH LANGUAGE TEACHING AND LEARNING IN LESOTHO?

Lipolelo Thamae, Wei Zhang, & Dzintra Iliško
Educational Science, Daugavpils University (Latvia)

Abstract

As Generative AI integration in education is gaining momentum, investigating its feasibility to enhance educational practices in Lesotho secondary schools cannot be overstated, particularly in the English language classrooms. This study investigates the integration of a generative AI to support English teaching and learning in Lesotho's secondary schools. Underpinned by TPACK and Social Constructivism, this study employed the two-dimension, three-stage, four-loop (2D3S4L) framework. This model views AI-supported instruction through two interfacing dimensions (the teacher and the student), three instructional stages (pre-class, in-class, post-class), and four pedagogical loops (analysis, design, implementation, evaluation) to examine how generative AI can possibly support teaching English across the pre-class, in-class, and post-class phases. This study adopted a mixed-methods approach, where survey and interviews were used to collect data. Data was analysed using descriptive statistics and SWOT analysis. The results reveal Generative AI tools used in teaching English, and unveiled the potential of AI to enhance English language instruction. Guided and ethical use of Generative AI is recommended for sustainability purposes.

Keywords: *Generative AI, education, 2D3S4L model, English, Lesotho.*

1. Introduction

The emergence of generative artificial intelligence (AI) has brought in a new era for education, with significant implications for English Language teaching and learning. Generative AI tools can produce text, audio, images, that are similar to those produced by humans, the use of these tools are gaining momentum for their efficacy (Bán, 2024). Their potential to change the way in which educational practices have been conducted is significant in contexts such as Lesotho (Theodorio et al., 2024; Ayanwale, 2023), where teachers and learners often face challenges of limited resources and large classroom sizes (Lekhetho, 2013). As adoption of these tools continues to grow, understanding how generative AI can enhance English Language teaching and learning in Lesotho is important. Since the introduction and growing use of tools such as ChatGPT and Copilot, generative AI has gained a lot of attention from teachers, policymakers and researchers. These tools are believed to have capacity to generate content that is relevant in specific contexts and also offer strategies of personalised learning to meet individual students' need, support assessment, and assist teachers in lesson planning (Ghimire et al., 2024; Kong & Yang, 2024; Tafazoli, 2024; Zaim et al., 2024).

Capitalising on the effective use of generative AI is beneficial. According to Kong 7 Wang (2024), it enables the teachers to develop learning materials that are current, and designed to meet the different learning style and needs of learners (Mittal et al., 2024). For example, teachers can use AI to plan the lesson, create study materials, grammatical exercises and engaging tasks, which in turn can save their time (Lodge et al., 2023). Nevertheless, using generative AI raises several concerns that cannot be overlooked. One major issue is the readiness of teachers to effectively integrate AI tools in their teaching practice (Wang et al., 2013). In their studies, Akanzire et al. (2025) and Moorhouse (2024) indicate that many teachers expressed their lack of confidence and lack of preparedness in bringing in generative AI into their teaching. Apart from that, challenges related to authentic and non-misleading content generated through the use of generative AI; the risk of depending on Generative AI; the potential to plagiarise and digital divide have been identified (Lodge et al., 2023). This emphasises the need to acquire relevant professional development.

In Lesotho, the potential influence of generative AI on English Language teaching and learning is promising. It is worthy to highlight that in Lesotho, English is the main language of instruction and a fundamental requirement to survive in academia and professional settings (Mphatsoane, 2024; Thamae, 2023). However, teachers frequently encounter challenges such as huge class sizes, limited access to teaching resources, and differing degrees in levels of student proficiency. In this case, generative AI provides a potential solution to these problems by making it possible to create customised teaching resources, which are tailored to meet different learners' learning styles (Anderson et al., 2023).

2. Theoretical framework

In this inquiry, the integration of generative AI in English Language teaching was studied through the philosophical lenses of two theories: Technological Pedagogical Content Knowledge (TPACK) (Mishra & Koehler, 2006) and Social Constructivism (Vygotsky, 1986). TPACK place emphasis on the importance of teachers' ability to combine their technological, pedagogical and content knowledge to create effective learning experiences (Ghimire et al., 2024; Mishra & Koehler, 2006). In this study's context, this means that English language teachers should not only understand how to use AI tools, but how to integrate them meaningfully into their lesson design and classroom practice. On the other hand, Social Constructivism advocates for learner-centred classrooms where learners are active and participate fully (Vygotsky, 1986). This suggests that use of AI should allow learners to construct knowledge through participatory activities. As mentors and facilitators, English language teachers are responsible to empower their learners to own their language development while leveraging Generative AI (Sari, 2025; Thamae & Matee, 2024). Supplementarily, a Two-Dimension, Three-Stage, Four-Loop (2D3S4L) model served as a blueprint for this study. This model is an educational framework that advocates for Diverse, Student-centred and sustainable learning across Four Learning Levels: (2D3S4L) model. This model views AI-supported instruction through two interfacing dimensions (the teacher and the student), three instructional stages (pre-class, in-class, post-class), and four pedagogical loops (analysis, design, implementation, evaluation). Contextually, it provided a structure for evaluating how generative AI tools support different English language lesson planning; personalised English language learning experiences, and established a long-term educational growth for the participants.

3. Research questions

- What generative AI tools do teachers use in English Language lesson planning, content generation, and assessment?
- What are the perceptions of teachers and learners regarding the integration of generative AI tools in teaching and learning English?

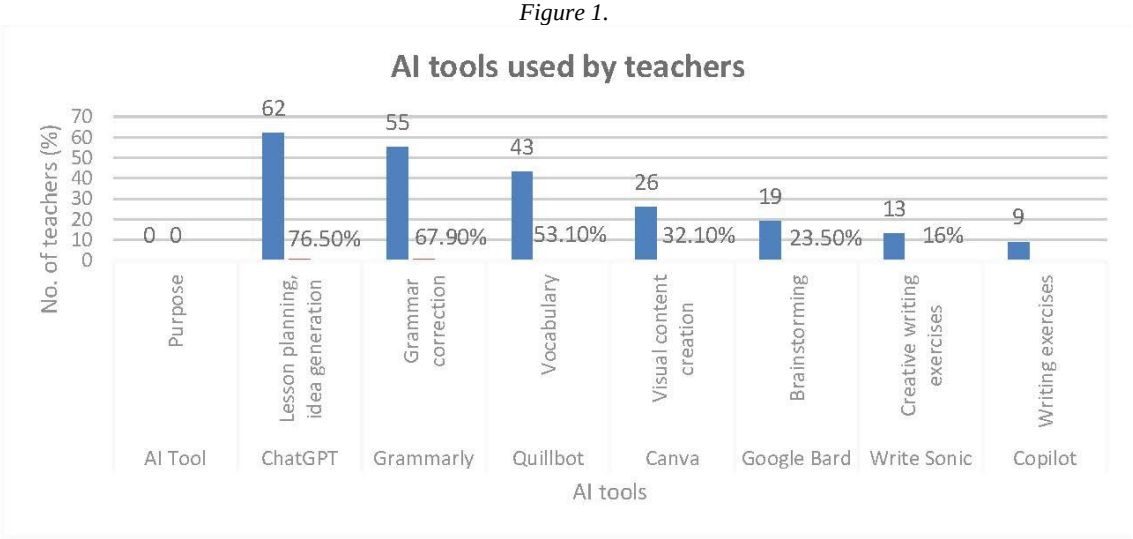
4. Methodology

This study adopted an explanatory sequential design of the mixed-methods research approach; quantitative data was collected first (Creswell & Creswell, 2017) through an administered survey (Johnson & Onwuegbuzie, 2004). Afterwards, qualitative data followed-up (Dawadi & Giri, 2021), and it was generated by virtual focus group discussion (FGD). Since the participants were geographically scattered, the FGDs were partitioned into three sessions. For Mahlangu (2024), this enables the researchers to draw rich insights from the participants' lived experiences and perceptions. English Language teachers (n-81) were purposively sampled to take part in this study; they were teachers who teach English language using Generative AI tools at both primary and secondary school levels. Additionally, English language learners (n-16) were sampled conveniently to participate in this study, a survey, through Google Forms was administered to the teachers, the collected data was analysed using descriptive statistics. Meanwhile, qualitative data was analysed thematically by SWOT analysis.

5. Results

RQ1: What generative AI tools do teachers use in English Language lesson planning, content generation, and assessment?

Figure 1.



The above graph demonstrates that most teachers (74.1%) use ChatGPT, Google Bard and Copilot to plan their different English language lessons; for content generation, 65.4% of the teachers prefer ChatGPT, Canva and Writesonic; for assessment-related tasks, they use Grammarly, Quillbot and ChatGPT (again).

RQ2: What are the perceptions of teachers and learners regarding the integration of generative AI tools in teaching and learning English?

Table 1.

SWOT categories	**Perceptions**
Strengths	Enhanced efficiency in teachers' lesson planning
	Vocabulary support for learners
Weaknesses	Inadequate digital literacy among teachers
	Learners' dependancy on AI generated content
	Misaligned with integrated curriculum
Opportunities	Teachers' digital skills development
	Learners' self-assessment
Threats	Misinformation
	Ethical concerns such as Plagiarism
	Internet access

The table above indicates that Generative AI tools enhance efficiency and creativity in English Language teaching and learning. However, it is acknowledged that challenges such as over-dependency on AI persist. Opportunities that come with using these tools are accompanied by threats.

6. Discussion

As per the research questions, Generative AI tools that the English language teachers in Lesotho use were established; these include but are not limited to ChatGPT, Canva, Quillbot. This buttresses Ghimire et al. (2024) and Tafazoli (2024)'s findings that use of these tools are gaining momentum in teaching English. As the 2D3S4L model indicates within the 3S dimension (pre-class, during class and post class), the teachers use these tools for different stages of their teaching. For example, the results showed that the teachers relied on the use of ChatGPT, Google Bard and Copilot to plan their different lessons (pre-class); to generate content, the English language teachers prefer ChatGPT, Canva and Writesonic (pre and during class); for assessment-related tasks, they use Grammarly, Quillbot and ChatGPT (post-class). This is supported by Mittal et al. (2024) who claim that teachers leverage these tools for different educational reasons. As a principle of Social Constructivism, an advantage of using mediated tools is that it promotes active participation in teaching and learning (Vygotsky, 1986). Other than that, SWOT analysis revealed strengths and opportunities including efficiency and personalised teaching and learning; this aligns with Zaim et al. (2024) findings that use of these tools allows customisation. Conversely, these findings

refute those of Moorhouse (2024), who claims that use of Generative AI comes with setbacks. Nonetheless, owing to the nature of SWOT analysis, weaknesses and threats were also established. The teachers and learners acknowledged that over-dependence and misinformation that comes with using these tools are disadvantageous. Akanzire et al. (2025) concurs that there are risks that emanate from use of these tools such as plagiarism. By extension, the TPACK framework suggests that this is bound to happen; in cases where teachers fail to apply their technological knowledge or lack technical skills, learners operate on their own and are bound to make mistakes.

7. Conclusion, ethical considerations and limitations

Conclusively, the SWOT analysis unearthed potential and challenges of integrating Generative AI tools in teaching English, thereby indicating that in as much as these tools may enhance pedagogical practices in this subject, guided and ethical use of these tools is needed for a balanced situation. The study ensured voluntary participation, anonymity and digital privacy in AI use.This study has some limitations, the findings are based on perceptions, which did not capture actual classroom practices. Thus, we recommend that the study of this nature should be conducted adopting action research and quasi-experimental designs.

Acknowledgements

I would like to pass my gratitude to Prof. Dzintra Ilisko, our dedicated supervisor, for her guidance and thirst to see us thrive in academia. Her support did not only motivated Wei Zhang to participate in the END conference, but inspired and facilitated our collaborative efforts. I am equally grateful to Wei Zhang for the valuable partnership and shared commitment to our research journey. Together we will take Europe, Asia and Africa far.

References

Akanzire, B. N., Nyaaba, M., & Nabang, M. (2025). Generative AI in teacher education: Teacher educators' perception and preparedness. *Journal of Digital Educational Technology, 5*(1), ep2508.

Anderson, N., McGowan, A., Galway, L., Hanna, P., Collins, M., & Cutting, D. (2023). Implementing Generative AI and Large Language Models in education. *2023 7th International Symposium on Innovative approaches in Smart Technologies (ISAS)*, 1-6, https://doi.org/10.1109/ISAS60782.2023.10391517

Ayanwale, M. A. (2023, September). Evidence from Lesotho Secondary Schools on Students' Intention to Engage in Artificial Intelligence Learning. *2023 IEEE AFRICON* (pp. 1-6). IEEE.

Bán, B. (2024). Leveraging On Ai Mentor to Boost Learning Effectiveness and Efficiency. *INTED2024 Proceedings* (pp. 7375-7383). IATED.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches.* Sage publications.

Dawadi, S., & Giri, R. A. (2021). *Mixed-Methods Research: A Discussion on its Types, Challenges, and Criticisms.* Sage

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational researcher, 33*(7), 14-26.

Lekhetho, M. (2013). Lesotho: Organisation, structures and challenges. *Education in Southern Africa*, 55-81.

Lodge, J., Thompson, K., & Corrin, L. (2023). Mapping out a research agenda for generative artificial intelligence in tertiary education. *Australian Journal of Educational Technology*, https://doi.org/10.14742/ajet.8695

Mahlangu, V. P. (2024). Examining The Time Prisoners Study Using E-Learning While in Prison: Sustainability of E-Learning Programs in Prison. *Discourse and Communication for Sustainable Education, 15*(2), 45-61.

Mittal, U., Sai, S., Chamola, V., & Sangwan, D. (2024). A Comprehensive Review on Generative AI for Education. *IEEE Access, 12*, 142733-142759. https://doi.org/10.1109/ACCESS.2024.3468368

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teachers' knowledge. *Teachers College Record, 108*(6), 1017-1054.

Moorhouse, B. L. (2024). Beginning and first-year language teachers' readiness for the generative AI age. *Computers and Education: Artificial Intelligence, 6*, 100201.

Mphatsoane, N. (2024). *The use of total communication approach to improve deaf learner's writing skills in English as a second language* (Master's thesis).

Sari, S. M. (2025). Empowering Language Learners: Innovative Strategies for 21st Century English Education. PEBSAS: *Jurnal Pendidikan Bahasa dan Sastra*, *3*(1), 30-38.

Thamae, L., & Matee, L. G. (2024). Critical Literacy Sustainability: What Pedagogical Practices? Whose Role? *Discourse and Communication for Sustainable Education*, *15*(2), 115-130

Thamae, L. (2023). Utilising phonemic-orthography to accelerate spelling proficiency for the development of critical literacy skills in a 9th Grade ESL classroom (Master's thesis, National University of Lesotho).

Theodorio, A. O., Waghid, Z., Mataka, T. W., & Adegoke, O. (2024). Demystifying Lesotho, Rwandan and Nigerian educators' viewpoints on smart technologies supporting AI in higher education. *Education and Information Technologies*, 1-23.

Vygotsky, L. S. (1986). *Thought and Language*. MIT Press.

Wang, X., Li, L., Tan, S. C., Yang, L., & Lei, J. (2023). Preparing for AI-enhanced education: Conceptualizing and empirically examining teachers' AI readiness. *Computers in Human Behavior*, *146*, 107798.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

BRIDGING ACADEMIA AND SOCIETY: INSIGHTS FOR CITIZEN SCIENCE AND INNOVATIVE PHD PROGRAM DESIGN

Maria Potes Barbas[1], Andreia Teles Vieira[1], Paulo Duarte Branco[1], & Maria Paula Pinto[2]
[1]CIAC - PLDIS, IPSantarém (Portugal)
[2]CIEQV, IPSantarém (Portugal)

Abstract

The principal objective of this study is to collate comprehensive insights from a diverse range of professional sectors, including academia, business, government, and civil society. This will enable the identification of critical themes and priorities that should inform future research initiatives. To this end, a structured questionnaire was developed as the principal instrument for data collection, crafted with great care to ensure a comprehensive understanding of the diverse perspectives of stakeholders. The questionnaire is composed of four sections. The first section provides general information about the survey, the second section gathers respondent sociodemographic data, the third section explores views on citizen science, and the final section solicits input on doctoral programs. A key focus of the study is on the public's and professionals' perceptions of citizen science, particularly its role in fostering collaboration between researchers and communities and its potential integration into doctoral curricula. The study thus seeks to gain a deeper understanding of these perspectives to identify the opportunities and challenges involved in aligning research priorities with the real-world needs of civil society. This focus is driven by the recognition that citizen science represents an important mechanism for democratizing knowledge production and addressing complex societal challenges through participatory research. The findings from this investigation will directly inform the ongoing collaborative effort to design a PhD program in Digital Communication, an initiative spearheaded by the University of Algarve and Santarém Polytechnic University. The program is envisioned as a multidisciplinary and innovative academic offering that incorporates both academic and non-academic dimensions. By soliciting feedback on the program's title, objectives, structure, and research priorities, the study guarantees that its design will align with the requirements of a diverse range of stakeholders and respond to the demands of a rapidly evolving digital communication landscape. The study's broader impact can be seen in its potential to shape a new paradigm in doctoral education, one that prioritizes inclusivity, innovation, and societal relevance. The program aims to equip future researchers and professionals with the requisite skills and knowledge to address pressing issues in digital communication while fostering collaborative engagement with non-academic sectors through the incorporation of feedback from diverse respondents. In conclusion, the study contributes to the advancement of digital communication as a discipline, with the dual aim of strengthening academic rigor and enhancing the capacity of research to drive meaningful societal change.

Keywords: *Societal impact of research, citizen science, academic-non-academic collaboration, collaborative education.*

1. Introduction

In an era marked by complex societal challenges that require interdisciplinary solutions, the relationship between science and society is undergoing a significant transformation (Bruneel et al., 2010). This paper explores the potential of citizen science and innovative PhD programs to serve as channels for aligning academic research with societal needs. By integrating participatory research methodologies and fostering cross-sector collaboration, educational institutions can enhance their societal impact while equipping doctoral students with a range of competencies relevant to a rapidly evolving global landscape context (Longmore et al., 2018; Barber, 2014).

As societal challenges become increasingly intricate, the role of academia in producing socially relevant knowledge has become more significant. Citizen science, which involves the public in scientific inquiry, is a promising approach to bridging the gap between research and society (Hitchcock et al., 2021). Incorporating citizen science methodologies into doctoral education can help universities democratize

knowledge production, enhance research impact, and foster interdisciplinary collaboration. This paper presents an analysis of stakeholder perspectives on citizen science and doctoral education, with a particular focus on a proposed PhD program in Digital Communication (Gantogtokh et al., 2017). The objective of the present study is to identify the key themes and priorities that should guide the development of the program to ensure its alignment with contemporary academic, industry, and societal needs. Specifically, the study addresses the following questions:

- What are the perceptions of academia, industry, government, and civil society regarding citizen science and its potential within doctoral education?
- What expectations do these stakeholders have for a PhD program in Digital Communication, particularly concerning curriculum design, research priorities, and skills development?
- How can citizen science methodologies be effectively integrated into a PhD program in Digital Communication to enhance its societal impact and relevance?

2. Design

The design of this study employs a mixed-methods approach, integrating qualitative and quantitative insights derived from a structured questionnaire. The survey was meticulously designed to elicit demographic information, perceptions of citizen science, and expectations for a PhD program in Digital Communication. Thematic analysis was employed to identify salient patterns and stakeholder priorities. This approach ensures a comprehensive understanding of how citizen science can be integrated into doctoral education while aligning academic research with societal needs.

2.1. Methodology

The data for this study were collected through the administration of a structured questionnaire to professionals from academia, industry, government, and civil society. The questionnaire explored respondent demographics, perceptions of citizen science, expectations for doctoral education, and recommendations for curriculum design. The responses were analyzed thematically to identify patterns and insights that inform the structure and objectives of the proposed PhD program.

A purposive sampling strategy was employed to select participants with relevant expertise and experience in citizen science, digital communication, and doctoral education. Potential participants were identified through professional networks, online databases, and recommendations from experts in the field. The questionnaire was administered online using a secure platform to ensure data privacy and confidentiality. Participants were provided with a clear explanation of the study's purpose and were informed of their right to withdraw from the study at any time.

The data analysis process involved a combination of descriptive statistics and thematic analysis. Descriptive statistics were used to summarize the demographic characteristics of the participants and their responses to the quantitative questions in the questionnaire. Thematic analysis was used to identify recurring themes and patterns in the qualitative responses to the open-ended questions. The thematic analysis process involved several stages, including data familiarization, code development, theme identification, and theme refinement. The themes were then organized into a coherent framework that captured the key insights and priorities of the stakeholders.

2.2. Objectives

The present study has been designed to achieve several key objectives. Firstly, it seeks to examine the role of citizen science in doctoral education by assessing its potential to bridge academia and society. Secondly, it aims to identify the perceptions and expectations of relevant stakeholders—including academia, industry, government, and civil society—regarding the integration of citizen science into a PhD program in Digital Communication.

The study also proposes a structured and interdisciplinary doctoral curriculum that incorporates participatory research methodologies, innovative teaching strategies, and industry collaborations. Finally, it outlines the challenges and opportunities associated with the inclusion of citizen science in doctoral training, offering concrete recommendations to enhance the program's impact and societal relevance.

3. Discussion

The survey participants represent a diverse group in terms of gender, age, and nationality, with the majority residing in Portugal and a smaller proportion holding dual nationality. The majority possess advanced academic qualifications, with the largest segments being PhD and master’s degree holders. Additionally, a significant proportion of respondents have professional experience in universities, research institutions, and industry sectors related to digital communication. This diversity provides a broad

perspective on the challenges and opportunities associated with integrating citizen science into doctoral training. The demographic diversity of the sample strengthens the validity and generalizability of the findings, as it captures a wide range of perspectives and experiences.

The integration of citizen science into academic research was a topic that received a high level of support from respondents, who emphasized its potential to enhance collaboration between researchers and the wider community. Many respondents expressed the view that citizen science fosters public engagement, democratizes knowledge, and enriches research through diverse perspectives. However, concerns were raised regarding data reliability, ethical considerations, and the long-term sustainability of citizen involvement. Despite these challenges, there is a broad consensus that citizen science methodologies should be incorporated into doctoral training to equip students with the skills necessary for participatory and community-oriented research. These concerns highlight the need for careful consideration of ethical and methodological issues when integrating citizen science into doctoral research.

The findings indicate strong support for a PhD program focused on Digital Communication, with respondents recognizing its relevance in both academic and professional settings. Participants suggested that the curriculum should include topics such as digital leadership, governance, and marketing, along with interdisciplinary studies that extend beyond traditional communication research. Interactive teaching methodologies, including workshop-based learning, project-driven research, and participatory discussions, were identified as essential for fostering critical thinking and practical application. The inclusion of citizen science components within the program was seen to encourage real-world problem-solving and meaningful community engagement. The emphasis on interdisciplinary studies and interactive teaching methodologies underscores the need for a holistic and experiential approach to doctoral education.

It was asserted by the relevant parties that there is a necessity for robust technological infrastructure to support research and learning in the domain of digital communication. Essential resources in this context include high-performance computing systems, audiovisual recording tools, and digital collaboration platforms. Concerning research priorities, there was strong support for interdisciplinary studies that address digital inclusion, the societal impact of emerging technologies, and the role of communication in fostering democratic participation. These focus areas are considered crucial for ensuring that research remains relevant and responsive to contemporary challenges. The identification of these research priorities reflects the growing recognition of the societal impact of digital communication technologies.

The importance of interdisciplinary studies in addressing issues such as digital inclusion, societal impact, and democratic participation was emphasized by stakeholders. The value of partnerships with the industry in providing practical experience and facilitating knowledge exchange was also recognized. While some institutions expressed willingness to offer external supervision, the availability and structure of such arrangements varied. It was noted that strengthening industry collaborations would be essential in ensuring that doctoral candidates acquire hands-on experience that complements their academic training. The emphasis on industry collaborations highlights the need for universities to forge stronger ties with the private sector.

The integration of citizen science into doctoral education represents an opportunity to bridge the gap between academic research and societal needs. The findings indicate a strong demand for interdisciplinary, practice-oriented, and socially relevant PhD training, and by incorporating participatory research methodologies, fostering industry partnerships, and equipping students with digital communication skills, the proposed PhD program can serve as a model for innovation in doctoral education. However, challenges such as ethical concerns, data validation, and institutional resistance must be addressed to ensure the effective implementation of citizen science within the curriculum. These challenges underscore the need for careful planning and implementation when integrating citizen science into doctoral education.

4. Conclusion

The study emphasizes the significance of formulating a PhD program that is interdisciplinary, participatory, and aligned with real-world challenges. Citizen science emerges as a pivotal mechanism for enhancing research impact and fostering collaboration between academia and society. To ensure the program's success, its curriculum must be meticulously structured to incorporate citizen science methodologies, diversify teaching approaches, and fortify industry partnerships (Kross et al., 2019 & 2021). By addressing these factors, the PhD program in Digital Communication has the potential to set a new standard for doctoral education, balancing academic rigor with societal relevance.

5. Recommendations

Based on the analysis, this paper proposes several recommendations for the development of the PhD program. First, the establishment of structured guidelines to facilitate the integration of citizen science into doctoral research is recommended. Second, the diversification of teaching methodologies to include interactive, practice-based learning approaches is recommended. Thirdly, the establishment of stronger industry collaborations is recommended to provide students with real-world research opportunities. Finally, the development of ethical frameworks is suggested as a means of guiding citizen science initiatives within the PhD curriculum. The implementation of these measures will ensure that the program effectively prepares future researchers and professionals to address the evolving challenges of digital communication.

References

Barber J. D., (2014). Integration of learning model: How college students integrate learning. *New Directions for Higher Education, 165*, 7-17. doi:10.1002/he.20079

Bruneel, J., D'Este, P., & Salter, A. (2010). Investigating the factors that diminish the barriers to university–industry collaboration. *Research Policy, 39*(7), 858-868.

Gantogtokh, O., & Quinlan, K. (2017). Challenges of designing interdisciplinary postgraduate curricula: case studies of interdisciplinary master's programs at a research-intensive UK university. *Teaching in Higher Education, 22*, 569-586. 10.1080/13562517.2016.1273211

González-Salamanca, J. C., Agudelo, O. L., & Salinas, J. (2020). Key Competences, Education for Sustainable Development and Strategies for the Development of 21st Century Skills. A Systematic Literature Review. *Sustainability, 12*(24), 10366. https://doi.org/10.3390/su122410366

Hitchcock, C., Vance-Chalcraft, H., & Aristeidou, M. (2021). Citizen Science in Higher Education. *Citizen Science: Theory and Practice*, *6*(1), 22. https://doi.org/10.5334/cstp.467

Kross, S., & Guo, P. (2021). Orienting, framing, bridging, magic, and counseling: How data scientists navigate the outer loop of client collaborations in industry and academia. *Proceedings of the ACM on Human-Computer Interaction, 5*(CSCW2), Article 311, 1-28. https://doi.org/10.1145/3476052

Kross, S., Peng, R. D., Caffo, B. S., Gooding, I., & Leek, J. T. (2019). The democratization of data science education. *The American Statistician, 74*(1), 1-7. https://doi.org/10.1080/00031305.2019.1668849

Longmore, A.-L., Grant, G., & Golnaraghi, G. (2018). Closing the 21st-Century Knowledge Gap: Reconceptualizing Teaching and Learning to Transform Business Education. *Journal of Transformative Education, 16*(3), 197-219. https://doi.org/10.1177/1541344617738514

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

BRING YOUR OWN DEVICE: INTEGRATING MOBILE LEARNING TECHNOLOGY FOR ENGAGEMENT AND BASELINE ASSESSMENTS IN SCIENCE LEARNING

Mafor Penn
Department of Mathematics, Science and Technology Education,
University of Johannesburg (South Africa)

Abstract

Integrating mobile technological tools into educational settings has been a game-changer in the way people teach, learn and engage with content. In science education, where engagements could sometimes be flooded with misconceptions and abstractions, the "bring your own device" (BYOD) strategy has proven to be helpful in creating meaningful engagements through applications like Mentimeter, Quizzes, Gimkit and Nearpod. This study investigates the potential of leveraging mobile devices brought to class by students for real-time engagements and formative assessments with the main aim of enhancing students' participation and attainment of learning outcomes in science classrooms. The study aims to provide insights into the effectiveness of the BYOD concept in creating an interactive and responsive learning environment for students. The study employed a sequential mixed methods design in capturing natural sciences students' engagements using the user engagement scale (UES) to measure engagement and semi-structured focus group interviews to capture students' experiences. A sample of 114 natural sciences students was purposefully selected to participate in a semester-long intervention where mobile devices were used for baseline assessments and interactive engagements during lectures. The researcher used the mentioned mobile learning platforms for questioning, instant feedback, and interactive engagements that were aligned with the topics being covered in the targeted semester. Pre- and post-UES data were analysed using statistical methods to measure changes in engagement before and after mobile learning interventions, while qualitative data were thematically analysed to identify patterns in student experiences during the semester-long intervention. Findings revealed significant improvements in student engagement and learning outcomes. Mobile-based formative baseline assessments through Quizzes and Mentimeter were noted for facilitating the connection between prior knowledge and new knowledge, thus increasing students' attainment of the learning outcomes during lectures. There were also significant positive changes in the user engagement score from pre- to post-UES. Additionally, 85% of students reported higher levels of motivation and interest in science topics, citing the immediacy of feedback and the interactive nature of the mobile assessments as key factors. Several advantages of the BYOD methods were also revealed as students generally felt confident using their own devices, which they already had a mastery of. Based on the findings, it is recommended that mobile learning tools be integrated into learning, especially to stimulate the recall of prior knowledge, experiences and engagement. Some setbacks of mobile formative assessment applications and the actual devices may always arise with technical issues and low internet connectivity. Nevertheless, the benefits of integrating engagement tools nested within the BYOD strategy outweigh the challenges. Trends in the data also highlight the importance of user-friendly interfaces and seamless integration of mobile learning tools into existing teaching plans for science students. Some further implications of the findings are captured in the manuscript.

Keywords: *BYOD, engagement, formative assessment, mobile learning technologies, user engagement scale (UES).*

1. Introduction and background

With the many technological advances in the 21st century, contemporary education is undergoing a paradigm shift, driven mainly by the pervasive influence of digital technologies (Ally & Tsinakos, 2014; Tlili et al., 2023). Among these technologies, mobile learning (ML)technologies have emerged with the potential to affect how teaching, learning and assessments take place. The "bring your own device" (BYOD) strategy, wherein students use their personal smartphones, tablets, or laptops for educational purposes, has gained considerable traction across various educational levels and disciplines (Song, 2014) since the

COVID-19 pandemic. This approach not only leverages resources already available to students but also capitalises on their familiarity and proficiency that people tend to have with their own devices.

In the context of science education, the integration of mobile technology through BYOD holds particular promise for increasing the amount of interactivity in the classroom, especially in the facilitation of baseline and formative assessment tasks (Burden & Kearney, 2016). Science, as a discipline, often grapples with abstract concepts and misconceptions that can hinder student understanding and engagement (Osborne & Freyberg, 1985). Traditional pedagogical approaches, including the use of pen and paper tests, may fall short in advancing the active participation and deep conceptual understanding required in science learning. Mobile applications such as Mentimeter, Quizzes, Gimkit, and Nearpod offer interactive and engaging platforms that can transform passive lectures into dynamic learning experiences for students in diverse educational settings. These tools facilitate real-time formative assessment, immediate feedback, collaborative activities, and access to a vast array of digital resources, thereby addressing some of the inherent challenges in science pedagogy as it relates to assessment (Hwang et al., 2018).

1.1. Problem statement

As highlighted by Burden and Kearney (2016), mobile learning (ML) formative assessments offer transformative potential for science education by enabling real-time feedback and personalised learning. However, a significant gap exists in their effective integration into science teaching, particularly in fostering sustained user engagement. Some of the current ML platforms lack interactive, context-specific features that align with science curricula, leading to low student and teacher adoption rates. Additionally, there is limited evidence on how these tools enhance engagement and learning outcomes in diverse classroom settings. Addressing this gap requires developing engaging, science-focused mobile assessment tools and evaluating their impact.

Research Questions:

- How do interactive mobile formative assessments affect students' engagement in science lessons when used as a baseline tool?
- How do mobile learning formative assessments (with their own devices) enhance the attainment of learning outcomes and participation in science learning from students' experiences?

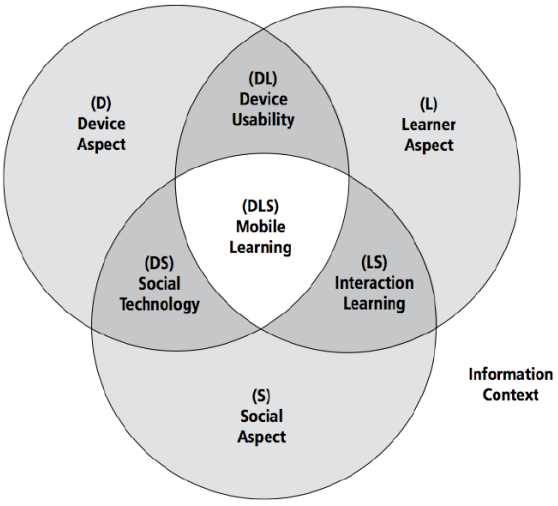
Research objectives:

- To assess the influence of mobile formative assessments on students' engagement in science lessons.
- To establish how mobile learning methods of formative assessments (with their own devices) enhance the attainment of learning outcomes and participation in science learning from students' experiences.

2. Theoretical framework

The Framework for the Rational Analysis of Mobile Education (FRAME) model suggested by Koole (2009) is well suited for this research as it is crucial in studying mobile learning formative assessments in science teaching, particularly when the user engagement scale is the analytical framework for engagement. Figure 1 below shows components of the FRAME model.

Figure 1. Components of the FRAME-Model (Koole, 2009, p. 27).



As seen in Figure 1, the FRAME model integrates three main aspects: device (usability, accessibility), learner (prior knowledge, motivation), and social (interaction, collaboration). It emphasises how mobile tools can be used to facilitate personalised, context-sensitive learning, aligning learning objectives set by the teacher. By focusing on the intersection of these aspects, the framework supports analysing how mobile assessments enhance engagement through usability, learner autonomy, and collaborative features in diverse classroom settings (Koole, 2009). The User Engagement Scale (UES) (O'Brien et al, 2018), a validated instrument that includes four main constructs, namely *"focused attention, perceived usability, aesthetic appeal, and reward factor"* associated with user engagements of technological tools and applications. This scale correlates with the FRAME model for mobile learning, which makes assessing student devices and the actual ML applications used for formative assessment easier.

3. Research methods

A sequential explanatory mixed-methods research design was employed in this study to provide a comprehensive description of the impact of BYOD and mobile learning formative assessments on engagement in science classes. The approach involves collecting and analysing quantitative data first, followed by the collection and analysis of qualitative data, where the qualitative findings help to provide explanations for quantitative results (Creswell & Plano Clark, 2023).

A sample of 114 natural sciences students from a teacher education program at a South African university was purposefully selected to participate in the intervention as part of research in the scholarship of teaching and learning (SOTL). Purposive sampling was deemed appropriate for collecting in-depth information from students directly involved in the semester-long mobile learning intervention within their natural sciences module. The selection criteria included willingness to participate, having a good working mobile device (laptop, tablet or cellphone) and being enrolled in the selected NS module. All ethical considerations, informed consent and assurance of anonymity and confidentiality were strictly adhered to.

During the semester-long intervention, natural sciences students used their own mobile devices (BYOD) to engage with various mobile learning platforms, including Mentimeter, Quizzes, Gimkit, and Nearpod. These platforms were integrated to facilitate formative assessments with the aim of assessing prior knowledge at the beginning of lectures, fueling engagement in the middle of content delivery, participation, discussions and providing instant feedback. The researcher served as the instructor to design and facilitate ML activities, ensuring alignment with the learning objectives for the targeted semester.

Data collection occurred in two phases. In phase one, the adapted User Engagement Scale (UES) was piloted with non-participating students from another module, then, after preliminary validation and reliability checks, it was administered to participants, pre- and post-ML interventions. The UES is a standardised questionnaire designed to measure various facets of user engagement with technology, with constructs focused on attention, perceived usability, aesthetic appeal, and reward (O'Brien et al, 2018), and respondents responded on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). In phase two, semi-structured focus group interviews were conducted with a subset of the participating students (N=60). The selection of students for focus groups aimed to capture a range of experiences and perspectives as reflected in the quantitative findings. The interviews were designed to explore students' experiences with the BYOD strategy, their perceptions of the mobile learning applications used, the impact on their learning and motivation, and any challenges encountered.

The quantitative data from the pre- and post-UES administrations were analysed using SPSS 30. Descriptive statistics (e.g., means, standard deviations) were calculated for both pre- and post-UES scores. Inferential statistical tests, such as a paired-samples t-test, were employed to determine if there were statistically significant changes in student engagement scores from before to after the ML intervention at a 95% confidence interval (p-value of <0.05). Braun and Clarke's (2006) six steps of thematic analysis guided the analysis of qualitative data to obtain themes.

4. Findings / results

The study yielded significant findings regarding the impact of integrating mobile learning tools within a BYOD strategy on natural sciences students' engagement and learning outcomes. The results are presented in a way that answers the research questions.

4.1. Quantitative findings: Interactive mobile formative assessments affect students' engagement in science learning

Results from the paired sample T-test of pre- and post-intervention UES data revealed a significant positive change in student engagement scores. The analysis revealed a highly statistically significant increase in the total UES score after the semester-long mobile learning intervention ($t(113)=-82.21$,

$p<0.001$). Significant improvements were also observed across all UES subscales: Perceived Usability ($t(113)=-38.48, p<0.001$), Aesthetics ($t(113)= -25.71$, $p<0.001$), Focused Attention ($t(113)=-46.14$, $p<0.001$), and Reward/Involvement ($t(113)=-40.08, p<0.001$). From thematic analysis of qualitative data, students reported higher levels of engagement after the semester-long intervention involving the use of mobile devices and applications like Mentimeter, Quizzes, Gimkit, and Nearpod. This suggests that the interactive and real-time nature of these tools, delivered through a familiar BYOD approach, effectively captured and maintained students' focused attention and involvement in the learning process.

4.2. Qualitative findings: Mobile learning tools enhance learning outcomes and student participation

The thematic analysis of the focus group interview data provided rich insights into students' experiences and corroborated the quantitative findings related to engagement. The findings also explicated several key themes that emerged from data analysis.

Immediate Feedback: Students found that the feedback provided by the formative assessment tools Quizzes and Mentimeter allowed for immediate assessment of their understanding of different concepts and provided them the opportunity to ask questions and clarify their misconceptions. This attribute of the ML apps helped in the identification of knowledge gaps and provided opportunities to adjust in a non-graded experience, unlike traditional assessments, where feedback may be delayed.

Enhanced Motivation and Interest: Students reported experiencing higher levels of motivation and interest in science topics during the intervention, especially in the mid-lecture quizzes, which checked for understanding. The content-focused nature of some of the assessments made the learning process very interesting, to learn the concepts and pay attention in class.

Interactive Nature of ML Assessments: The game-like features of platforms such as Gimkit and Quizzes, along with the polling and interactive presentation capabilities of Mentimeter and Nearpod, transformed learning from a passive activity into an engaging and enjoyable experience. Students found these methods more stimulating than the traditional lecture format, which consisted of just asking and answering questions.

ML facilitates prior knowledge connection to new knowledge: A significant finding was the perceived effectiveness of mobile-based formative baseline assessments in connecting prior knowledge with new scientific concepts. Students noted that using tools like Quizzes and Mentimeter at the beginning of topics helped them recall relevant information and identify what they already knew, making it easier to integrate new material. This bridging of past and present learning was seen as crucial for improving their attainment of learning outcomes during lectures.

Advantages of the BYOD Strategy: Students generally expressed confidence and comfort in using their own mobile devices for learning. Key advantages identified included: Familiarity and mastery, as students indicated that they were already proficient in using their own devices, and this minimised the learning curve associated with new technological devices and allowed them to focus on the content rather than grappling with unfamiliar hardware. Also, the accessibility of ML learning tools readily available on students' personal devices was perceived as convenient, allowing flexible access to learning materials and activities.

Challenges of the BYOD strategy: While the overall response was positive, students also acknowledged some setbacks associated with mobile formative assessment applications: Occasional technical glitches with the applications or with device connectivity were reported as potential sources of frustration for students. Reliance on stable internet access was a concern in some sessions, particularly if the institutional Wi-Fi was shaky, then students depended on their own limited mobile data.

Despite these challenges, participant students indicated that the benefits of integrating these mobile engagement tools within a BYOD strategy significantly outweighed the challenges for learning Natural Sciences concepts. The findings underscore the potential of these technologies to create a more interactive, responsive, and student-centred learning environment in science education.

5. Discussion

The findings of this study provide compelling evidence for the positive impact of integrating ML applications through a BYOD strategy on student engagement and learning in Natural Sciences. The statistically significant increase in UES scores shows that using students' devices for classroom interactions increases their involvement and interactivity in the learning process. These findings concur with findings from other studies, which reveal that ML motivates for more active participation compared to traditional didactic interactions (Burden & Kearney; Hwang et al., 2018). The qualitative results offered more evidence for why students felt their engagement was better with ML formative assessment integration. Students' increase in motivation and interest, attributed to the immediacy of feedback and the interactive nature of tools like Mentimeter, Quizzes, Gimkit, and Nearpod, resonates with the FRAME model of ML (Koole, 2009). Immediate feedback allows students to self-assess and co-construct meaning through active interactions and gamification in the learning environment (Dicheva et al., 2015). A particularly noteworthy

finding is the role of mobile-based formative baseline assessments in connecting prior knowledge to new information. The use of Quizzes and Mentimeter for this purpose directly addresses Ausubel's (1968) theory of meaningful learning, which emphasises the importance of anchoring new concepts to existing cognitive structures. By activating prior knowledge and identifying misconceptions at the outset, educators can tailor their instruction more effectively to address students' concerns, leading to improved attainment of learning outcomes, as reported by the students. This highlights the strong relationship between mobile technology and sound pedagogical principles of formative assessment.

The benefits of the BYOD approach (students' confidence and mastery of their own devices) cannot be overlooked in this research. This familiarity reduces cognitive load associated with learning the manipulation of a new or given device, allowing students to focus their mental resources on the scientific content instead of the technology. This practical benefit simplifies the implementation of ML for instructors and tutors. Although equity issues regarding device access and quality could hinder some ML experiences, this was not the case in this study, as all participants had either a tablet or a smartphone.

6. Conclusions and recommendations

This study successfully investigated the potential of leveraging students' mobile devices within a BYOD approach to enhance engagement and learning outcomes through baseline assessments in natural sciences classrooms. The mixed-methods approach provided both quantitative evidence of increased engagement and rich qualitative insights, supported by these findings from students' reported experiences.

Based on the findings and conclusions of this study, the researcher recommends that Natural Sciences instructors integrate ML applications like Mentimeter, Quizzes, Gimkit, and Nearpod into their teaching, particularly for stimulating recall of prior knowledge, conducting formative assessments and the active participation of students. Lecturers can also consider using the BYOD strategy, ensuring clear guidelines and instructions for use while being mindful of the potential digital divides that this might promote in a context where not all learners have smart devices. For researchers, a longer-term study could be conducted to examine the sustained impact of BYOD and mobile learning on student engagement, learning outcomes, and interest towards the learning of Natural Sciences.

Overall, the thoughtful integration of mobile technology through a BYOD strategy, using ML applications for formative assessment and interactive learning, holds good promise for classroom interactions in science education. By creating more responsive, participatory, and motivating learning environments, students feel more confident in their knowledge of the subject.

References

Ally, M., & Tsinakos, A. (2014). *Increasing access through mobile learning*. Vancouver, BC, Canada: Commonwealth of Learning.

Burden, K., & Kearney, M. (2016). Future scenarios for mobile science learning. *Research in Science Education, 46*, 287-308.

Creswell, J. W., & Plano Clark, V. L. (2023). Revisiting mixed methods research designs twenty years later. *Handbook of mixed methods research designs, 1*(1), 21-36.

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in education: A systematic mapping study. *Journal of educational technology & society, 18*(3), 75-88.

Hwang, G. J., Lai, C. L., Liang, J. C., Chu, H. C., & Tsai, C. C. (2018). A long-term experiment to investigate the relationships between high school students' perceptions of mobile learning and peer interaction and higher-order thinking tendencies. *Educational Technology Research and Development, 66*, 75-93.

Kearney, M., Schuck, S., Burden, K., & Aubusson, P. (2012). Viewing mobile learning from a pedagogical perspective. *Alt-J-Research in Learning Technology, 20*(1).

Koole, M. (2009). A model for framing mobile learning. In M. Ally (Ed.), *Mobile learning: Transforming the delivery of education and training* (Vol. 1, pp. 25-47). Edmonton, Canada: AU Press.

O'Brien, H. L., Cairns, P., & Hall, M. (2018). A practical approach to measuring user engagement with the refined user engagement scale (UES) and new UES short form. *International Journal of Human-Computer Studies, 112*, 28-39.

Osborne, R., & Freyberg, P. (1985*). Learning in Science. The Implications of Children's Science.* Heinemann Educational Books, Inc.

Song, Y. (2014). "Bring Your Own Device (BYOD)" for seamless science inquiry in a primary school. *Computers & Education, 74*, 50-60.

Tlili, A., Padilla-Zea, N., Garzón, J., Wang, Y., Kinshuk, K., & Burgos, D. (2023). The changing landscape of mobile learning pedagogy: A systematic literature review. *Interactive Learning Environments, 31*(10), 6462-6479.

SOUTH AFRICAN LIFE SCIENCES TEACHERS' EXPERIENCES WHEN EMPLOYING DIFFERENTIATED INSTRUCTION TO FOSTER INCLUSIVITY

Unathi Notshweleka, & Thasmai Dhurumraj
Department of Mathematics, Science & Technology Education,
University of Johannesburg (South Africa)

Abstract

In South Africa, addressing historical inequalities in education and embracing diverse learner needs remains crucial. Globally, the Salamanca Statement on Education for All has greatly influenced the adoption of inclusive education policies in various schools. This led to the inclusion of learners regardless of intellectual, physical, emotional and linguistic changes. Consequently, South Africa cemented its commitment with Education White Paper 6 (EWP6), outlining strategies that can be adapted by schools to cater to diverse learning needs, especially in heterogenous classrooms commonly found in full-service schools. Moreover, the Curriculum and Assessment Policy Statement (CAPS) document encourages teachers to create inclusive and responsive learning environments. To meet these demands, differentiated instruction (DI) must be employed by teachers to address various learner profiles in heterogeneous classrooms. As such, this study aimed to explore Life Sciences' teachers experiences of employing DI to foster inclusivity in their classrooms within a public full-service school in Johannesburg, South Africa. Four Life Sciences teachers participated in semi-structured interviews and lesson observations to collect data for the adopted qualitative case study methodology. The Reformed Teacher Observation Protocol (RTOP) tool was used to evaluate the extent to which the lessons aligned with DI principles. Findings reveal that although teachers have a sound conceptual understanding of DI and value its affordances in fostering learner engagement and improving academic performance, they have significant challenges. These challenges entail limited resources, time constraints, heavy administrative duties, late detection of learning barriers, learners' disinterest and inadequate support from the School-Based Support Team (SBST) and School Management Team (SMT). Also, while helpful, teachers find the Secondary School Improvement Program (SSIP) workshops overly theoretical and CAPS guidelines offering limited practical support on how to create inclusive classrooms through DI. The findings contribute to the ongoing studies on inclusive education in South Africa by uncovering the lived experiences of Life Sciences teachers. Furthermore, they highlight the need for clear and practical DI guidelines in CAPS, enhanced teacher training programs and improved resource allocation to support teachers in fostering inclusivity through DI practices.

Keywords: *Differentiated instruction, full-service school, inclusive education, life sciences teachers' experiences.*

1. Introduction

South African classrooms are characterized by being diverse, thus challenging teachers to effectively cater to every learner's needs (Onyishi & Sefotho, 2020). Learners' diversity entails differences in gender, ethnicity, race, socio-economic backgrounds, languages, and learning styles, amongst other factors (Majoko & Phasha, 2018; Possi & Milinga, 2018). As a result, when teachers employ traditional teaching methods, they often fall short in addressing the wider range of learning needs existing in a classroom (Mkhalemele & Jama, 2023). To address this issue, differentiated instruction (DI) has become a viable approach for teachers to create inclusive learning environments (Onyishi & Sefotho, 2020; Gheyssens et al., 2023). Defined as an instructional approach that considers the employment of various ways of teaching to accommodate individual learner needs (Tomlinson, 2017), DI permits teachers to strategically plan lessons that cater to varied learner profiles in their classrooms (Mulder, 2014).

The South African policy was heavily influenced by the Salamanca Statement and Framework for Action on Special Needs Education (UNESCO, 1994; Department of Education [DoE], 2001). It is the document that served as a foundational basis for South African inclusive education (Tebele & Chaka, 2024).

Since then, the Education White Paper 6 (Special Needs Education: Building on Inclusive Education and Training System, 2001) was introduced, advocating for an inclusive education approach (Department of Basic Education [DBE], 2011). This Education White Paper 6 (EWP6) entails adapting education structures, systems, and pedagogies to meet the needs of all learners while acknowledging their unique identities and experiences (Maphalala & Ngubane, 2023). Concurrently, the South African Curriculum and Assessment Policy Statement (CAPS) document for Life Sciences underscores the seriousness of inclusivity, emphasizing that it should be a central aspect of school organization, planning, and teaching (Department of Basic Education [DBE], 2011). Masunungure and Maguvhe (2023) emphasize that to achieve this, teachers should be educated about inclusion to support the vast needs of learners.

This research, therefore, aims to uncover teachers' experiences of employing DI as a means of promoting inclusive classrooms when teaching Life Sciences. To achieve this, four teachers were interviewed and observed in a full-service school in Johannesburg.

2. Review of literature

DI is an approach that allows teachers to strategically plan to meet the needs of all learners (Tomlinson, 2010; Tomlinson, 2017; Onyishi & Sefotho, 2020). Ismail (2019) posits that DI aims to address learners' needs according to their interests, readiness level and learning profiles by adjusting the curriculum. In a study conducted by Aftab (2015), it was revealed that teachers have a positive attitude towards DI. Teachers expressed that employing DI does not only address diverse learning styles but also accommodates learners with special needs (Aftab, 2015; Talain & Mercado, 2023). Moreover, Ginja and Chen (2020), and Sibanda (2021) revealed that more teachers believe that DI can positively impact their pedagogy in their diverse classrooms. However, Santos and Miguel (2019) argue that it is possible for teachers' beliefs to be incongruent to what they practice in class.

Life Sciences classrooms have learners from diverse cultural backgrounds, genders, learning preferences and languages (Motloung, 2019). Thus, it becomes necessary to employ DI to attend to all learners' needs. Differentiated learning activities are mostly learner-centered, contrary to traditional instructional strategies (de Jager, 2019). Learners become actively involved in constructing knowledge (Tomlinson & Imbeau, 2010). As opposed to banking by Freire (2000).

Despite the affordances of DI, its implementation is not without shortcomings. Bondie et al. (2019) and Suprayogi et al. (2017) discovered that various challenges prevent teachers from successfully incorporating DI into their instructional practices, including a lack of resources and time, personal beliefs, and insufficient training, competence, and collaboration. de Jager (2017) highlighted similar issues prevalent in South African schools. Also, Maphumulo (2016) uncovered that pre- and in-service teachers receive less quality training. As result, teachers require constant support and professional development to effectively enact DI practices (Gheyssens & Engels, 2020).

3. Research methodology

To uncover Life Sciences teachers' experiences when employing DI, a qualitative case study approach was used. This entailed semi-structured interviews and lesson observations (Creswell, 2017). Ethical considerations involved consent forms, acquisition of ethical clearance and maintaining the anonymity of the participants through using pseudonyms. Also, ethical clearance to conduct the study was issued *(S E M 1-2 0 2 4 -1 1 4 /5 June 2024).*

3.1. Sampling

Four teachers from a school in Johannesburg North, D10 district, Gauteng, participated in this study. These teachers are registered with the South African Council for Educators (SACE) and employed by the DBE in a Johannesburg public school, and they specialize in Life Sciences teaching, from Grade 10-12. The method of sampling that was selected was a purposeful sampling. In purposive sampling, samples are selected to create an in-depth view of the investigated factor (Shaheen et al., 2016). This implies that, in the first step of this sample, the researcher had selected participants who have more knowledge or expertise on DI.

3.2. Data collection process

Four semi-structured interviews were conducted, recorded and transcribed online through Microsoft Teams. Ruslin et al. (2022) argues that semi-structured interviews are mostly effective in a qualitative study since they enable the researcher to get in-depth information from the participants including their perceptions, challenges and affordances of DI implementation. To corroborate the findings, participants were observed and recorded on two occasions, making a total of eight lesson observations.

3.3. Data analysis

Using transcribed data from MS teams, codes were generated and categorized into seven themes. However, this paper only focused on three themes. Also, video recordings of the lesson observations were coded and categorized as per the themes from the Reformed Teaching Observation Protocol (RTOP) instrument (Sawada et al., 2002; Ndihokubwayo et al., 2020).

4. Findings

The findings of the study unpacked Life Sciences teachers' experiences when employing DI in their classrooms from the semi-structured interviews and lesson observations. Data from interviews were categorized into three themes namely teachers' understanding of DI, perceived affordances and challenges of employing DI to foster inclusivity. To corroborate these findings, lesson observations were analyzed against RTOP criteria. For ethical reasons, pseudonyms were used instead of teachers' real names.

4.1. Theme 1: Teachers' understanding of DI in life sciences classrooms

In this theme, teachers showed a great conceptual understanding of DI in teaching Life Sciences. This was noted in teacher Naledi's response:

> *Naledi: …My understanding of differentiated instruction is being able to tailor a lesson and instructions to better accommodate learners with different learning abilities.*

Teacher Naledi's conceptualization of DI suggest a sound understanding and what it entails such as tailoring and lesson and instruction for catering to differently abled learners.

4.2. Theme 2: Perceived affordances of DI in Grade 11 Life Sciences classrooms

The second theme was generated based on the affordances of DI in the context of Life Sciences teaching based on the responses provided by teacher Naledi and Rofhiwa:

> Naledi: *…it becomes a game changer. Learners become more confident, enjoy the subject and want to learn the subject.*

> Rofhiwa: …*Using differentiated instruction enables learners to have a deeper understanding of the content.*

Similar to Theme 1, Teachers' responses suggested that DI is an innovative strategy in enhancing Life Sciences learning promotes learners' confidence and enjoyment of the subject. Also, it facilitates the comprehension of the content.

4.3. Theme 3: Challenges of employing DI in grade 11 life sciences classrooms

The third theme captured numerous challenges faced by teachers when implementing DI to foster inclusivity in their classrooms. These challenges encompass time constraints, limited resources which fostered teachers to self-fund themselves. Also, teachers experienced time constraints as teachers have heavy administrative responsibilities to fulfil and late identification of learning barriers. The following responses came from teachers:

> Margaret: …*Sometimes you must buy something. …that money comes out of your pocket.*

> Oludara: …*Sometimes the non-teaching activities are more than the teaching activities. There are many admin duties.*

> Rofhiwa: …*Some learners have a challenge with handwriting and it's things that are that are not even picked up early.*

These findings elucidate that due to limited resources, teachers are forced to buy them. Also, due to pressures of syllabus completion and heavy administrative duties, barriers learning are not identified earlier. Moreover, teachers heighted that, although supportive, SBST and SMT does not provide adequate support for employing DI. Evident to this was teacher Oludara's response stating *"From time to time they support... but some of the resources you need are beyond the SMT or SBST."*

Furthermore, teachers claimed that SSIP workshops and the CAPS are overly theoretical. This was noted as Oludara stated that, *"Workshops are organized from time to time, but they are mostly theoretical... the practical aspects are not addressed.*

Naledi also shared similar sentiments saying, *"CAPS and the policies help us, but more training is needed to fully address learner diversity in the classroom."*

5. Discussions

Teachers' understanding emphasizes that DI is not just about adapting instructional methods but also involves tailoring tasks to individual learners' abilities, as supported by Tomlinson (2017). The researchers identified similar patterns in teachers' responses, in that, they all value the affordances of DI. Similarly, the studies conducted by Ginja and Chen (2020) and Sibanda (2021) identified that teachers have positive perceptions towards DI. While the findings show that teachers value DI, its implementation is not without problems. The major obstacles identified were a lack of resources, insufficient time and pressure for syllabus completion, low learners' interest, inadequate support from the school structure, lack of training in DI techniques. These challenges mirror those identified by Bondie et al. (2019) and de Jager (2019), who found that South African teachers struggle to employ DI due to inadequate support systems and heavy workloads. According to Gheyssens and Engels (2020), effective DI relies on clear and actionable policy support, yet current CAPS guidelines lack the depth needed to support practical differentiation in classrooms. Without explicit guidance, teachers face uncertainty in adapting lessons to meet diverse learner needs, which impedes the full implementation of DI.

6. Conclusions and recommendations

This study explored Life Sciences teachers' experiences of employing differentiated instruction for fostering inclusivity in their classrooms. The findings revealed that teachers understand DI and value its role in Life Sciences. However, there were various challenges encountered by teachers, hindering DI employment. These challenges included lack of resources, time constraints, poor learner interest, minimal support from SBST and SMT, unclear and over theoretical workshops and CAPS. Therefore, this study recommends that teachers should receive continuous training on DI strategies particularly integrating technology in resource-constrained environments. Schools should reconsider curriculum pacing guides and reduce administrative workload to provide more flexibility for teachers to employ DI, reducing reliance on traditional teaching due to time pressures. Education departments should invest in providing schools with sufficient technological resources and multimedia tools to enable teachers to employ DI more effectively in fostering inclusivity. Also, the government needs to provide teachers with necessary guidance on safely disposing of expired chemicals, to foster a safe and supportive learning environment. Moreover, Teachers should receive training in effective classroom management techniques that support learner-centered approaches, minimizing disruptions while promoting active participation. Lastly, there should be follow ups from the SSIP training programs to ensure that teachers effectively employ differentiated instruction in their classrooms.

References

Bondie, R. S., Dahnke, C., & Zusho, A. (2019). How does changing "one-size-fits-all" to differentiated instruction affect teaching?. *Review of Research in Education, 43*(1), 336-362. https://doi.org/10.3102/0091732X18821130

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

De Jager, T. (2019). Application of biometric finger printing to encourage the active involvement of student teachers in lectures on differentiated instruction. *South African Journal of Education, 39*(2), 1-10.

De Jager, T. (2023). Evaluating Effective Differentiated Instruction in Multicultural South African Secondary Schools. In *Effective Teaching Around the World: Theoretical, Empirical, Methodological and Practical Insights* (pp. 691-705). Cham: Springer International Publishing.

Department of Education (South Africa). (2001). *Education white paper 6: Special needs education: Building an inclusive education and training system*. Pretoria: Department of Education.

Department of Basic Education. (2011). *Curriculum and Assessment policy statement: FET phase, Life sciences*. Pretoria: Government Gazette.

Gheyssens, E., & Engels, N. (2020). *Adopting differentiated instruction to create inclusive classrooms*.

Gheyssens, E., Griful-Freixenet, J., & Struyven, K. (2023). Differentiated instruction as an approach to establish effective teaching in inclusive classrooms. In *Effective Teaching Around the World: Theoretical, Empirical, Methodological and Practical Insights* (pp. 677-689). Cham: Springer International Publishing.

Gibbs, K. (2023). Voices in practice: challenges to implementing differentiated instruction by teachers and school leaders in an Australian mainstream secondary school. *The Australian Educational Researcher*, *50*(4), 1217-1232.

Ismail, S. (2019). Impact of differentiated instruction on the writing process of ESL learners. *ELF Annual Research Journal*, *21*, 130-153.

Majoko, T., & Phasha, N. (2018). *The state of inclusive education in South Africa and the implications for teacher training programmes*. South Africa: British Council. https://doi.org/10.13140/RG.2.2.30210.56009

Makhalemele, T., & Jama, P. P. (2023). COVID-19 impact on support services in South African full-service schools: Views of support structures. *South African Journal of Education*, *43*(1), S1-S12. https://doi.org/10.15700/saje.v43ns1a2383

Maphumulo, T. B. (2019). *Exploring the role of a school based support team (SBST) in supporting teachers at a rural primary school* (Doctoral dissertation).

Masunungure, A., & Maguvhe, M. (2023). Paving Ways for Effective Inclusion in Selected Mainstream Secondary Schools in Gauteng Province, South Africa. *International Journal of Learning, Teaching and Educational Research*, *22*(5), 558-569. https://doi.org/10.26803/ijlter.22.5.28

Modibe, M., & Madunungure, A. (2024). Exploring the support needs of teachers in inclusive schools. *Education and New Developments, 2*, 498-502. https://doi.org/10.36315/2024v2end110

Mulder, Q. (2014). *The effect of differentiated instruction on student mathematics achievement in primary school classrooms* (Master's thesis, University of Twente). Retrieved from https://essay.utwente.nl/66645/

Onyishi, C. N., & Sefotho, M. M. (2020). Teachers' Perspectives on the Use of Differentiated Instruction in Inclusive Classrooms: Implication for Teacher Education. *International Journal of Higher Education*, *9*(6), 136-150. https://doi.org/10.5430/ijhe.v9n6p136

Possi, M. K., & Milinga, J. R. (2018). Learner Diversity in Inclusive Classrooms: The Interplay of Language of Instruction, Gender and Disability. *MOJES: Malaysian Online Journal of Educational Sciences*, *5*(3), 28-45. Retrieved from https://ejournal.um.edu.my/index.php/MOJES/article/view/12522

Sawada, D., Piburn, M. D., & Judson, E. (2002). Measuring Reform Practices in Science and Mathematics Classrooms: The Reformed Teaching Observation Protocol. *School Science and Mathematics*, *102*(3), 245-253.

Sibanda, S. (2021). *Exploring teachers' perceptions of differentiated instruction in the foundation phase in a Tshwane south district school* (Doctoral dissertation. Muckleneuk, Pretoria: University of South Africa).

Tebele, N., & Chaka, J. (2024). Exploring teachers' perceptions when supporting learners with dysgraphia and dyslexia in a rural school. *International Journal of studies in Psychology*, *4*(1), 15-28. https://doi.org/10.38140/ijspsy.v4i1.1057

Ruslin, R., Mashuri, S., Rasak, M. S. A., Alhabsyi, F., & Syam, H. (2022). Semi-structured Interview: A methodological reflection on the development of a qualitative research instrument in educational studies. *IOSR Journal of Research & Method in Education (IOSR-JRME)*, *12*(1), 22-29.

Tomlinson, C. A. (2017). Differentiated Instruction. In C. M. Callahan, & H. L. Hertberg-Davis (Eds.), *Fundamentals of Gifted Education* (pp. 279-292). New York, NY: Routledge. https://doi.org/10.4324/9781315639987-26

UNESCO. (1994). *Final Report: World Conference on Special Needs Education: Access and Quality*. Paris: UNESCO.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

ETHICAL LEADERSHIP AS A DELICATE EMBROIDERY FOR INTEGRITY: NEW DIRECTIONS FOR SCHOOL PRINCIPALS

Sipiwe Mudadigwa, & Edwin Darrell De Klerk
Professional Studies in Education, North-West University: Mahikeng Campus (South Africa)

Abstract

Recent research in the academic literature expressed the urgency for new directions to assist school principals to understand ethical leadership toward leading with integrity. Notably, leading with integrity is an ongoing learning process, yet the advantages are undisputable. The aim of this paper, therefore, was to showcase ethical leadership as a delicate embroidery for the enactment of integrity, proposing moral ribbons that can be used by school principals to act ethically in the line of their duties. Through the lens of integrity theory, this conceptual paper presents an analysis of selected texts in the *South African Standard for Principalship* (SASP) which outlines key ribbons for school principals in subscribing to educational ethics. Data mining techniques were used to search for and select texts that could provide insights into school principals' application of ethical leadership toward acting with integrity. The findings suggest that *having and doing one's own*, *an escape from the cave*, and *integrity kingship* can be vital moral ribbons to fuel school principals with new directions on how to apply ethical leadership as a delicate embroidery for the enactment of integrity. This paper should be regarded as an act of planting fresh seeds for the enactment of integrity in the hope that principals will reap the fruits of living an honourable life as moral agents in schools.

Keywords: *Delicate embroidery, ethical leadership, integrity, new directions, school principals*.

1. Introduction

In the complex landscape of modern-day education, ethical leadership (EL) must provide the steadiness and moral coaching so that principals can lead with integrity, honesty and fairness toward fostering a renewed sense of a positive school environment (Ahmed, 2023). Despite this expectation, there is a prevailing cynicism about EL, ranging from a negative attitude and a lack of integrity (Brown & Treviño, 2006) to blaming policies to be too comprehensive, too vague, and too elaborate (Ngoepe-Ntsoane & Webb, 2021), thus creating confusion regarding ethical leadership. The problem with policy implementation is that individuals in schools might be uninterested, demotivated or inexperienced to understand the attractiveness policy benefits and realization of policy goals in practice (Ngoepe-Ntsoane & Webb, 2021). We, therefore, contend that it has become more urgent than before that researchers explore new directions to arm educational leaders with moral ammunition to act ethically and lead with veracity. We further assert that an analysis of policy texts can provide new directions into school principals' application of ethical leadership toward acting with integrity. Our contention is supported by the notion that, although policymakers and researchers paid some attention to looking at EL from different lenses, there remains an emptiness about leading ethically in contemporary educational spaces (Hsieh & Tai, 2023). Also, Mlambo (2021) asserts that, although legislation and ethical codes exist, unethical behaviour has not end due to a lack of training and the development of attitudes and virtues for guiding human conduct. Considering the uncertainties regarding the phenomenon, we felt that it was high time that ethical leadership, like a delicate embroidery, should get the required attention through proposing moral ribbons that can be used by principals to lead with integrity in schools. In this regard, we asked the question: *how can an analysis of the South African Standard for Principalship (SASP) contribute to an understanding of ethical leadership as a delicate embroidery so that school principals can lead with integrity*? In responding to this question, we proposed moral ribbons that can be used by school principals to lead with integrity and live honourable lives as moral agents in schools.

2. Ethical leadership as a delicate embroidery

Embroidery is the art of decorating already existing fabric (Rani, Jining & Shah, 2021) with needle and thread with meaningful and symbolic connotations (Von Kürthy et al., 2023). When approached

delicately, an embroidery "*shape the feelings and thoughts*" (Rani et al., 2021, p. 9), influences the mind and can promote change within individuals' lives (Von Kürthy et al., 2023). Drawing on the mentioned authors (Rani et al., 2021; Von Kürthy et al., 2023), we believe that the act of embroidery has a transformative influence on the way school principals perform ethical leadership in schools. We aligned ethical leadership as a delicate embroidery with a seminal view of Lloyd (1957) who purports that when something is regarded as an embroidery, it serves as a discovery and promotion of elementary principles into attractive moral floss appropriate for people to use. In this regard, principals must be enlightened of how to be authentic and intrinsically motivated so that they can lead with integrity (Terzieva, 2023). In this regard, ethical leaders should personify integrity (Zhu, Zhi & Fang, 2025) so that ethical leadership can be performed more legitimately and effectively, and therefore, be more relevant to the needs of individuals in schools. Significantly, ethical leadership as a delicate embroidery asks from individuals to "*start at the back of the textile, work the needle and thread through the fabric, and return through the fabric to the backside of the tapestry*" (Lehman, 2023, n.p.). This implies that ethical leadership cannot be regarded as superficial but rather requires a deep and patient investigation into the self and a careful crafting of principles toward creating a moral textile filled with ribbons of integrity.

3. Integrity as a process of continuous moral crafting

We hold the view that integrity is more than merely following the golden rule, rather, it requires the 'stitching of ethical actions' together towards fostering a culture of trust in schools. Drawing from, we considered the 'stitching of moral actions' as a combination of moral imagination and promise-keeping (Robinson, Parry & Sun, 2016) and proactive personality (Aghighi, 2020) – elements we regarded as representatives of floss for continuous moral crafting. Firstly, moral imagination, as the first 'stitch', involves the stitching of individuals' specific ideals and values with new ethical possibilities in particular situations (Rindova & Martins, 2023). In this regard, individuals anticipate and explore the ethical effects of decisions and actions (Gerrits et al., 2023). Representing the second stitch, promise-keeping is associated with truthfulness, suggesting that individuals assess their intentions and actions toward improving their conduct (*vide:* Mozumder, 2022). The third stitch, proactive personality, hinges on the notion that individuals repetitively follow their instincts about what might be the right thing to do, yet they frequently change their frames of references about their ethical behaviour and "*if they see something that they don't like, they keep changing*" (Aghighi, 2020, p. 16). These stitches complement each other in the sense that 'new ethical possibilities' (moral imagination), 'improving their conduct'(promise-keeping), and 'frequently change' (proactive personality), ask from ethical leaders to constantly assess and morally change their ways of acting with integrity.

4. Education policy texts as threads for delicate embroidery

Harman (1984) explains that education policy is a goal-oriented document that comprises of various courses of action. Fan and Popkewitz (2020) elaborate that education policy should be regarded as a code of conduct formulated to meet the needs of development in particular areas of education. As a "course of action" and "code of conduct", education policy provides options for best practices to address issues of educational concern. These views (Fan & Popkewitz, 2020; Harman, 1984) align with the aim of this paper which was to explore how an analysis of texts in the SASP (RSA, 2015) can contribute to an understanding of ethical leadership as a delicate embroidery so that school principals can lead with integrity. The SASP explains the roles of school principals, focusing on their level of competencies and professionalism, and provide guidance in terms of principals' leadership and developmental needs (RSA, 2015). The SASP explicitly indicates that "*ethical leadership in all its various facets, and more particularly in leading diversity, is of paramount importance for an effective principal*" (RSA, 2015, p. 3). This statement implies that an application of ethical leadership must be an act of making sound judgements in schools. We carefully studied texts in the SASP (RSA, 2015) to find key ribbons that can assist in leading with integrity in schools.

Before presenting an analysis of texts in the SASP (RSA, 2015), we first delineate the theory that underpinned this study and then explain the research processes followed in this research study.

5. Application of integrity theory

This paper adopts Williams' (2002) explanation of integrity theory as individuals' ability to "*follow the internal route, and expresses the self in authentic way, in which we should follow our deepest impulses, listen to ourselves within, be true to ourselves and expresses ourselves sincerely, thus a true self is revealed*" (p. 184). This frame of thinking implies that individuals have the intelligent ability to make knowledgeable choices that embrace answerability when they act upon the choices they make. Such answerability requires leaders to act in tandem with moral principles to avoid any actions that might compromise their moral values (Zarghamifard & Danaeefard, 2020) so that they can guide, influence, and

inspire others to uphold similar ethical standards. When aligned to the application of ethical leadership, an application of integrity theory (Williams, 2002) guided our thinking in terms of school principals' ability to present their true selves and avoid actions that may compromise their moral values, while they guide, influence, and inspire others ethically.

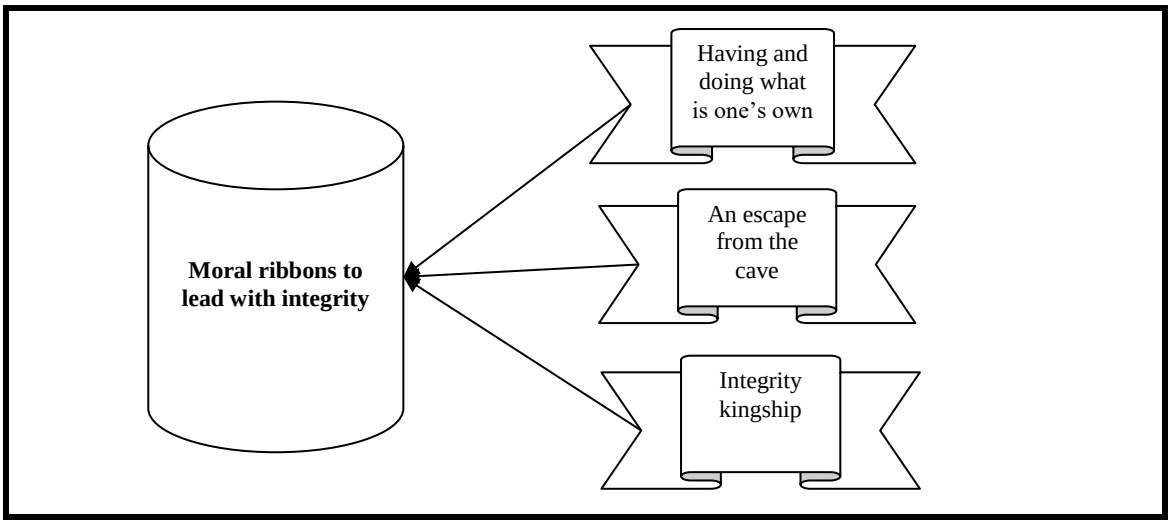
6. Methodology

This conceptual paper employed a qualitative approach, analysing the content in documents, allowing researchers to understand how ideas and information are presented and what meanings can be derived about phenomena (Dalglish, Khalid & McMahon, 2020). In this paper, data is represented by selected texts in the SASP (RSA, 2015). We first scrutinized several South African education policy documents and found that the SASP (RSA, 2015) provides the strongest information that could be used to find information about how ethical leadership can be regarded as a delicate embroidery so that school principals can lead with integrity. We employed data mining, which is an exploratory method of knowledge finding, focusing on the detection and mining of significant patterns of information (Rasid et al., 2017). Firstly, we thoroughly combed through the large volume of texts in the SASP (RSA, 2015) and transferred relevant information to a WORD document (which we called our georgette – a relatively delicate silk). Secondly, we arranged the texts on the 'georgette' in layers ranging from mostly relevant to less relevant. Thirdly, we worked delicately to select those texts with the strongest connection to ethical leadership and integrity. Notably, we gently performed the text selection to avoid the georgette from twisting, implying that we were cautious not to leave out important information toward analysis. Next, we scrutinized the texts and were able to identify understandable, valid and useful pattens, which, after another round of scrutiny, assisted us to identify three moral ribbons that represent ethical leadership as a delicate embroidery of integrity: *having and doing what is one's own*, *an escape from the cave*, and *integrity kingship*.

7. Results and discussion

As a reminder to the reader, this paper asked the following question: *how can an analysis of the South African Standard for Principalship (SASP) contribute to an understanding of ethical leadership as a delicate embroidery so that school principals can lead with integrity*? Derived from the SASP (RSA, 2015), we next discuss the three identified moral ribbons (Figure 1):

Figure 1. Moral ribbons to lead with integrity.



Firstly, the SASP (RSA, 2015) is adamant that principals should act with "fair-mindedness, patience, empathy, compassion, respect and humility in all dealings with others" (p. 6). These ethical characteristics, when delicately sewed together, align with Plato's view of *having and doing one's own – a form of justice* (Wright, 2020), and becomes a valuable ribbon for principals to enact ethical leadership. As such, the SASP (2015) reminds principals that they should refine their knowledge (having) about acts of justice and revisit their understanding (having) of what is morally right. Principals are supposed to be individuals with well-ordered souls, implying that they ought to know what justice is and should, therefore, act according to the knowledge they have (Wright, 2020). In this regard, justice aligns with integrity, specifically when school principals are able "*to align their inner thoughts and intentions with their outward*

words and actions" (Khaulah, Komariah & Kurniady, 2024, p. 421). When principals would adopt this kind of attitude of justice, they may have a deeper sense of *having* and *doing* integrity as advised by the SASP (RSA, 2015).

Secondly, the SASP (RSA, 2015) provide principals with the opportunity to *escape from the cave* through shaping "integrity and fairness in all dealings with people" (p. 6). An escape from the cave resonates with Plato's allegory, implying an escape from ignorance and a search for a different truth regarding things, which considers the implications of knowledge and responsibility (Makwudo & Nkwakudo, 2025). Responsibility presupposes that individuals take ownership of their actions and being answerable for the consequences. In relation to the SASP (RSA, 2015), responsibility implies that principals break free from unethical practices, cultivate a disposition to challenge difficult realities, and contest long-held convictions so that they can broaden their perspectives regarding integrity. Also, in terms of the SASP (RSA, 2015), an escape implies an ethical duty toward others, therefore, principals should take a brave stance to distance themselves from immoral behaviour toward searching for new opportunities and a greater understanding of how to act with integrity.

Thirdly, principals must subscribe to the "core values that underpin everything that happens at a school and that inform everything that the principal does in leading and managing the school" (RSA, 2015, p. 9). This text requires principals to act with *integrity kingship*. Interestingly, kingship is referred to as a characteristic belonging to an individual who represents a king, and who is regarded as extraordinary and respected, while acting with moral authority (Riccardo, 2005). According to ``11q and Klein (2017), moral authority endows individuals the power to ascertain whether things are right or wrong in specific situations. When aligned to the SASP (RSA, 2015), 'doing what might be right' and 'discarding what might be wrong' should inform principals' ability to act with integrity in schools. Notably, when principals interact with others, they should explicitly condemn unethical behaviour and strongly consider their kingship by honouring their moral commitments, even when it might not suit them (Isserow & Klein, 2017). As such, integrity kingship asks from school principals to garner honour as integrity mentors.

8. Conclusion

This paper asked the question: *how can an analysis of the South African Standard for Principalship (SASP) contribute to an understanding of ethical leadership as a delicate embroidery so that school principals can lead with integrity*? We first conducted a literature review and derived three valuable insights. Firstly, ethical leadership requires a deep and patient examination into the self and a careful crafting of principles toward creating a moral textile filled with ribbons of integrity. Secondly, integrity presupposes that moral imagination, promise-keeping and a proactive personality requires ethical leaders to continuously appraise morally transform their ways of doing things. Thirdly, education texts provide valuable options for the enactment of ethical leadership. After engaging with data mining of texts in the SASP, we found that having and doing what is one's own, an escape from the cave and integrity kingship are representative of ethical leadership as a delicate embroidery to lead with integrity. Principals should adopt an attitude of justice to have a deeper sense of *having* and *doing* integrity. Also, principals should distance themselves from immoral behaviour toward searching for new opportunities and a greater understanding of how to act with integrity. Furthermore, principals should portray an extraordinary and respected attitude so that they take a strong stance in condemning immoral behaviour. This paper did not include the views of human participants; therefore, we suggest that an empirical study be conducted to elicit the voices of principals and other educational stakeholders about cultivation of integrity spaces for teaching and learning success in schools.

References

Aghighi, A. (2020). The role of ethical leadership & proactive personality on organizational citizenship behaviors: Mediating role of positive & negative emotions. *International Journal of Ethics & Society (IJES), 2*(2), 11-18. http://www.ijethics.com/

Ahmed, E. I. (2023) A systematic review of ethical leadership studies in educational research from 1990 to 2022. *Educational Management Administration & Leadership, 2023*, 1-20. https://doi.org/10.1177/1741143223119325

Brown, M. E., & Treviño, L. K. (2006). Ethical leadership: A review and future directions. *The Leadership Quarterly, 17*, 595-616. https://psycnet.apa.org/doi/10.1016/j.leaqua.2006.10.004

Dalglish, S. L., Khalid, H., & McMahon, S. A. (2020). Document analysis in health policy research: the READ approach. *Health Policy and Planning*, *35*(10), 1424-1431. https://doi.org/10.1093/heapol/czaa064

Fan, G., & Popkewitz, T. S. (2020). *Handbook of education policy: Value, governance, globalization and methodology*. Volume 1. Springer Open. https://link.springer.com/chapter/10.1007/978-981-13-8347-2_2

Gerrits, E. M., Assen, L. S., Noordegraaf-Eelens, L., Bredenoord, A. L., & Van Mil, M. H. W. (2023). Moral imagination as an instrument for ethics education for biomedical researchers. *International Journal of Ethics Education, 8*, 275-289. https://doi.org/10.1007/s40889-023-00171-z

Harman, G. (1984). Conceptual and theoretical issues. In J. R. Hough (Ed.), *Education policy: An international survey* (pp. 13-27). Australia, Sydney: Croom Helm Ltd.

Hsieh, C., & Tai, S., & Li, H. (2023). A bibliometric review of ethical leadership research: Shifting focuses and theoretical insights. *AERA Open, 9*(1), 1-13. https://doi.org/10.1177/23328584231209266

Isserow, J., & Klein, C. (2017). Hypocrisy and moral authority. *Journal of Ethics and Social Philosophy, 12*(2), 191-222. https://doi.org/10.26556/jesp.v12i2.224

Khaulah, S., Komariah, A., & Kurniady, D. A. (2024). Integrity and professionalism driven visionary leadership of school principals for enhancing school quality. *Tadbir: Jurnal Studi Manajemen Pendidikan [Tadbir: Journal of Educational Management Studies], 8*(2), 417-436. http://dx.doi.org/10.29240/jsmp.v8i2.11501

Lehman, C. (2023, November 21). *Embroidery: meaning, types & examples*. https://study.com/academy/lesson/what-does-embroidery-mean-in-textiles.html

Lloyd, D. (1957). *Classification of art and design*. New York: Cambridge University Press.

Makwudo, K. K., & Nkwakudo, A. E. (2025). Escaping the cave: A platonic analysis of "Japa" as the philosopher's journey from darkness to light. *Trinitarian International Journal of Arts and Humanities, 1*(1), 45-61. https://journals.ezenwaohaetorc.org/index.php/TIJAH/article/view/3126/3253

Mlambo, F. A. (2021). Exploring the ethical leadership practices of school management teams in selected secondary schools in Gauteng Province (MEd dissertation, University of South Africa). https://uir.unisa.ac.za/handle/10500/28273.

Mozumder, N. A. (2022). Can ethical political leadership restore public trust in political leaders? *Public Organization Review, 22*(3), 821-835. https://doi.org/10.1007/s11115-021-00536-2

Ngoepe-Ntsoane, M. J., & Webb, W. N. (2021). Ethical leadership: Resolving the failure of public policies in corruption prevention. *Journal of Contemporary Management, 17*(2), 86-108. https://doi.org/10.35683/jcm20_3.134

Rani, S., Jining, D., & Shah, D. (2021). Embroidery and textiles: A novel perspective on women artists' art practice. *Rupkatha Journal on Interdisciplinary Studies in Humanities, 13*(4), 1-11. https://doi.org/10.21659/rupkatha.v13n4.37

Rasid, N., Nohuddin, P. N. E., Alias, H., Hamzah, I., & Nordin, A. I. (2017). Using data mining strategy in qualitative research. In H. B. Zaman, P. Robinson, A. F. Smeaton, T. K. Shih, S. Velasting, T. Terutoshi, A. Jaafar & N. M. Ali (Eds.), *Advances in visual informatics* (pp. 100–111). *Proceedings of the 5th International Visual Informatics Conference, IVIC 2017*, Bangi, Malaysia, November 28–30, 2017. https://doi.org/10.1007/978-3-319-70010-6_10

Republic of South Africa (RSA). (2015). *Policy of the South African Standard for Principalship*. Pretoria: Government Printer.

Riccardo, G. (2005). *Kingship: An overview* [Blog post]. https://www.encyclopedia.com/environment/encyclopedias-almanacs-transcripts-and-maps/kingship-overview

Rindova, V., & Martins, L. L. (2023). Moral imagination, the collective desirable, and strategic purpose. *Strategy Science, 8*(2), 170-181. https://doi.org/10.1287/stsc.2023.0190

Terzieva, K. (2023, February 28). *The rise of ethical leadership in modern business enterprises* [Blog post]. https://www.forbes.com/councils/forbescoachescouncil/2023/02/28/the-rise-of-ethical-leadership-in-modern-business-enterprises/

Von Kürthy, H., Aranda, K., Sadlo, G., & Stew, G. (2023). Embroidering as a transformative occupation. *Journal of Occupational Science, 30*(4), 647-660. https://doi.org/10.1080/14427591.2022.2104349

Williams, B. (2002). *Truth and truthfulness*. Princeton: Princeton University Press. https://doi.org/10.1023/B:INQU.0000019140.71721.d1

Wright, W. (2020, August 28). *A critique and defense of Plato's "just state"* [Blog post]. https://www.wrightswriting.com/post/a-critique-and-defense-of-plato-s-just-state

Zarghamifard, M., & Danaeefard, H. (2020). What drives leader integrity? *International Journal of Business Governance and Ethics, 14*(1), 1-33. https://doi.org/10.1504/IJBGE.2020.104685

Zhu, J., Zhi, W., & Fang, Y. (2025). Ethical leadership, organizational learning, and corporate ESG performance: A moderated mediation mode. *International Review of Economics and Finance, 98*(2025), 1-14. https://doi.org/10.1016/j.iref.2025.103966

OUR SCHOOL SHOULD BE FOR US: EARLY CHILDHOOD PHYSICAL LEARNING ENVIRONMENT

Tuğba Baş, & Nergiz Teke
Department of Preschool Education, Bartın University (Turkey)

Abstract

It is essential that administrators and teachers feel comfortable and happy in the school environment because teachers and administrators spend most of their time in schools. In addition, creating appropriate environments for the educational processes carried out in indoor and outdoor spaces in the school environment can also increase the quality of education. In this study, case study design, one of the qualitative research techniques, was used to determine the views of school administrators and teachers on the physical environment characteristics that should be present in the school building. The study was conducted in two independent kindergartens in Çankaya district of Ankara province. Seven participants, including three teachers, two school principals, and two assistant principals, were included in the study. A structured interview technique was used to obtain the data. The data obtained were analyzed using the content analysis technique. According to the results of the research, it was found that school administrators and teachers stated that there should be materials suitable for age groups, playgrounds, a restroom for teachers, natural light, spaciousness, a garden, the use of wooden materials, and the school building should not be more than two floors. According to another result of the research, teachers and administrators argued that there should be plants in the garden, plants can be grown, there should be areas and materials for children to play, there should be a resting area, it should be clean, animals can be fed and it should be large and spacious. In addition, teachers and administrators agree that light color tones should be used in schools, especially in interior spaces.

Keywords: *Learning environment, teacher, administrator, schoolyard, indoor, outdoor.*

1. Introduction

Well-organized preschools contribute positively to children's academic, literacy (Mashburn, 2008), cognitive, and social skills (Günindi, 2011; Peisner-Feinberg et al., 2001; Ramazan & Özdemir, 2020). The key elements of adequate early learning spaces include a simple, inviting atmosphere, bright spaces, and outdoor connections (Berris & Miller, 2011). Classroom design should reflect the distinctive features of each learning center, provide ample space for movement, and include appropriate educational tools (Fardlillah & Suryono, 2019). According to Şenalp & Çınar's (2022) research, in line with the studies conducted in the literature, it is stated that it is important for a child-friendly preschool education institution to be accessible and close to green areas to have planting and playgrounds in its garden to be sheltered at the same time, and to have a large and spacious interior space. The lighting, ventilation, heating, and cleaning of the interior space are also important criteria, as well as the furniture in the classroom being portable, appropriate in color, easy to clean, flexible, and aesthetic, and the school building being single-storey for the safety of children. In Durmuşoğlu, Çelikel, & Bilgen's (2023) study, when the existing and imagined school environments for preschool education institutions were compared in the interviews with preschool teachers, it was determined that there were results such as the physical facilities of the existing environments were not suitable, there were no learning centers, there was no variety of materials, the park/garden area was insufficient, there were no different grounds, and there were no areas suitable for developmental areas.

When the current situation is examined, there are several deficiencies and inadequacies in standardization in the context of educational environments in preschool education institutions. Although there are common standard areas for preschool education within the framework of some regulations specified in the relevant legislation in Türkiye, it is thought that the definition of the standards and the details provided do not overlap in most places (Babaroğlu, 2018). Similarly, Babich et al. (2023) noted inconsistencies in standards across countries and over time and that more comprehensive approaches that simultaneously consider multiple indoor environmental quality factors are needed.

For preschool education institutions to provide quality education, they must first organize a quality educational environment, and it is essential that the administrators, who are the main ones responsible for this, and the teachers, who are the people who provide education, feel comfortable and happy in the school environment. This comfort and peace will enable them to express themselves better and may increase the effectiveness of the education. For all these reasons, the views of administrators and teachers should also be considered when shaping ideal school buildings because teachers and administrators spend most of their time here, both in terms of private and teaching. This study can contribute to a more productive time spent by teachers and administrators at school by giving an idea of how an ideal school building should be according to preschool teachers and administrators. This study aims to determine the views of school administrators and teachers working in preschool education institutions on the physical environment characteristics that should be present in school buildings.

2. Methods

2.1. Research design

A case study design, one of the qualitative research techniques, was used to determine the views of school administrators and teachers on the physical environment characteristics of preschool education institutions.

2.2. Research group

The study was conducted in two independent kindergartens in Çankaya district of Ankara province. A total of 8 people, including three teachers, two school principals, and two assistant principals, participated in the study. Five teachers were coded as T1, T2, and T3, and four school administrators were coded as SA1, SA2, SA3, and SA4. The number of administrators participating in the study was four (two female and two male), and the number of teachers was three female. Only one of the participants had a master's degree, and the other had a bachelor's degree. The participants' working years as teachers/administrators ranged from a minimum of two years to a maximum of 19 years. When it is examined how many different schools the teachers and administrators worked in until their last school, the number of schools varied from a minimum of three to a maximum of 11.

2.3. Data collection and analysis

A structured interview technique was used to obtain the data. The interview questions prepared by the researchers were edited and finalized after receiving the opinions of three field experts. The questions consisted of two parts. In the first part, there are questions about demographic information. In the second part, there are questions to determine the opinions of school administrators and teachers about the physical learning environment. The data were collected through interviews of approximately 10-15 minutes with volunteer participants and audio recordings. The opinions of the participants who did not consent to be audio recorded were recorded by taking notes during the interview. After the interviews were transferred to the computer and analyzed, they were analyzed using the content analysis technique. Similar codes were grouped under the same themes, and related sample statements were included.

3. Results

The results of the analysis of the opinions of teachers and school administrators on the key elements that should be found in the indoor and outdoor physical learning environment of school buildings are given in Table 1.

Table 1. Views of teachers and school administrators on the key factors to be found in the indoor and outdoor physical learning environment of the school building.

	Themes	Participants
Indoor	Security	T2, SA2, SA4
	Finding Materials Suitable for the Age Group	T1, SA1
	Availability of Playgrounds	T1,T3
	Availability of Workshops for Various Activities	T1, T3, SA2, SA3, SA4
	Natural Light	SA3, SA4
	Spacious School Building	T1,T2, SA1, SA4
	Having a Rest Room	T3, SA1
	Use of Wood Materials	T2
	Supporting Recycling	T2
	Light Tones Should Be Used	T1, T2, T3, SA1, SA2, SA3, SA4

	The building should not be multi-storey	T1, T3, SA2, SA3, SA4
	Having a Garden	T1, SA1, SA3
	Plant Cultivation	T2, T3, SA3, SA4
	Having Plants	T1, T2, T3, SA1, SA2, SA3, SA4
	Safety	T2, T3, SA2
	Availability of space and materials for children to play	T2, T3, SA1, SA3
Outdoor	Availability of Rest Area	T2
	Cleanliness	T2, SA2
	Animal Feeding	T2, SA4
	Light Tones Should Be Used	T1, SA1, SA2, SA3
	Each wall should be painted a different color	T3
	Cartoon Characters Should Be	T2, SA4
	Supporting Recycling	T2

According to Table 1, the themes identified by teachers and school administrators regarding the physical learning environments in the interior of school buildings include factors such as safety, availability of materials suitable for the age group, support for recycling, playgrounds, workshops for various activities, natural light, the width of the school building, rest room, use of wooden materials, and light colors. These themes stand out as important factors in the physical configuration of school buildings. The views of one teacher were expressed as follows:

T2: "It should be safe. Doors and windows should open outwards. There should be no stairs. Wooden materials should be used in the building. Fire precautions should be taken. Building materials should be well selected. Cables should not be in the middle. The heating tank should not be close to the classrooms. There should be no cutting materials in the building."

This view emphasizes the critical measures for the safety of school buildings and the potential impact of the materials used on the educational environment.

The themes of teachers and school administrators regarding the physical learning environments that should be present in the outdoor spaces of school buildings are not having many floors, having a garden, being able to grow plants, having plants, being safe, having areas and materials for children to play, having a recreation area, being clean, being able to feed animals, being large and spacious, using light colors, supporting recycling, having cartoon characters on the walls and painting them in various colors, supporting recycling. Sample statements regarding the participants' views on the outdoor physical features of school buildings are as follows:

T2: "There should be a large green area, animals. The park should be safe. Toys should be strong, and they should not break or harm children. There should be security in the garden. Plants and vegetables should be grown. There should be benches.. There should be a garbage bin for waste. There should be a sandbox and fruit trees."

The views of teachers and administrators on the suitability of school buildings for children with disabilities are presented in Table 2.

Table 2. Analysis of teachers' and administrators' views on the suitability of school buildings for children with disabilities.

Suitability of the building for children with disabilities	**Themes**	**Participants**
Suitable	Single Storey Building	T1, T2, T3, SA2
	Convenient Building Entrance	T1, T2
	Having a Support Education Room	T3
Not Suitable	Stairs at the Building Entrance	SA1
	Stairs inside the building	SA3, SA4
	Embossed Text and Lack of Visual Stimuli	SA3
	Multi-storey building	SA4

According to Table 2, when the opinions of teachers and administrators on the suitability of school buildings for children with disabilities were evaluated, and two categories were formed. These were named as opinions that the school building is suitable for children with disabilities and opinions that the school building is not suitable for children with disabilities. The participants who said the school building is suitable for children with disabilities explained that the building is one-storey. The entrance is without stairs, there is a disabled ramp at the entrance of the building for children with orthopedic disabilities, and there are support education rooms in the building where individual education can also be provided. The participants who said that the school building was not suitable for children with disabilities explained that there were stairs at the entrance of the building instead of a disabled ramp, there were many stairs in the

building, there were no embossed text and visual stimuli for visually impaired children, and the building was multi-storey.

A teacher who said that the school building was suitable for children with disabilities expressed her opinion in the following words:

T1: *"Our school building is one-story, the entrance is suitable for wheelchairs, and there are no stairs at the entrance. Therefore, it is suitable for the disabled."*

An administrator stated that the school building was not suitable for children with disabilities:

SA1: *"I don't think our school building is suitable for students with disabilities because we have a staircase, and a child using a wheelchair may have difficulty in this regard. Also, there are no applications for visually impaired or hard-of-hearing children. We only have children with learning difficulties. For them, our trained teachers come and take care of them."*

The views of teachers and administrators on the suitability of school buildings for children's health and safety are presented in Table 3.

Table 3. Analysis of teachers' and administrators' views on the health and safety of school buildings for children.

Theme	**Participants**
School being suitable for student health.	T1, T2, T3, SA1, SA2, SA3, SA4
Safety of the School Building	T1, T2, T3, SA1, SA2, SA3, SA

According to Table 3, when the opinions of teachers and administrators on the health and safety of school buildings for children were evaluated, it was seen that all teachers and administrators who participated in the research found school buildings safe and healthy. All participants also stated that school buildings are hygienic. Among the participants who thought the school building was safe, T3: *"Our school building is safe because there are not many stairs in our school."*

SA4, one of the participants who thought the school building was suitable for health: SA4: *"The environments are cleaned regularly in our school."*

4. Discussion and conclusion

The results of the study show that teachers and administrators emphasized the importance of safety, natural light, age-appropriate materials, designs that support recycling, multi-purpose workshops, and spacious areas in indoor spaces. In outdoor spaces, they emphasized extensive gardens, safe playgrounds, areas for growing plants, opportunities to interact with animals, and arrangements that support recycling. Similarly, according to Şenalp & Çınar's (2022) study, in line with the studies conducted in the literature, it was stated that it is important for a child-friendly preschool to be accessible and close to green areas to have planting and playgrounds in the garden, to be sheltered at the same time, and to have a large, spacious interior. The lighting, ventilation, heating, and cleaning of the interior space are also important criteria, as well as the furniture in the classroom being portable, appropriate in color, easy to clean, flexible, and aesthetic, and the school building being single-storey for the safety of children. According to another study, teachers and administrators argued that plants should be in the garden. A study conducted by Kılıç (2013) in preschool education institutions concluded that children wanted natural elements such as flowers, trees, soil, water, and sand in the school garden. According to Karasolak (2009), in his study conducted in primary schools, it was revealed that there were no creative playgrounds, sand and water playgrounds, or grass playgrounds in any of the school gardens included in the study. In short, instead of man-made materials such as asphalt and structured toys in school gardens, there is a need for elements that are found in nature and require exploring nature.

Different opinions were expressed about the suitability of school buildings for children with disabilities. While single-storey buildings, ramps, and support education rooms were positive; multi-storey buildings, stairs, and lack of stimuli for the visually impaired were among the important deficiencies. This indicates that school buildings should be designed with a more inclusive approach. Research also emphasizes that preschool education institutions should be single-story for the safety of children (Şenalp & Çınar, 2022).

According to the research results, the sine qua non of a school building is generally expressed as the school building being safe. In addition, the participants also mentioned that there should be security at the entrance of the building, the perimeter of the school should be surrounded by a high wall, doors and windows should open outwards, there should be no stairs, fire precautions should be taken, building materials should be well selected, cables should not be in the middle, the heating tank should not be close to the classrooms, there should not be any sharp materials in the building, toys should be firm and should not break and harm children. Similarly, Karaküçük (2008) found that garden security was inadequate,

window security was adequate, and fire safety was inadequate. In Çınar's (2022) study, preschool teachers stated that the factors that threaten security at school are the absence of a security guard, iron gates, and concrete in the garden instead of grass or soil. They also stated that pointed objects, wall edges, or objects such as honeycombs should be covered, cabinets should be fixed to the wall and should be the size of children, and electrical installations should be hidden or out of the reach of children. Studies have also emphasized that preschool education institutions should be constantly inspected regarding security (Mwoma, Begi & Murungi, 2018).

According to the study results, teachers and administrators determined that security is the most important element of an ideal school building. From this point of view, it is recommended that security personnel be placed in front of the school buildings and that the materials purchased and currently used in the school be reviewed in terms of security. The results show the importance of designing both the interior and exterior of school buildings to meet the diverse needs of children. More inclusive and sustainable designs will contribute positively to children's learning processes. At the same time, health and safety measures need to be integrated into procedures and the physical infrastructure.

References

Babaroğlu, A. (2018). Preschool education institutes in terms of education environments. *Bolu Abant Izzet Baysal University Journal of Faculty of Education*, *18*(3), 1313-1330. https://doi.org/10.17240/aibuefd.2018.18.39790-471118

Babich, F., Torriani, G., Corona, J., & Lara-Ibeas, I. (2023). Comparison of indoor air quality and thermal comfort standards and variations in exceedance for school buildings. *Journal of Building Engineering*, *71*, 106405.

Berris, R., & Miller, E. (2011). How design of the physical environment impacts on early learning: Educators' and parents' perspectives. *Australasian Journal of Early Childhood*, *36*(4), 102-110.

Çınar, C. (2022). The Opinions of Teachers Working in Pre-School Education Institutions on Indoor and Outdoor Security in Their Schools. *International Social Mentality and Researcher Thinkers Journal*, *8*(65), 2149-2157. http://dx.doi.org/10.292 28/smryj.66007

Durmuşoğlu, M., Çelikel, B., & Bilgen, Z. (2023). Evaluation of pre-school period learning environments from the perspectives of children and teachers. *Mehmet Akif Ersoy University Journal of Education Faculty*, *66*, 110-138. https://doi.org/10.21764/maeuefd.1000695

Fardlillah, Q., & Suryono, Y. (2019). Physical environment classroom: Principles and design elements of classroom in early childhood education. In *International Conference on Special and Inclusive Education (ICSIE 2018)* (pp. 120-127). Atlantis Press.

Günindi, Y. (2011). The Evaluation of Social Skills of Children Attending to Independent Preschool and Kindergarten. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi* [Ahi Evran University Kirsehir Faculty of Education Journal], *12*(1), 133-144. https://dergipark.org.tr/en/pub/kefad/issue/59498/855238

Karaküçük, S. A. (2008). A Study On Physical/Spatial Conditions of The Preschool Education Centers: In Sivas. *Sosyal Bilimler Dergisi/Journal of Social Sciences*, *32*(2), 307-320.

Karasolak, K. (2009). *The investigation of the opinions and teachers and students about their school buildings and gardens in the primary schools that architectural features are different.* (Unpublished Master's Thesis), Çukurova University, Adana, Türkiye.

Kılıç, Z. (2013). *Determination of what kind of environmental features kindergarten children would like to see at the school playground*. Ankara University, Ankara, Türkiye.

Mashburn, A. J. (2008). Quality of social and physical environments in preschools and children's development of academic, language, and literacy skills. *Applied Development Science*, *12*(3), 113-127. https://doi.org/10.1080/10888690802199392

Mwoma, T., Begi, N., & Murungi, C. (2018). Safety and security in preschools: A challenge in informal settlements. *Issues in Educational Research*, *28*(3), 720-736.

Peisner-Feinberg, E. S., Burchinal, M. R., Clifford, R. M., Culkin, M. L., Howes, C., Kagan, S. L., & Yazejian, N. (2001). The relation of preschool child-care quality to children's cognitive and social developmental trajectories through second grade. *Child development*, *72*(5), 1534-1553. https://doi.org/10.1111/1467-8624.00364

Ramazan, M. O., & Özdemir, H. (2020). Examining the relationship between preschool children's time spent in learning centers and their social skills. *Journal of Early Childhood Studies*, *4*(3), 682-699. https://doi.org/10.24130/eccd-jecs.1967202043254

Şenalp Ş. & Çınar K., (2022). Architectural Design Criteria for Child-Friendly Pre-School Education Buildings. *Journal of Konya Art, 5*, 48-70. https://doi.org/10.51118/konsan.2022.17

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

ACADEMIC PERCEPTIONS OF THE VALUE OF TEACHING FOR UNIVERSITY PERFORMANCE

Jonna Käpylä[1], Jenni Poutanen[2], & Elisa Enlund[2]
[1]*Faculty of Management and Business, Tampere University (Finland)*
[2]*Faculty of Built Environment, Tampere University (Finland)*

Abstract

This study aims to find out how the value of teaching is perceived in the valued outputs and impacts of universities, and their metrics, and how this relates to the nature of academic work. The study was conducted as a qualitative interview study (n=23) in two Finnish higher education institutions in relation to the work environment change projects. By examining the interplay between the nature of academic work and the metrics used to evaluate teaching performance, the study provides new insights into the structural and systemic reasons for the undervaluation of teaching and suggests ways to address them. This study shows that, compared to research, teaching in higher education lacks metrics to assess its performance in terms of quality and at the individual academic level. However, the nature of academic work is such that it highlights the importance of measuring individual academic performance in career advancement. Together these two aspects may create a mechanism that leads to undervaluing teaching.

Keywords: *Performance measurement, higher education, teaching, academic work, interview study.*

1. Introduction

The two main jobs of universities are research and teaching, and the prevailing conception is that teaching and research are complementary and overlapping activities (Cadez et al., 2017). Even though the research-teaching-nexus is valued as symbiotic in general beliefs, it contains tensions (Cadez et al. 2017), and it has also been convincingly argued that teaching and research are unrelated and not naturally complementary (Hattie and Marsh, 1996; Marsh and Hattie, 2002; Maisano et al., 2023). However, in the performance measurement systems of universities the research is more highly valued (Cadez et al., 2017). As the managerial performance measurement paradigm with control mechanisms drives the core actions of universities (Kenny, 2017), this lack of attention to teaching in measuring performance has led to an undervaluation of teaching and concerns that research-based performance evaluation is detrimental to quality teaching (Cadez et al., 2017).

This paper discusses the valuation of teaching at universities in the context of performance evaluation and measurement, and the role of teaching in the valued outputs/impacts of universities and their measures. The research aims to describe academic perceptions of the value of teaching for university performance and evaluates the perceived nature of academic work in relation to the experienced performance outputs/impacts, their metrics, and people, who produce these outcomes. Thus, this study aims to find out *how the value of teaching is perceived in the valued outputs and impacts of universities, and their metrics, and how this relates to the nature of academic work.* By examining the interplay between the nature of academic work and the metrics used to evaluate teaching performance, the study provides new insights into the structural and systemic reasons for the undervaluation of teaching and suggest ways to address them.

2. Academic work and performance evaluation in higher education institutions

Academic work, as defined in this paper, is carried out in universities or higher education institutions and consists of scientific research, education and social interaction with the society. The nature of academic work is seen as self-managed, intrinsically motivated with high levels of personal commitment, and with academic's identity that is closely aligned with their work (Kenny, 2017). Academic work can be categorised as knowledge work, which Kropsu-Vehkaperä and Isoherranen (2018) characterise as focusing on information handling and processing as the main task and producing knowledge as the main output. The innovative and creative element is crucial in knowledge work, which is not just the application of already

existing knowledge. De Sordi et al. (2021, p. 65) define knowledge work as "the continuous, systematic and predominant expansion of organizational knowledge through the mechanism of exploration" as opposed to mere exploitation of knowledge. There are many similarities between knowledge work and academic work: it is primarily produced through mental processes, it requires the need for balancing between concentration and interaction, and it involves a wide variety of activities with frequent shifts between them (Indergård and Hansen, 2024). This raises the question of whether there is something special or peculiar about academic work compared to knowledge work in general. Indergård and Hansen (2024) argue that the key distinctive feature of academic work is the academics' constant alternation between supervision, teaching, concentration work and administrative tasks, i.e. even more frequent shifts between an even greater variety of activities. They also see that some academics close links to practice, for example through fieldwork and architectural practice, are different from traditional knowledge work. However, the relationship between knowledge work and academic work has not been widely addressed in the literature, nor linked to the discussion about performance measurement at higher education institutions.

The relationship between research and teaching performance is not straightforward and previous studies have found both negative and positive links between them (Cadez et al., 2017). Cadez et al. (2017) finds that research productivity (i.e., amount of research output) is not related to teaching quality, but instead research quality is positively related, concluding that high quality research improves teaching quality. On the contrary, for example, Coccorese et al. (2024) show a trade-off between research and teaching quality concluding that teachers pursuing greater research quality may be compelled to neglect teaching. The relationship between teaching and research is thus complex and influenced by various factors. The contradictions highlight the fact that both teaching and research should be the focus of university performance measurement if measurement is to drive action. This is because the productivity or effectiveness of one does not necessarily guarantee the productivity or effectiveness of the other. Rather than being complementary, there could be at least some decoupling between them (Hattie and Marsh, 1996; Marsh and Hattie, 2002; Maisano et al., 2023).

3. Research context and method

The study was conducted as a qualitative interview study in two Finnish higher education institutions in relation to the work environment change projects, where certain facilities of the universities were renewed. In Finland, the universities are independent legal entities with autonomy to make decisions on their internal administration. However, the Ministry of Education and Culture (OKM) steers universities' performance through funding. OKM is the main funder of universities, and the most significant part, 76 %, of the total funding allocated to universities consists of funding based on performance-based indicators, of which 42 % have come (in 2021–2024) from education indicators (Bachelor's degrees and Master's degrees 30 %, continuous learning 5 %, number of employed graduates and quality of employment 4 %, student feedback 3 %) and 37 % from research-based indicators (PhD degrees 8 %, scientific publications 14 % and competitive research funding 12 %) (Ministry of Education and Culture, n.d.). Universities may decide on the internal allocation of funding independently based on their strategic choices. Besides the funding by OKM, higher education institutions receive financing from other sources, i.e. external funding, which is mainly related to research project activities.

The data consists of 23 interviews conducted in June-October 2024 representing both top and middle management, researchers, teachers and administrative staff at the universities as well as representatives of the work environment change design and the property owner. The interviews were semi-structured and focused on three themes: 1) nature of academic work, 2) productivity of academic work and its metrics, and 3) effectiveness of academic work and its metrics. Thus, we approach the measurement of university performance from the perspectives of productivity and effectiveness. We define productivity as the relationship between outputs and inputs, with the aim of maximising outputs while minimising inputs, and effectiveness as the long-term impacts or changes generated by an activity. These general definitions were also communicated to the interviewees. Interviewees were then asked how they understand academic productivity/effectiveness, what factors contribute to/hinders them, and further how they can be measured. Following these themes, interviews also included questions related to the work environment change and its objectives, implementation process and status but these were excluded from this study. However, due to the context, interviewees may have approached the issues of academic work and its productivity/effectiveness specifically from a work environment perspective. To reduce this bias, these topics of academic work and its performance were asked before moving on to the issue of work environment change. The interview data was analysed by using Braun and Clarke's (2006) thematic analysis steps, which involved coding the data and then searching for, reviewing and defining themes.

4. Results and discussion

4.1. Nature of academic work

The results of the interview study show that there are many similarities between academic work and knowledge work. Interviewees recognised that academic work consists of independent work and collaborative work, which was also seen as a question regarding knowledge work in general (Indergård and Hansen, 2024). In addition, the innovative and creative nature of academic work and the search for new perspectives was brought up, which is also acknowledged to be a key feature of knowledge work in general (De Sordi et al., 2021).

Along with the similarities, three distinctive characteristics of academic work emerged from the interview study: 1. the diverse nature of the work, 2. independence and autonomy (with freedom and responsibility), and 3. entrepreneurial and personal spirit. The diverse nature of work comes out both at the organisational and individual level; the job description of many individuals is very diverse, including teaching, research and administrative tasks. Tasks cover a wide range of responsibilities and can change throughout the day. As a result, academic work is often multi-locational. This was well summed up by two interviewees, who said, *"The work is very varied compared to quite a lot of professions."* and *"It is work that takes many different forms. It's certainly not one kind of work, in my opinion."* This finding is in line with the study by Indergård and Hansen (2024), who argue that frequent shifts between a wide variety of activities distinguish academic work from knowledge work in general. Another key feature of academic work was its independence and autonomy. Interviewees described it by saying, for instance: *"It [academic work] is quite free, based on your own interest, your own enthusiasm."* Interviewees also emphasised the independent nature of academic work by highlighting the need for concentration and own space, but discussed also the importance of community and peer support. Although the need for collaboration and teamwork were acknowledged emerging more often, the concept of academic work as individual work and demanding concentration and peace emerged strongly. While autonomy is seen as a key characteristic in knowledge work (Drucker, 1999), the analysis suggests that it is highly emphasised in academic work.

The third distinctive characteristic, the entrepreneurial and personal spirit, was somewhat related to the autonomous nature of work, but deepens it by recognising the personal, identity-based nature of academic work and the individual responsibilities and obligations associated with it. The workroom was seen to have symbolic significance – perhaps because academics' identity is so closely aligned with their work (Kenny, 2017). Academic work was equated with entrepreneurship by saying *"It is, in a sense, a group of private entrepreneurs out there who are taking forward their own discipline."* and *"It [academic work] is a bit entrepreneurial in modern Finland."* Previous research has also emphasised the managerial, competitive and individualistic paradigm that has entered academia (Kenny, 2017), highlighting "the challenges that a neoliberal agenda with its attendant focus on measurement, accountability, marketisation and consumerism has presented to academics" (Brew et al., 2022, pp. 942). As a result of these changes, performance measurement of the individual academic's outputs has come to the fore in universities.

Overall, the results imply that academic work is work that is subject to a wide range of requirements (due to the diverse nature of the work) and these requirements seem to be particularly strongly targeted at individuals personally, because the nature of academic work is independent and autonomous. Furthermore, academic work is also described as entrepreneurial due to individual freedom but also responsibilities, which may derive from the performativity of academic work recognised in the previous literature (Kenny, 2017; Visser et al., 2024).

4.2. Role of teaching in university performance and its metrics

In describing productivity of academic work, quantitative indicators and OKM objectives were highlighted. The role of teaching was presented, alongside research, as the key outputs of university and was mainly described in terms of the number of degrees produced in the target time, as well as number of thesis guidance and credits. Teaching productivity was thus described through quantitative measures that did not take quality into account. It was also pointed out that teaching is typically jointly produced, whereas research outputs are more easily attributed to a specific individual: *"It is not the individual teacher who produces those degrees as a whole, but rather they are the result of the collective effort by a larger group."* The interviews also highlighted the productivity requirement arising from the measurement: *"It's true that productivity is this kind of input-output ratio, but in the long run it seems that resources have not increased, but still you should produce more and more."* At the same time, many highlighted the importance of personal enthusiasm, motivation and attitude to productivity in academic work and the individual's own ability to influence the promotion of productivity due to the autonomous and free nature of the work: *"You could be doing 15 hours of totally low quality work, but you could be doing two or three hours of really high quality work. So, what's the input is how much effort you put into it, and effort is more than just hours worked, how you approach it and how seriously you do it."* Both these aspects can be seen as putting

productivity pressure on the individual academic worker, which can also reduce motivation and increase stress: *"Sometimes we are under conflicting pressures: we want to invest in quality and feel burdened by the fact that we have to get an inferior publication or a degree with less competence at the expense of quality."*

However, many linked academic productivity to quality and effectiveness, but found it challenging to measure: "*Of course, productivity is easy to calculate if you look at the student-teacher ratio, for example. If the same teacher can teach 10 or 100 people, the productivity difference is easy to measure. But the effectiveness, how to get the student to learn. Just because there are a lot of listeners doesn't mean that anything happens in terms of learning. That is perhaps the problem of productivity in academia."* Furthermore, the results show that teaching is seen to have a significant role in the effectiveness of academic work. Some interviewees focused only on the impacts of research but many brought out the crucial impact of teaching: *"Our most central impact is how we make smart young people even smarter and how they then make a difference in society. The impact of that lasts for a generation."* In terms of measuring effectiveness, some teaching-related indicators were mentioned such as employment of graduates, but overall, the question of metrics seemed difficult, for example how to measure increased understanding, knowledge and motivation to act for society. It was also pointed out that the difficulty of measuring effectiveness and impacts may hinder their realisation, because of the significant guiding role of indicators.

In summary, the results show that the underestimation of quality and effectiveness in university performance measurement is evident and that this is particularly focused on education, which lacks direct quality indicators, compared to research, where it is possible, for example to measure the level of publication and the number of citations. Of course, it was also noted by interviewees that despite these proxy measures of research quality, these indicators do not give a complete picture of the academic, let alone societal, impact of research.

4.3. Mechanism behind structural undervaluation of teaching

The findings show a paradox in the valuation of teaching. At the same time, teaching is both valued regarding its outputs and impacts and undervalued in terms of measuring those outputs and impacts. Our results provide evidence of how this undervaluation can occur due to two aspects: first, due to the nature of academic work and second, due to the nature of output metrics related to teaching. Academic work is characterised by the diverse nature of work, independence and autonomy, and entrepreneurial and personal spirit in a performative environment that emphasises the measurement of outputs. Academic work can be seen as private entrepreneurship, done for oneself, about things that are meaningful to oneself. Accordingly, researchers and teachers list their academic outputs on their resumes. Thus, the measurement of outputs matters in academic work. We propose that this characteristic may lead to valuing individual outputs over collective or community outputs.

However, regarding the nature of output metrics related to teaching, it appears that performance measures that the interviewees relate to teaching operate at the organisational level (e.g., number of degrees) when compared with the output metrics of research (e.g., publications and their level), which can be allocated to the individual or team level. Thus, teaching output metrics cannot be directly allocated to those people (individuals or teams) that produce these outcomes. As noted in the previous section, the outputs and impacts of teaching are typically the result of the collective efforts of a larger group. We suggest that together these two aspects may create a mechanism that leads to undervaluing teaching in practice.

5. Conclusions

This study shows that, compared to research, teaching in higher education lacks metrics to assess its performance in terms of quality and at the individual academic level. However, the nature of academic work is such that it highlights the importance of measuring individual academic performance in career advancement. This creates a mechanism that leads to undervaluing teaching in practice. At least two alternative, actionable solutions to the problem can be identified. First, a valid measure of the quality and effectiveness of teaching could be developed that could also be applied at the individual level. In addition, related to the productivity metrics of teaching, the allocation of study attainments downwards from the university level to the faculty and unit level and furthermore to individual academics, who teach, could be developed. The credits allocated to the teacher could include some kind of intensity factor, which is linked to the amount of work required to teach the courses that the teacher teaches. In turn, the research metrics could be developed towards measuring community outputs. The second, more radical proposal relates to the transformation of the whole financial steering model, which is based on performance-based quantitative indicators. At present, the funding model does not encourage the development of teaching quality and effectiveness, which raises the question of whether the whole idea of performance-based financial steering should be rejected if it is not possible to measure the fundamental performance outcome of universities,

i.e., teaching effectiveness. Visser et al. (2024), in their critique of the 'performative 'university, which relies on the quantification, the ideal of perfect control and fabrication, also suggest that the focus should be shifted from metrics to scientific content and quality, for example in hiring, promotion and funding decisions. The same conclusion can be extended to education.

Future research should seek to explore these possibilities further. This study is limited to the Finnish higher education context. However, based on the literature, the undervaluation of teaching at universities appears a general concern internationally as well (Brew et al., 2022; Bull et al., 2024; Yu et al., 2024), so the structures behind the undervaluation of teaching identified in this study may be valid also elsewhere.

Acknowledgments

We would like to thank Emmi Villberg, who contributed to the data collection for this study. We would also like to thank the anonymous reviewers of this paper, and especially the one reviewer who articulated the narrative and core of our research well and helped us to clarify it.

References

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101.

Brew, A., Boud, D., Lucas, L., & Crawford, K. (2022). Hampering teaching excellence? Academics making decisions in the face of contradictions. *Studies in Higher Education, 47*(4), 941-952.

Bull, S., Cooper, A., Laidlaw, A., Milne, L., & Parr, S. (2024). 'You certainly don't get promoted for just teaching': experiences of education-focused academics in research-intensive universities. *Studies in Higher Education*, 1-17.

Cadez, S., Dimovski, V., & Zaman Groff, M. (2017). Research, teaching and performance evaluation in academia: the salience of quality. *Studies in Higher Education, 42*(8), 1455-1473.

Coccorese, P., Dell'Anno, R., & Restaino, M. (2024). Are outstanding researchers also top teachers? Exploring the link between research quality and teaching quality. *Socio-Economic Planning Sciences, 96*, 102098.

De Sordi, J. O., Azevedo, M. C. D., Bianchi, E. M. P. G., & Carandina, T. (2021). Defining the term knowledge worker: Toward improved ontology and operationalization. *Knowledge and Process Management, 28*(1), 56-70.

Drucker, P. F. (1999). Knowledge-worker productivity: The biggest challenge. *California Management Review, 41*(2), 79-94.

Hattie, J., & Marsh, H. W. (1996). The relationship between research and teaching: A meta-analysis. *Review of Educational Research, 66*(4), 507-542.

Indergård, K., & Hansen, G. K. (2024). Academic work – something else? *Journal of Corporate Real Estate, 26*(2), 113-130.

Kenny, J. (2017). Academic work and performativity. *Higher Education, 74*(5), 897-913.

Kropsu-Vehkapera, H., & Isoherranen, V. (2018). Lean approach in knowledge work. *Journal of Industrial Engineering and Management, 11*(3), 429-444.

Maisano, D. A., Mastrogiacomo, L., & Franceschini, F. (2023). Empirical evidence on the relationship between research and teaching in academia. *Scientometrics, 128*(8), 4475-4507.

Marsh, H. W., & Hattie, J. (2002). The relation between research productivity and teaching effectiveness: Complementary, antagonistic, or independent constructs? *The Journal of Higher Education, 73*(5), 603-641.

Ministry of Education and Culture. (n.d.). Steering, financing and agreements of higher education institutions, science agencies and research institutes. Retrieved January 24, 2025, from: https://okm.fi/en/steering-financing-and-agreements

Visser, M., Stokes, P., Ashta, A., & Andersson, L. M. (2024). The 'performative' university: theoretical and personal reflections. *Journal of Education Policy, 39*(6), 1030-1048.

Yu, F., Guo, H., Hu, C., & Fu, S. (2024). 'Can teaching help me get promoted?' A qualitative study of the career development of pre-tenure faculty in China. *Higher Education Research & Development*, 1-16.

NAVIGATING EMPLOYMENT CHALLENGES: SUSTAINABLE EMPLOYABILITY AND GENDER DISPARITIES AMONG THIRD COUNTRY NATIONALS IN GREECE

Magdalini Bakali, & Konstantina Karameri
Stimmuli for Social Change (Greece)

Abstract

This study investigates employer practices and challenges related to the employment of Third Country Nationals (TCNs) in Greece, with a particular focus on sustainable employability and gender-based disparities in the labor market. The data was collected during the project SustainHer, a project that aims to protect and promote access to sustainable employment opportunities for socially and economically vulnerable women, through skill-building and vocational training. While immigrant employment has risen over the last ten years, unemployment rates among foreign-born individuals are higher than those of native-born individuals in four out of five countries, and they are double the rate across the EU. Despite the rise of skills level immigrant occupations finding a skill-adequate job remains a challenge for immigrants and 30% of elementary jobs are held by migrants in the EU, more than 50% in German speaking countries, Cyprus, Norway and Sweden. This study investigates employer practices and challenges related to the employment of Third Country Nationals (TCNs) in Greece, with a particular focus on sustainable employability and gender-based disparities in the labor market. Through empirical research involving 23 Greek employers, following a preliminary survey of 7 respondents, the study examined current employment situations, barriers to employment, and organizational preparedness for TCN integration, while incorporating the gender component in the collected data and analysis. The findings reveal that language barriers (65.22%) and cultural differences (52.17%) constitute the primary challenges in TCN employment. The research identified significant gender-based disparities, with women TCNs disproportionately concentrated in low-skilled positions (73.91% compared to 65.22% for TCNs overall). Women TCNs face additional barriers including prevalent stereotypes and prejudices (52.17%), skill recognition challenges (43.48%), and work-life balance difficulties (39.13%). While 43.48% of employers feel prepared to hire TCNs, significant gaps remain in staff training and legal framework understanding. Financial support (60.87%) and targeted training programs (56.52%) emerged as the most desired support mechanisms for facilitating TCN employment. The study's findings emphasize the need for gender-responsive interventions alongside general support systems, including targeted professional development programs for women TCNs, anti-discrimination measures, and initiatives to facilitate upward mobility from low-skilled positions. These findings suggest that policy interventions should address both general TCN employment barriers and gender-specific challenges to ensure equitable labor market integration in Greece.

Keywords: *Sustainable employment, TCNs, employer practices, gender inclusion.*

1. Introduction

Greece has historically been a country characterized by emigration, exporting its workforce to various parts of the world. However, since the early 1970s, the dynamics of migration have shifted significantly, transforming Greece into a destination for immigrants from Asia, Africa, and neighboring countries (Poulopoulou, 2007). This change was notably marked by the influx of migrants and refugees in 2015, with arrivals surpassing previous records (Afouxenidis et al., 2017). Despite efforts to manage these flows through agreements such as the EU-Turkey deal in 2016, Greece continues to face substantial challenges in integrating a diverse immigrant population.

As of March 2023, Greece hosts over 757,000 legally residing immigrants, necessitating robust policies to foster social cohesion and mitigate social exclusion (Ministry of Migration and Asylum, 2023). The evolution of national integration strategies, beginning with the first National Strategy for Integration in 2013 and its subsequent revisions, underscores the country's commitment to supporting migrants and refugees. These strategies emphasize education, employment, housing, and access to health services, aiming to facilitate the integration of third-country nationals (TCNs) into Greek society.

Despite these efforts, TCNs encounter significant barriers to accessing their rights, particularly in employment, health, and education. The Migrant Integration Policy Index (MIPEX) highlights that non-EU citizens in Greece face more obstacles than opportunities, with the country's policies only partially promoting social integration (MIPEX, 2019). This paper explores the current conditions of professional training and skills development for TCN women in Greece, examining the intersection of sustainable employability and gender disparities within this vulnerable group.

2. Objectives

The objective of this research is to investigate the current state of vocational training and skills development for TCN women in Greece, focusing on the obstacles faced by employers and TCN women, as well as the training needs identified by employers. In addition, in this paper suggestions for training needed have been collected, analyzed and presented.

3. Design

This paper is the product of research conducted during the project SustainHer: Promotion of Sustainable Employment for Vulnerable Women at risk of Poverty and Social Exclusion, that aims to protect and promote access to sustainable employment opportunities for socially and economically vulnerable women through skill-building and vocational training a project that ran for 12 months (March 1st, 2024, to February 28, 2025). In general, the research focused primarily on women third country nationals residing in Greece, but the data collected also included desk research to provide European and national context as well focus groups with civil society organization representatives from different European countries in addition to Greece. A separate paper has been published with those results. The research data and analysis presented here targeted employers based and operating all over Greece, primarily focusing on different industries in Greece that generally hire or are more likely to hire third country nationals such as tourism, logistics and construction. The data collected by the employer questionnaires is one part of the research.

4. Methods

The research was designed to collect data through a structured questionnaire targeting Greek employers who either employed, had employed in the past or were likely to employ Third Country Nationals. The questionnaire was distributed online through an extended network of the research team's stakeholders. The survey was distributed and filled in during the period November- December 2024. The stakeholders distributed the survey to various employers and the results are analyzed below. In total 23 questionnaires were analyzed for this paper. A preliminary survey was drafted and distributed in November 2024 to a smaller sample of employers. The goal was to test out some questions and see the employers' responses. The survey was distributed during a career event where enterprises and businesses that work with third country nationals were in attendance. After processing the data, the survey was further developed and improved to gather as much targeted data as possible. A few questions about TCN women were incorporated in the questionnaire to collect the employers' perspectives.

The questionnaire was designed in a manner to both collect quantitative data but also allow employers to provide their opinion and suggestions. It was structured into four main sections to gather comprehensive information about companies and their practices regarding the employment of Third Country Nationals (TCNs). The first section, "Company Information," includes questions about the type of company, such as "Which of the following categories does your company/organization belong to?" (e.g., Tourism, Hospitality, Cleaning Services), and the size of the company. The second section, "Hiring Practices and Employment of TCNs," explores the company's current and future employment of TCNs, including questions such as "Does your company currently employ or intend to employ TCNs?" and "Please select the usual gender of individuals you hire or who come to seek employment at your company." The third section, "Skills and Training," addresses the skills and training needs of TCNs before joining the company, with questions like "In which skills do you think TCNs need additional training before joining the company?" The final section, "Support and Collaboration," seeks to identify the types of support that would facilitate the hiring of TCNs and assess the adequacy of employees' skills and knowledge to hire and employ TCNs. The questionnaire comprises a total of 10 main questions and 7 sub questions, making a total of 17 questions. It includes 15 multiple-choice questions and 2 open-ended questions. The open-ended questions aim to gather detailed information about the company's location and specific skills or certifications that TCNs might need before joining the company.

The limitation in this research is that there is a small sample number of questionnaires collected (23). It should be noted that only 10 months were allocated to research for this project it has been therefore challenging to collect a lot of usable data. However, the results are valuable because they provide an insight into employers' perspective, while bringing in the gender component, in the employment of third country nationals that is not regularly researched in Greece.

5. Discussion

The following results include demographic information of the employers surveyed as well as the obstacles TCN employees and particularly women face and the needs for training both for TCN employees and employers as they have been identified by employers.

5.1. Participants

Among the employer representatives surveyed, 47.83% belonged to the tourism sector, 34.78% to construction, and 8.7% to logistics. The remaining participants were from food services, sales, and office jobs. All the businesses that participated in the survey are small to medium-sized. Specifically, 47.8% of the companies have 100-200 employees, 17.3% have 50-100 employees, and 8.7% have 20-50 employees. Among the respondents, 43.4% held roles in administration, 39% were HR/Personnel Managers, and 17% held other positions such as office and sales managers. The companies are located in various regions, with a larger representation from Northern Greece, particularly Central Macedonia and Eastern Macedonia and Thrace. The employers surveyed were familiar with the populations discussed, with 65.2% already employing third-country nationals (TCNs) and 21.7% expressing interest in employing these populations in the future. Only 13% of respondents indicated that they are not currently employing TCNs.

5.1.1. Obstacles Faced by Employers. The most significant challenge identified by respondents in hiring third-country nationals (TCNs) is the language barrier, cited by 78.3% of participants. Following this, checking the legality of documents was noted by 52.2% as a challenge while the difficulty of recruitment procedures was identified as a challenge by 39.1% of the responding employers. Only 26.1% of the respondents identified the lack of familiarity of TCNs with the culture and processes of the company as a barrier to their hiring process.

5.1.2. Obstacles faced by TCN women according to employers. When employers were asked about challenges that TCN women might be facing in relation to hiring process s or/and work in their company as well as what level of positions are usually filled by female TCN depending on the industry the answers revealed the following: While 65.22% of the respondents said that they seek to fill low-skilled positions with individuals of diverse background, 30.4% of the respondents said that they seek to fill positions of skilled staff, while 56% and 52.2% said that they seek to fill support staff and seasonal staff positions with individuals of diverse background. As shown in Table 1, the level of positions usually covered by TCN women are those of low skilled staff.

Table 1. Job Level covered by TCN women.

Job Level	Percentage (%)
Low-skilled staff	71.4
Skilled staff	19.0
Support Staff	66.7

As far as the challenges TCN women face in relation to hiring process and/or work in the surveyed companies, language and communication barriers emerged as the most significant issue, mentioned by 60.87% of responding employers. A substantial proportion of employers also noted family commitments (26.09%), a smaller proportion cited cultural differences as a challenge and 13.04% cited lack of training/lack of necessary work certificate or license as a difficulty.

5.2. Needs for training for TCNs employees

When asked about skills and training they thought TCNs needed before joining the company, the highest percentage of employers as seen in Table 2, said that language skills are needed, followed by communication skills (other than language). Technical skills such as knowledge in machine handling and computer/digital skills were also identified as much-needed training by 43.48% of employers.

Table 2. Needs for training among TCNs.

Skills Category	Percentage (%)
Language skills, especially knowledge of the Greek language	**69.57**
Technical skills (e.g., use of equipment/machinery, use of computer)	**43.48**
Communication skills	**66.70**
Soft skills	**34.78**
No additional training is needed	**8.70**

Employers provided several suggestions for additional training and courses to enhance the skills of Third Country Nationals (TCNs). These included specialized training in the use of sewing machines and professional ironing techniques, as well as vocational training for plumbers, electricians, and handymen. In the tourism sector, employers recommended seminars or specialized courses covering various aspects such as service, kitchen operations, and reception duties. Additionally, there was an emphasis on integrating TCNs into the work mentality of the Western world and providing language courses in English and Greek to improve communication and facilitate better workplace integration. These recommendations highlight the diverse range of skills and training needs identified by employers to support the employability and professional development of TCNs.

5.2.1. Employers' needs for hiring TCNs. Employers identified several types of support that would significantly facilitate the recruitment of Third Country Nationals (TCNs). The highest percentages of respondents indicated that reducing bureaucracy and simplifying the recruitment process (60.87%), providing free Greek language learning programs for TCNs (60.87%), and creating networks for workforce search for TCNs (60.87%) would be most beneficial. Additionally, a very small percentage of employers (4.35%) suggested that free Greek language lessons alone would be helpful. These insights underscore the importance of addressing administrative barriers, enhancing language skills, and establishing supportive networks to improve the employability and integration of TCNs in the workforce.

5.3. Employers' skills in hiring TCNs

When asked whether the employees in their company or organization have sufficient skills and knowledge to hire and employ third-country nationals (TCNs), most respondents (56.52%) indicated that their employees partly possess the necessary skills and knowledge. Additionally, 34.78% of respondents believe their employees do have sufficient skills and knowledge. A smaller percentage (4.35%) believe their employees do not have sufficient skills, and another 4.35% are unsure. This data highlights the varying levels of confidence among employers regarding their staff's capabilities in effectively hiring and integrating TCNs into the workforce.

5.3.1. Necessary training. Employers identified various types of training and support needed to facilitate the recruitment of Third Country Nationals (TCNs). As shown in Table 3, most respondents indicated that training related to bureaucratic issues (34.78%) and support in finding TCN individuals who meet the criteria for available positions (30.43%) are the most critical needs. Additionally, 21.74% of employers suggested training related to interculturality, while 4.35% mentioned the need for training in hotel specialties and communication. Other recommendations included providing allowances and housing for seasonal workers in tourism who are out of work for five months at the end of the season, and basic training for TCNs in hotels, such as housekeeping, to reduce the time employers spend on job-specific training. These insights underscore the importance of addressing administrative challenges, enhancing cultural understanding, and offering practical support to improve the recruitment and integration of TCNs in the workforce.

Table 3. Training for employers.

Category	Percentage (%)
Support in finding TCN individuals who meet the criteria for available positions	30.43
Training related to bureaucratic issues	34.78
Training related to interculturality	21.74
Training in hotel specialties	4.35
Communication	4.35
Other	13.04

6. Conclusions

In Greece, migrants cover significant shortages of staff in the fields of agriculture, construction, tourism and other fields (Dianeosis, 2024). The research results presented in this paper highlights several critical aspects of the employment challenges faced by Third Country Nationals (TCNs) in Greece, with a particular focus on gender disparities and sustainable employability. The findings reveal that language barriers and cultural differences are the primary obstacles in TCN employment, significantly impacting their integration into the workforce. Employers identified the need for targeted training programs, particularly in language skills, communication, and technical skills, to enhance the employability of TCNs. The study also underscores the gender-specific challenges faced by TCN women, who are disproportionately concentrated in low-skilled positions and encounter additional barriers such as stereotypes, skill recognition issues, and work-life balance difficulties. These findings suggest that policy interventions should address both general TCN employment barriers and gender-specific challenges to ensure equitable labor market integration.

Employers expressed a need for support mechanisms to facilitate the recruitment of TCNs, including reducing bureaucracy, providing free Greek language learning programs, and creating networks for workforce search. Additionally, employers highlighted the importance of training related to bureaucratic issues and interculturality to improve their staff's capabilities in hiring and integrating TCNs.

Overall, the research emphasizes the necessity of gender-responsive interventions alongside general support systems, including targeted professional development programs for TCN women, anti-discrimination measures, and initiatives to facilitate upward mobility from low-skilled positions. By addressing these challenges, Greece can foster a more inclusive and equitable labor market, promoting sustainable employability for all TCNs.

Acknowledgments

The research results presented here are the products of research conducted during the project *SustainHER* that is implemented in the context of the *BUILD project*, with implementing actor Irida Women's Centre and partner Stimmuli for Social Change. BUILD is co-funded by the European Union through the program Citizens, Equality, Rights and Values (CERV), Bodossaki Foundation, and NGO Support Centre. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union, the European Education and Culture Executive Agency, or the Bodossaki Foundation. Neither the European Union nor the granting authority can be held responsible for them.

References

Afouxenidis, A., Petrou, M., Kandylis, G., Tramountanis, A., & Giannaki, D. (2017). Dealing with a Humanitarian Crisis: Refugees on the Eastern EU Border of the Island of Lesvos. *Journal of Applied Security Research*, *12*(1), 7-39. https://doi.org/10.1080/19361610.2017.1228023

Dianeosis. (2024). *Integration of migrants and refugees in Greece*. Retrieved December 20, 2024, from https://www.dianeosis.org/wp-content/uploads/2024/09/Immigration_brochure-v4.pdf

International Organization for Migration (IOM). (2019). *Glossary on migration*. Retrieved January 8, 2025, from https://publications.iom.int/system/files/pdf/iml_34_glossary.pdf

Ministry of Migration and Asylum. (2023). *Reduction of 51% in residents in the territory for March 2023 compared to last year*. Retrieved January 10, 2025, from https://migration.gov.gr/en/meiosi-51-stoys-diamenontes-stin-epikrateia-gia-ton-martio-toy-2023-se-schesi-me-perysi/

Poulopoulou, I. (2007). *The Migration Challenge* (pp. 1-936). Papazisis.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

HUMAN CAPITAL'S THEORETICAL MODEL AND SUSTAINABILITY: INVESTMENT IN TRAINING AND FUTURE VALUE OF INTANGIBLES

Lidia García-Zambrano[1], Yolanda Chica-Paez[2], & Maite Ruiz-Roqueñi[2]
[1]Department of Public Policy and Economic History, University of the Basque Country UPV/EHU (Spain)
[2]Department Financial Economic II, University of the Basque Country UPV/EHU (Spain)

Abstract

Human capital refers to the set of skills and competencies of people that generate value within the business framework, where we include creativity, experience, skills, training, motivations, and different competencies. These human competencies could contribute to competitive advantage for many companies and, often, the most valuable resource. Skills and employee knowledge are essential to obtain a lasting competitive advantage. In addition, training is one of the critical factors determining an organization's effectiveness. The success of any human resources strategy, specifically a training activity, should be measured by what contributes to the achievement of the organization's stakeholders. Therefore, its analysis and management are necessary and vitally important to increase the company's sustainable value. The main objective of this paper is to propose a theoretical model that analyses the influence that the accumulated investment in employee training has on the sustainable value of companies' intangibles. We presented a simple linear regression model to explain it, and the main result of this paper proves that a significant investment in human resources is reflected in better and more sustainable results in the company's future market value.

Keywords: *Intellectual capital, human capital, stock market value, investment, sustainability.*

1. Introduction

The growing concern about intangible resources is unquestionable. Although they have always existed in organizations, companies did not begin to worry about their importance until the mid-nineties of the last century. The process of economic globalization leads to a society of constant change, where the weight of knowledge is constantly growing. In a knowledge-based society, intellectual capital constitutes the key resource for organizations. The knowledge economy requires creating knowledge products and services, which is a logical step because knowledge is the future. That is why it is understandable that many companies are forced to change their approach for simple survival. This has led to intangible resources being the main drivers of an economy in constant progress and dynamism. Factors that have contributed to increasing the importance of intangibles in the company are the increase in business competition motivated by the globalization of markets and the advent of information technologies, which have their clearest exponent on the Internet. Other important changes that the current economy has brought are the deregulation of key economic sectors, the need for differentiation, and the preponderance of service companies over production companies, the geographical dispersion of organizations, and the strengthening of regimes of intellectual property (Cole, 1998; Teece, 1998). In the knowledge economy, the key to the success of companies is their ability to improve the economy. Therefore, the organizations' current trend is to focus more on intangible resources, especially those based on knowledge, the intellectual capital. When we talk about intellectual capital (IC), we see the need to distinguish the three dimensions of it: human capital, structural capital, and relational capital. Human capital refers to the set of skills and competencies of people that generate value within the business framework, where we include creativity, experience, skills, training, motivations, and different competencies. Structural capital refers to the group of intangibles that make up the way a company is organized in such a way that they remain in it even if an employee decides to leave it. Among them, we can include information and communication systems, work processes, patents, copyrights, and intellectual properties. Finally, relational capital includes all those relationships of the company, not only with customers but also with all the stakeholders that are part of the environment of the company. The growing importance of these intangibles naturally challenges the way in which organizational behaviour and functional models are established. Therefore, the future of organizations will

depend largely on how they manage their intangible resources. Greater and better knowledge of the aforementioned intangible resources would make their management more accurate. Today, the key to competitiveness lies in the people who direct the different fields of action of companies. Therefore, the changing environment where they evolve determines the new demands in terms of knowledge, skills, and the abilities of workers. In this context, human capital is an essential element for the survival of the company, and it represents a potential for greater efficiency (Becker and Gerhart, 1996; García-Merino et al., 2008; García-Zambrano et al., 2018; Veselinović et al., 2022; Murugan et al., 2023). Therefore, the main objective of this research work is to establish a theoretical model that shows the relationship between the proactive management of human competencies and business results in Spanish companies. Specifically, we analysed the influence that investment in employee training has on the business sustainable value.

2. Training as a representative value of human capital

Human capital is a set of capabilities, skills, knowledge, and competencies that the worker has acquired from the company through experience and training. Without the existence of human capital, the creation of competitive advantages within the company would not be possible. Although the company has cutting-edge technological elements or material, elements that give economic value to the company, without qualified personnel for the execution of the said resources, these alone will not increase in value within the company. Human capital represents one of the fundamental elements for competitiveness to exist in the organizational field. Many authors (Murugan et al., 2023; Štaffenová and Kucharčíková, 2024) consider human capital as the most important dimension of intellectual capital to generate value for the company. Nowadays, the key to competitiveness lies in people. Therefore, employee training is essential since various studies consider employee training as a key factor of human capital (Bassi et al., 2002). As a concept, training is the education received to be able to acquire general and specific knowledge whose purpose is to put it into practice. Therefore, preparing employees through continuous training is a key factor for companies today. To deal with it, the company must train all personnel from the highest to the lowest positions. Training is one of the essential factors determining organizations' effectiveness. Several studies (García, et al., 2008; García-Zambrano, eta al., 2018) consider the employee training as a critical representative factor of human capital. Improving the quality of people and the organization will not necessarily increase shareholder value. The success of any human resources strategy, specifically a training activity, should be measured by what contributes to the achievement of the organization's stakeholders. Training should not be an ultimate goal but rather a means to improve the competitiveness of organizations. Therefore, it is necessary to consider that the investments made in workers via training will have an impact in the near future, and the improvement in results will not be immediate (García, et al., 2008). Authors such as Lev et al. (2005), and Yang and Lin (2009) indicate that it is necessary to take into account more than one year in the training variable due to the delayed effect it can have on the value of intangibles; that is why in our study the training is cumulative. Therefore, our study proposes a theoretical model that analyses the impact of investment in employee training on business results.

3. Proposed model: Relationship between investment in training and intangible value

As proposed by Lev et al. (2005), we present a simple linear regression model that relates the influence of human capital through investment in worker training and the value of the organization's intangibles. In our model, the variable X refers to the investment in accumulated training, and the independent variable Y takes the value of intangibles as a reference. Thus, the main objective of our model is to verify whether investing in human capital through employee training really increases the company's intangible value. Likewise, we consider the variable total assets in the Balance Sheet item and the net worth in the profit and loss account to be able to use it to avoid size biases among the participating companies. Furthermore, we hava taken the difference between the market value (stock market value) and the company's net accounting equity (the result being divided by the assets to avoid size biases) as a representative variable of intellectual capital). The authors Yang and Lin (2009) point out that there is a delayed effect of investments made in human capital on the value of intangibles. Therefore, in our model, we have not considered investments in training in year t, but rather those made in year t-1 and disbursements in previous k years.

Therefore, the proposed model would be the following:

$VI^*t = f\left(\sum_{t=0}^{n} CF_{t-1}\right) + \tilde{\varepsilon}_t$ (1)

Where:

VI*t: VIt/ VAt

VIt: Intangible value of company at period t.

VAt: Value of actives of the company at period t.

CFt-1: IFA t-1/ VAt

IFAt-1: Accumulated investment in employee training during the three k periods.

εt: Error in t.

In this way, equation (1) collects the delayed impact of disbursements in employee training investment in the years before t. Therefore, the equation includes the impact of k years on the future value of the company's intangibles.

4. Conclusions

In this work, we propose establishing a model that relates the importance of investment in forming human capital through the influence on intangible future values. This research exposed a theoretical framework of the main intangible elements, distinguishing the difference between assets and intangible resources. We have studied human capital with its particularities, among which the impossibility of appropriating it stands out, that is, the human resource can leave the company at any time because there is no legal link to it, more beyond your employment contract, which can be terminated, practically without penalties in the vast majority of situations. This is why it is important to retain talent, a resource that must be trained to make it increasingly interesting to keep it within the company. In our case, we consider a maximum limit of 3 years since training depreciates quickly, as we have verified. After that, we established the representative variable of human resources, and we considered the intellectual capital variable as the difference between the market value (stock market value) and the accounting net worth of the company. Finally, we propose a linear regression model that relates the investment in employee training in three times before t, with the intangible value of the companies taking t as the base year. As future lines of research, it would be interesting to apply the proposed model to several companies in several countries to obtain more conclusions from the proposal.

Acknowledgements

The University of the Basque Country, UPV/EHU (ECISE, GIU21/025) has partially supported this paper financially.

References

Becker, G. S., & Gerhart, B. (1996). The impact of human resource management on organizational performance: progress and prospects. *Academy of Management Journal, 39*(4), 779-801. https://doi.org/10.2307/256712

Cole, R. E. (1998). Introduction, special issue on knowledge and the firm. *California Management Review, 40*(3), 15-21.

García-Merino, D., Rodríguez, A., Arregui, G., Vallejo, B. (2008). Importancia y valoración de los intangibles: la percepción de los directivos. *Estudios de Economía Aplicada, 26*(3), 27-55. Retrieved from http://www.revista-eea.net/documentos/26303.pdf

Garcia-Zambrano, L., Rodríguez-Castellanos, A., & Garcia-Merino, J. D. (2018). Impact of investments in training and advertising on the market value relevance of a company's intangibles: The effect of the economic crisis in Spain. *European Research on Management and Business Economics, 24*(1), 27-32. https://doi.org/10.1016/j.iedeen.2017.06.001

Lev, B., Sarath, B., & Sougiannis, T. (2005). R&D reporting biases and their consequences. *Contemporary Accounting Research, 22*(4), 977-1026. https://doi.org/10.1506/7XMH-QQ74-L6GG-CJRX

Murugan, M., Sakthivel-Sujatha, T., & Ganapathy, S. (2023). Empirical Study of Human Capital and Its Influence on Business Performance. *Journal of Historical Research, 53*(1), 1-23. https://ssrn.com/abstract=4439903

Rodríguez-Castellanos, A., Ranguelov, S., & García-Merino, J. D. (2006). Intangible resources and value creation in firms: A review. In B. Kilsberg, & C. Mercado (Eds.), *Los límites de la responsabilidad social de la empresa. Responsabilidad social de la empresa, universidad y desarrollo* (pp. 489-496). Buenos Aires: Academia Europea de Dirección y Economía de la Empresa, Universidad de Buenos Aires y Universidad Rey Juan Carlos.

Štaffenová, N., & Kucharčíková, A. (2024). Human capital management – values, competencies, and motivation – concerning Industry 4.0. *Economic Research-Ekonomska Istraživanja, 37*(1), 1-22. https://doi.org/10.1080/1331677X.2024.2324160

Teece, D.J. (1998). Capturing Value from knowledge assets: the new economy, markets for know-how, and intangible assets. California Management Review, 40(3), 55-79.
DOI:10.1142/9789812796929_0002
Veselinović, N., Krstić, B., Rađenović, T. (2022). The impact of human capital value on human capital efficiency and business performance. Economics and Organization, 19(1), 13-26.
https://doi.org/10.22190/FUEO211118002V
Yang, C. Lin, C. (2009). Does intellectual capital mediate the relationship between HRM and organizational performance? Perspective of a healthcare industry in Taiwan. International Journal of Human Resource Management, 20(9), 1965-1984. https://doi.org/10.1080/09585190903142415

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

ADVANCING PRINCIPALS' HUMAN RIGHTS LEADERSHIP PRACTICES IN AN ERA OF DIGITAL TRANSFORMATION

Ngozi Blessing Enebe[1], & June Monica Palmer[2]
[1]*Professional Studies in Education, Edu-HRight, North-West University: Mahikeng Campus (South Africa)*
[2]*Professional Studies in Education, Edu-HRight, North-West University: Potchefstroom Campus (South Africa)*

Abstract

The rapid pace of digital revolution in education requires school principals to reconsider and adjust their methods of leadership. To handle the opportunities and difficulties presented by digital transformation, this study suggests a Human Rights Leadership (HRL) action toolkit for school principals. Digital technologies not only change the way education is managed and led, but it redefines the concepts of social justice, equality, and inclusion in educational settings. It is increasingly expected of principals to combine digital literacy with human rights competencies to establish learning environments that respect the rights of all learners and educators. The study emphasized human rights leadership practices necessary for promoting an inclusive learning, reducing digital divides, and guaranteeing that technological improvements benefit all learners. The Human Rights-Based Approach (HRBA) was used as the theoretical framework for this paper. We qualitatively analysed stipulations from *UNICEF's policy guide on children and digital connectivity* to show the nature and importance of human rights leadership practices in an era of digital transformation. The results demonstrated that in an era of digital change, *affordable access, protection from harm and privacy and identity* can be useful tools for advancing principals' human rights leadership practices which we propose in a human rights leadership action toolkit. By integrating digital innovation with human rights imperatives, the findings advance school principals' responsibilities as agents of educational and societal transformation and digital leadership. To promote human rights leadership in the digital age, this paper recommends that principals strive to be an agent of transformation to advance HRL in an era of digital transformation.

Keywords: *Digital transformation, human rights leadership, principals, toolkit, UNICEF.*

1. Introduction

Digital transformation is changing the educational landscape by integrating technologies such as cloud-based platforms, artificial intelligence and the Internet of Things (IoTs). These technologies improve individualised learning and promote global connectedness (UNESCO, 2021). However, the current issues with equity and inclusion are exacerbated by these technological changes. While schools with more resources are quick to adopt these advanced tools, a staggering 1.3 billion children aged 3-17 are without internet access in underprivileged areas, thereby threating the achievement of the United Nations Sustainable Development Goals (SDG 4) for inclusive education (United Nations, 2015). Given the foregoing, school principals face challenges in navigating a complex environment where the digital divide is worsened by socio-economic, geographic and gender disparities (Van Dijk, 2020). In addition, ethical issues such as data privacy breaches and biased AI systems pose a threat to learners' rights (Regan & Jesse, 2019; Williamson, 2017). Notably, the predominant school leadership practices are devoid of addressing human rights practices necessary for fostering digital transformation in schools. The lack of requisite human rights leadership skills could be associated with a disconnect between technological adoption and adherence to the principles that guides its ethical use (Ross, 2022). To bridge the identified gap, this paper drew on the *UNICEF's policy guide on children and digital connectivity* (2018) to propose a digital transformation toolkit for school principal in the era of digital transformation.

2. Literature review

2.1. Human Rights Leadership (HRL)

Human Rights Leadership (HRL) in education is a transformative approach rooted in social justice principles that empower school principals to advocate for learners' rights and ensure equitable access to

education (Robinson, 2023). It enables school principals to address systemic disparities and align school policies with the broader goals of educational equity (Dladla, 2020). HRL encompasses establishing a clear vision that prioritizes learners' rights and welfare thereby creating an environment where they feel heard and respected (National Council for Social Studies, 2021). This leadership model transcends the traditional educational management approach by emphasizing smooth interpersonal relationships practices (Smylie et al., 2016) promoting diversity and countering injustice (Stamaria & Stamaria, 2015). Additionally, it encompasses the development of responsive leadership practices (Naido, 2019) that equip school leaders to create a human right-informed atmosphere thereby contributing to a more equitable and socially just society.

2.2. Human rights leadership in an era of digital transformation

Given the cascading effects of school leadership on learning outcomes, the role of school leaders in the implementation of digital transformation is paramount as it entails the infusion of a computer-oriented approaches to learning into traditional teaching and learning processes (Karakose, et al., 2023; Maisyaroh, et. al., 2024). Scholarly evidence suggests that digital transformation may be associated with improved instructional delivery and increased learner digital nativity (Flores & Mean, 2025; Garcia-Penalvo, 2021). However, the rate of digital assimilation in the education sector varies across developing economies due to infrastructural deficits, government priorities and socio-economic disparities. Despite the associated benefits, adherence to human rights policy guidelines such as data privacy, equitable access and online safety remain a concern in these economies (Jogezai et al., 2023; Karakose et al., 2023). To mitigate these challenges, the adoption of a human rights-based approach to digital transformation could promote an agenda of inclusion, privacy protection and ethical data usage as well as the safeguard learners' rights (Flore & Mean, 2025; Maisyaroh, 2024).

2.3. UNICEF's policy guide on children and digital connectivity (2018)

To ensure equitable access and offer guidelines for adoption of digital technologies, *UNICEF's Guide on Children and Digital Connectivity* (2018) serves as a blueprint for the adaptable deployment of digital connectivity in schools. The guideline provides for safe, inclusive and equitable access to digital technology for learners. Specifically, the policy document addresses the potential risks and challenges associated with digital transformation in schools via its provision for protection against harmful content, violation of data privacy and disparities in access to digital resources (UNICEF, 2018). The policy document outlines six thematic areas that serve as blueprints for the deployment of digital literacy in schools. These areas include affordable access to digital skills, protection from harm, privacy and identity, business standards and government policy. Consistent with tenets of human right leadership, the *UNICEF policy guidelines on children and digital connectivity* (2018) serve as a framework for the deployment of digital literacy in schools. The provision of the guidelines suggests that its adoption would reduce digital divides among marginalized groups including female learners, learners with disabilities and those in rural schools. It would also enable school leaders to integrate digital literacy into the curriculum as well as develop robust data protection practices (UNICEF, 2018: 12-15). Ultimately, the adoption of these policy guidelines could serve as the basis for developing human rights leadership skills among school principals.

3. Theoretical framework

This study employs the human rights-based approach (HRBA). The goal of a HRBA is to make sure that human rights are actively incorporated into daily activities and decision-making, not only recognized in policies (Fitzgerald et al., 2020). In the era of digital transformation, school principals are advised to imbibe a HRBA to protect and defend the rights of learners for inclusivity, access and privacy in their daily involvement with digital devices. The Organisation for Economic Co-operation and Development (2024) posit that policies should be used to ensure that digital transformation remains human-centric and rights-oriented. A rights-based approached in a digital era is further emphasized by UNICEF (2018) which maintained that international standards and best practices must serve as the foundation for protective measures and safeguards, which must maintain a balance between protecting children's privacy and data and other rights. An application of the HRBA was thus relevant because policy requires school principals to consider how they can enact human rights leadership in the age of digital transformation.

4. Methodology

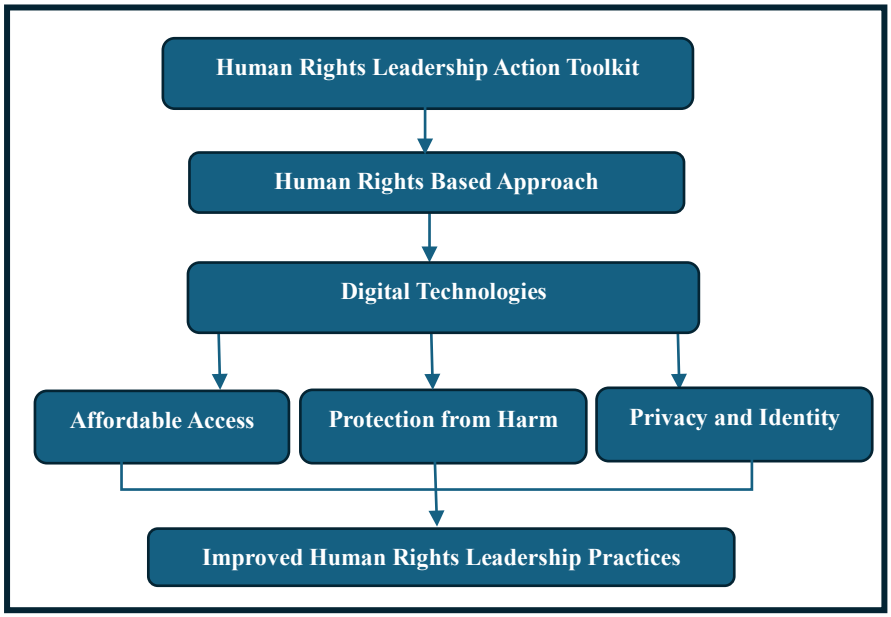
We adopted a qualitative approach in our study to explore the meaning of texts in the UNICEF (2018) *Guide on Children and Digital Connectivity* to advance principals' HRL in an era of digital transformation. A document analysis was conducted of selected texts within the Guide to interpret meanings

within to obtain a deeper understanding of a specific phenomenon or problem. Due to the consistency of the data, it is advantageous to analyse pre-existing texts as the data remains unchanged (Merriam & Tisdell, 2016). In using this method, pre-existing texts are critically examined to identify meaningful trends and insights (Morgan, 2022). Complementary to a qualitative approach, we applied a conceptual research design (CRD) which focuses on scrutinizing existing concepts from texts in policies and information already in the public domain (Heinonen & Gruen, 2024). We analysed texts in UNICEF's Policy Guide on Children and Digital Connectivity (2018) to understand new ways to advance principals' HRL in an era of digital transformation. First, we read the document to acquaint ourselves with relevant texts that have possible significance with principals' HRL in the era of digital transformation. Second, we reread and selected texts with the closest relationship and patterns with the phenomenon being studied. Third, the selected texts were coded to check their coherence and labelled with phrases that represent their content (Linneberg & Korsgaard, 2019). Afterwards, we identified three themes that strongly aligned with principals' HRL in the era of digital transformation, namely, affordable access, protection from harm and privacy and identity. We then employed thematic analysis to understand how the three selected texts communicate information of principals' human right leadership in a digital era.

5. Discussion

We propose a Human Rights Leadership Action toolkit (HRLAT) that can contribute to advancing principals' HRL in an era of digital transformation (Figure 1).

Figure 1. Human rights leadership action toolkit (HRLAT).



5.1. Affordable access

According to UNICEF (2018) *"affordable access is defined as the availability of digital devices and internet connectivity at a rate that enables all children irrespective of their socioeconomic background, to use them effectively for communication, learning and engagement in the digital world"* (p. 9). Although the Universal Declaration of Human Rights does not specifically list internet and digital access as a human right, it is acknowledged that these resources are necessary for the exercise of other fundamental rights, including freedom of speech and right to information (Malatsi, 2025). In South Africa, the constitution emphasizes the importance of access to information and freedom of expression (RSA, 1996). As a result, principals can further their HRL by fostering digital literacy and guaranteeing all learners and teachers have fair access to digital resources. Hamzah et al., (2021) contends that this entails offering professional development, encouraging an innovative culture and using data to guide decisions on digital integration. More so, principals promote HRL by advocating for policies that make digital devices and internet accessible, prioritizing digital training and fostering partnership to mitigate digital divide (OECD, 2022). In sum, affordable access to internet and digital devices are thus relevant for advancing principals' HRL as it would foster freedom of speech and right to information. These are fundamental human rights critical to address digital divides and guarantee fair access to technology.

5.2. Protection from Harm

UNICEF (2018) advised that principals should use their leadership *"to address online risks, vulnerability and harm"* (p. 17). Protecting learners from harm in the era of digital transformation necessitates a multifaceted strategy that emphasizes digital literacy, appropriate online conduct, and strong reporting and support mechanisms. Teaching children about online safety, privacy, and moral behaviour should be a top priority for school principals who should also set up explicit procedures for reporting instances of abuse (UNICEF, 2023). Protecting learners in school is an act of defending their human rights. This could be championed by guaranteeing a secure and welcoming learning environment free from abuse and discrimination, premised on equality and inclusion. The South African Human Rights Commission [SAHRC], (2012) discloses that protecting learners from online abuse and discrimination entails safeguarding their rights to equality, safety and non-discrimination which culminates as educational rights of learners. Further, the South African Constitution and SAHRC placed a significant interest in protecting learners from every form of harm (including in the use of digital devices) and always emphasized learners' interest. This involves defending learners' access, privacy and ensuring that abusive contents were properly reported (RSA, 1996; SAHRC, 2012). In this regard, principals' HRL can be advanced when they protect learners and educators from online abuse, discrimination and harm, while ensuring digital literacy and ethical online conduct.

5.3. Privacy and identity

The constant changes in the age of digital transformation requires school principals to search for *"appropriate strategies to avoid risks and seek support when needed"* (UNICEF, 2018, p. 13) so that individuals' privacy can be protected. Privacy and identity are pertinent safety measures to be considered when making use of digital devices as they could have a direct impact on users' safety, autonomy, and human dignity particularly for younger learners and other vulnerable populations (UNICEF, 2018). Notably, privacy and identity are fundamental human rights enshrined in the Universal Declaration of Human Right (United Nation, 1948) as freedom of expression and thinking depends on people being able to manage their personal information and choose how it is shared. Moreover, accessing services, exercising rights, and guaranteeing legal protection all depend on having a distinct and identifiable identity. In the South African context, the enactment of the constitutional rights to privacy and identity in the digital age are seen in the "Protection of Personal Information Act [POPIA]" and "Regulation of Interception of Communications and Provision of Communication-Related Information Act [RICA]" (RSA, 1996; Staunton, 2020) which points to the profound attention given to the exercise of human rights. Therefore, to advance school principals' HRL in the fast-growing digital world, a grasp of privacy and identity as fundamental human rights should be upheld to ensure dignity, safety and autonomy of learners.

6. Conclusion

This study advances our understanding of human rights leadership in the context of digital transformation in education. This study highlights the challenging role of school principals in navigating digital transformation in schools while upholding human rights principles. To overcome these hurdles the study proposes a human rights leadership action toolkit (HRLAT) as a framework for principals to advance human rights leadership practices during digital integration. Underpinned by the provisions of UNICEF's policy guideline on children and digital connectivity 2018, the toolkit also addresses some of the challenges associated with the implementation of digital transformation in schools. This study contributes to the ongoing debate on best practices regarding human rights leadership in schools. Given the conceptual nature of the study, future research could focus on conducting empirical and longitudinal studies to assess its practicality and the long-term efficacy of the proposed toolkit.

References

Dladla, T. (2020). *Exploring ethical leadership practices in challenging township school contexts: A multiple case study* (Doctoral dissertation, University of KwaZulu-Natal, Edgewood).

Fitzgerald, S., Behan, L., McCarthy, S., Weir, L., O'Rourke, N., & Flynn, R. (2020). Translating a Human Rights-based Approach into Health and Social Care Practice. *Journal of Social Care*, *3*(1), 3-17.

Flores, E., & Mean, U. (2025). Digital transformation in Cambodian higher education: Current trends and future directions. *Edelweiss Applied Science and Technology*, *9*(1), 867-878. https://doi.org/10.55214/25768484.v9i1.4267

García-Peñalvo, F. J. (2021). Avoiding the Dark Side of Digital Transformation in Teaching. An Institutional Reference Framework for eLearning in Higher Education. *Sustainability*, *13*(4), 20-38. https://doi.org/10.3390/su13042023

Hamzah, N., Nasir, M. & Wahab, J. (2021). The Effects of Principals' Digital Leadership on Teachers' Digital Teaching during the Covid-19 Pandemic in Malaysia. *Journal of Education and e-Learning Research, 8*(2), 216-221. https://doi.org/10.20448/journal.509.2021.82.216.221

Heinonen, K., & Gruen, T. (2024). Elevating conceptual research: Insights, approaches, and support. *Academy of Marketing Science Review, 14*(2), 1-6. https://doi.org/10.1007/s13162-024-00283-9

Jogezai, N. A., Baloch, F. A., & Koroleva, D. (2023). Teachers' digital competence in the post COVID-19 era: The effects of digital nativeness, and digital leadership capital. *Contemporary Educational Technology*, *15*(4), 450-466. https://doi.org/10.30935/cedtech/13620

Karakose, T., Tülübaş, T., Polat, H., Demirkol, M., Yirci, R., & Ozdemir, T. Y. (2023). A Conversation with ChatGPT about Digital Leadership and Technology Integration: Comparative Analysis Based on Human–AI Collaboration. *Administrative Sciences*, *13*(7), 157-172. https://doi.org/10.3390/admsci13070157

Linneberg, M. S., & Korsgaard, S. (2019). Coding qualitative data: a synthesis to guide the novice. *Qualitative Research Journal*, *19*(3). 259-270. https://doi.org/10.1108/QRJ-12-2018-0012

Maisyaroh, M., Juharyanto, J., Wiyono, B. B., Nawi, A. M., Adha, M. A., & Lesmana, I. (2024). Unveiling the nexus of leadership, culture, learning independence, passion trend-based learning, and teacher creativity in shaping digital student skills. *Social Sciences & Humanities Open*, *9*(3), 100-116. https://doi.org/10.1016/j.ssaho.2024.100884

Malatsi, S. (2025, March 25). *OPINION | Affordable digital connectivity for all a fundamental human right*. SowetanLIVE. https://www.sowetanlive.co.za/opinion/2025-03-25-opinion-affordable-digital-connectivity-for-all-a-fundamental-human-right/

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey Bass.

Morgan, H. (2022). Conducting a Qualitative Document Analysis. *The Qualitative Report, 3*(1) 1-16. https://doi.org/10.46743/2160-3715/2022.5044

Naido, P. (2019). Perceptions of teachers and school management teams of the leadership roles of public school principals. *South African Journal of Education*, *39*(2), 1-14. https://doi.org/10.15700/saje.v39n2a1534

Organisation for Economic Co-operation and Development [OECD]. (2022). Rights in the digital age: Challenges and ways forward. https://www.oecd.org/content/dam/oecd/en/publications/reports/2022/12/rights-in-the-digital-age_d3a850de/deb707a8-en.pdf

Organisation for Economic Co-operation and Development [OECD]. (2024). Shaping a rights-oriented digital transformation // OECD Digital Economy Papers. https://doi.org/10.1787/86ee84e2-en

Regan, P. M., & Jesse, J. (2019). Ethical challenges of edtech, big data, and personalized learning: Twenty-first century student sorting and tracking. *Ethics and Information Technology, 21*(3), 167-179. https://doi.org/10.1007/s10676-018-9492-2

Republic of South Africa [RSA]. (1996). *Statutes of the Republic of South Africa-constitutional law constitution of the Republic of South Africa.* https://www.gov.za/sites/default/files/images/a108-96.pdf

Robinson, R. (2023). *Centering Human Rights Through a Whole School Approach*. Retrieved from https://rfkhumanrights.org/our-voices/centering-human-rights-through-a-whole-school-approach/

Ross, J. (2022). *Digital futures for learning: Speculative methods and pedagogies*. Routledge.

Santamaría, L. J., & Santamaría, A. P. (2015). Counteracting Educational Injustice with Applied Critical Leadership: Culturally Responsive Practices Promoting Sustainable Change. *International Journal of Multicultural Education*, *17*(1), 22. https://doi.org/10.18251/ijme.v17i1.1013

South African Human Rights Commission (2012). *PAIA manual report 2011/12*. Available at: http://www.sahrc.org.za/home/21/file/PAIA%Annual%20Report%20201112.pdf

Smylie, M. A., Louis, K. S., & Murphy, J. (2016). Caring School Leadership: A MultiDisciplinary, Cross-Occupational Model. *American Journal of Education*, *123*(1), 1-35. https://doi.org/10.1086/688166

Staunton, C., Adams, R., Anderson, D., Croxton, T., Kamuya, D., Munene, M. & Swanepoel, C. (2020). Protection of Personal Information Act 2013 and data protection for health research in South Africa, *International Data Privacy Law, 10*(2), 160-179. https://doi.org/10.1093/idpl/ipz024

UNESCO. (2021). *AI and education: Guidance for policy-makers*. Paris: UNESCO.

UNICEF (2023). *Child protection in digital education*. New York: UNICEF.

UNICEF. (2018). *Policy guide on children and digital connectivity*. New York: UNICEF.

United Nations. (1948). *Universal declaration of human rights*. https://www.justice.gov.za/vc/docs/international/UN%20Human%20Rights.pdf

United Nations. (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. http://bit.ly/TransformAgendaSDG-pdf

Van Dijk, J. (2020). *The digital divide*. John Wiley & Sons.

Williamson, B. (2017). *Big data in education: The digital future of learning, policy, and practice*. SAGE.

DEVELOPMENT OF STUDENT HEALTH MANAGEMENT – THE UNIVERSITY AS A SETTING FOR MENTAL HEALTH LITERACY PROMOTION

Natalie Banek*, Janine Michele, & Ariane Steuber***
Institute of Vocational Education and Adult Education, Leibniz University of Hannover (Germany)
**Dr., ** M. A.*

Abstract

The general state of health of students deteriorated significantly between 2015 and 2023. Due to the extensive change processes in the German higher education system, e.g., the Bologna reform, but also internationalization and digitalization processes, the perception of complexity and stress as well as emotional exhaustion among students have increased significantly. This is reflected in a significant increase in mental illness. The contribution presents the university's project "Mindful Campus" (MinCa), which aims to promote mental health literacy (MHL) among students of the vocational teaching profession and to establish student health management (SHM) at the university. At the beginning of MinCa, the overarching question is how organizational university structures can contribute to supporting the individual learning of MHL and enabling the integration of health literacy promotion into the curricula in order to establish an SHM at the university, analogous to existing occupational health management. In the long term, the project aims to expand the current internal structures beyond the institutes and central university facilities involved in health promotion. In order to enable a sustainable continuation of the pedagogical content to promote students' MHL, MinCa aims to expand curricularly defined modules in the medium and long term. This is linked to the objective of a permanently embedded micro degree in MHL across degree courses. A micro degree is composed of several micro credentials, which are smaller learning units that can be taken flexibly and are designed to be competence-oriented. In addition to strengthening students' individual MHL, it is also necessary for universities as educational institutions to become aware of their responsibility for the development of a health-promoting environment, to recognize the effects of crises and disadvantages within their organizational structures and to take them into account by designing their university culture in a correspondingly responsive manner. As a result, universities increasingly see themselves as actors in health promotion and anchor the associated values in their self-image, e.g. in the form of an SHM. The aim of the SHM is to create a health-promoting university environment for all students and to systematically implement and sustainably integrate it into the university structures. This contribution therefore examines the question how supporting the individual development of mental health of students can contribute to developing a participatory approach to enable the integration of MHL into the curricula in order to establish a sustainable SHM.

Keywords: *Health promotion, mental health literacy, student health management, micro degree.*

1. Mental health (literacy) of the students

The general state of health of students has deteriorated significantly between 2015 and 2023, which is due to an increase in stress and strain among students and which has led to a significant overall increase in mental illness (Techniker Krankenkasse [TK], 2023). The increased emotional stress of students should be seen as a warning signal for burn-out and other mental illnesses and therefore as a central problem (TK, 2023). In addition to the extensive change processes in the German higher education system, e.g. the Bologna reform, but also increasing internationalization and digitalization processes, as well as study-related factors, such as examination pressure, competition and student financing, social and political phenomena, such as the COVID-19 pandemic, the global climate crisis or the Middle East conflict, are also having an increasing impact on the perception of complexity and stress as well as emotional exhaustion and thus on the psychosocial stress of students (Brock et al., 2024). Further challenges can arise due to intersectional health inequalities and inequities in the university context, as various socio-structural characteristics such as disabilities, chronic illnesses, immigration background, sexual orientation or care

responsibilities, e.g., childcare or caring for relatives, can influence the development and maintenance of mental health (Brock et al., 2024). In this way, a conglomerate of challenges can arise for affected students that is usually invisible to the outside world and can have a negative impact on their ability to study (Banek, Gillen, Michele, & Steuber, 2025). This initial situation results in a growing need for individual mental health literacy (MHL) and for a structurally anchored, university-wide Student Health Management (SHM) similar to the existing Occupational Health Management at Leibniz University Hannover (LUH). A sustainably anchored SHM aims to systematically promote the health of students and strengthen their health-related resources (Brock et al., 2024; Kompetenzzentrum Gesundheitsfördernde Hochschulen, 2024). The overarching question of this article is therefore how organizational university structures can contribute on a curricular and structural level to promoting the individual development of students' MHL. The aim of the article is to use the example of the participatory project "Mindful Campus - Promoting mental health literacy among students" (MinCa) to show how the university setting can be a decisive factor in promoting students' MHL and developing an SHM. On the one hand, the focus is on the setting approach and, on the other, on the consolidation of individual curricular MHL support through a micro degree in "Mental Health Literacy".

2. Project mindful campus

The MinCa project, funded for two years by the TK, a German health insurance, has been piloted at LUH since January 2025 in the area of teaching at vocational schools. The overarching objective of the project is to develop a participatory concept and strategy to establish a SHM to promote MHL among students through measures at curricular and structural university level. At the beginning of the project, the overarching questions are how individual development of MHL can be supported, how the integration of health literacy promotion into the curricula can be made possible, and how organizational university structures can contribute to the establishment of an SHM at LUH in this way. In the long term, MinCa aims to expand the university's internal structures in terms of a health literacy-promoting university health management approach beyond the institutes and central facilities at LUH that have been involved in health promotion to date.

The basis for this is a salutogenetic understanding of health, which is detached from the normative concept of being healthy, in which health is understood as a continuum. Analogous to this understanding of health, physical, psychological and social factors are included as conditions of origin and development factors for the individual state of health (Antonovsky, 1991). In this way, the promotion of MHL can develop constructive mechanisms for coping with stress as well as the cognitive, social and motivational abilities and skills of an individual that help them to independently access health-related information that contributes to coping with illness, disease prevention and/or health promotion (Sørensen et al., 2012).

2.1. Participation as a research approach

MinCa pursues a participatory research approach that aims both to develop individual MHL among students and to structurally consolidate an overarching SHM. Participation is understood as the individual or collective involvement of people in health-related decisions for their lives in the narrower sense (Wihofszky, Hartung, & Narimani, 2020). For this reason, close involvement of students as co-researchers in all research-theoretical and operational decision-making processes is essential. As part of an initial needs analysis by MinCa, students were involved in a first step in the form of an exploratory workshop and then qualitative, problem-centered interviews were conducted with other students from various departments at LUH. The student assistants were involved in the evaluation of the interviews as well as in the curricular design of the seminars on MHL content. The student assistants are also involved in the regular steering group meetings of the SHM to be developed, alongside the relevant LUH employees, as well as in the other MHL offerings organized as part of the project, such as the training for mental health first aiders and the LUH health week organized in cooperation with the occupational health management.

2.2. University as health actor

Against the backdrop of the Okanagan Charter (2015), universities have recently come to understand their responsibility as active shapers and actors of health-promoting environments. As a result, they are anchoring the corresponding values in their self-image, e.g., in the form of an SHM (Brock et al., 2024). The aim of the SHM is to create a health-promoting university environment for all students and to strengthen students' individual health resources. It is advisable to systematically implement SHM and integrate it sustainably into university structures (Kompetenzzentrum Gesundheitsfördernde Hochschulen, 2024). The setting approach focuses on health literacy promotion in people's actual living environment and thus addresses both the framework conditions and personal behavior. This makes it the core strategy of health promotion and networking its most important development tool at universities (TK, 2020). Against

this background, the university is understood as a socio-spatial system in which health-promoting measures and processes are implemented in both working and learning contexts. Especially since the amendment of the Prevention Act in 2015, this approach has been increasingly taken up by universities, thus emphasizing the relevance of concrete measures and focused structural development in the university context.

2.3. Project goals and actions at curricular and structural level

The core goals and actions of MinCa can be divided into medium and long-term. These include both the promotion of individual MHL and the anchoring of health-related content in the curriculum, as well as the development of an SHM and networking within and outside the university and, finally, the consolidation of the offerings as part of a micro degree in "Mental Health Literacy". On this basis, a curricular and structural plan of actions was developed that enables the promotion of MHL at LUH on an individual and organizational level.

2.3.1. Curricular level. MinCa is currently guided by the overarching question of how the organizational structures of the LUH can contribute to supporting students in their individual learning of MHL. To this end, various content-related offerings to promote MHL among vocational teacher training students were designed at curricular level with the help of the university didactic approach of innovative forms of teaching and learning and initially piloted at the Institute of Vocational Education and Adult Education. In further steps, these curricular, individual offers will be extended to other subject areas. In order to enable a sustainable continuation of the pedagogical content to promote students' MHL, MinCa is aiming to expand the curricular modules in the long term. In order to make these modules certifiable, a general LUH-wide micro degree system is currently being developed. This will enable the introduction of a micro degree not only in the vocational teaching profession for MHL, but also in other subject areas such as natural sciences for other content. The corresponding preparatory work, e.g. the necessary LUH-wide structural and organizational changes, is currently being carried out. A micro degree is made up of several micro credentials, i.e. smaller course units with 5 credit points (CP) each, which are designed to be competence-oriented and can be taken flexibly by students from all subject areas. The long-term goal is a permanently embedded additional certificate in form of a micro degree in MHL with 30 CP, which can be taken across all degree programs at LUH.

2.3.2. Structural level. In addition to the individual promotion of students' MHL at a curricular level, universities have recently become increasingly aware of their responsibility as educational institutions for the development of a health-promoting environment. Accordingly, MinCa at LUH has set itself the long-term goal of recognizing the effects of crises and disadvantages within its organizational structures and taking them into account by designing its university culture in a correspondingly responsive manner. As a result, LUH increasingly sees itself as an actor in health promotion, which leads to the associated values being anchored in its self-image and becoming visible in the form of a newly established SHM analogous to the existing occupational health management at LUH. The aim of the SHM, analogous to the setting approach, is to create a health-promoting university environment for everyone by expanding the existing internal structures beyond the institutes and central university health promotion facilities. This includes systematic implementation and sustainable integration of the services into the university structures. As a further measure at a structural level, a steering committee was formed to coordinate and strategically develop the various activities to promote health literacy at LUH under the leadership of the Center for University Sports. The steering committee, which consists of representatives of LUH's internal health stakeholders, two student assistants and the responsible university advisors from TK, will continue to work on the development of the SHM throughout the duration of the project and – in cooperation with the occupational health management – on the development of a university health management in the long term. In this way, it enables the use of synergies of existing measures and initiatives of university facilities and institutions.

Further project measures include cross-institutional, internal networking as well as cross-university, external networking, e.g., since August 2024 as part of the membership of the *Healthy Universities North* network, as well as accompanying research and evaluation on the topic of MHL.

3. Methods

In a first step, ten qualitative, semi-structured and problem-centered interviews were conducted with students according to Witzel (2000) for the needs analysis. In addition to advertising via a news tile on the LUH homepage and via social media, in particular the LUH Instagram channel, advertising flyers were developed to select interview partners via the snowball system, providing information about the

project and calling for participation in the interviews. The flyers were distributed on campus in the current *Zeit Campus Mental Health* 2024 and 2025 magazines.

The core objective of the interviews with the students was to identify content-related and structural factors that influence the subjective mental health perception of students in their living environment and thus in the university setting at LUH. The interviews conducted were then transcribed and analyzed using the thematic coding method according to Flick (2017).

In a next step, the course coordinators involved in the vocational teaching degree program were also included in the needs assessment in the form of a problem-centered survey in order to gain the perspective of those actors who are primarily involved in advising students. Furthermore, additional interviews were conducted with doctoral students in order to supplement the resulting needs analysis with the needs of doctoral students.

4. Discussion

Initial findings from the needs analysis interviews include requirements and needs, such as the need for individual, curricular and organizational support and structural integration of students, as well as perceived study-related stress factors. The initial insights gained from this needs analysis are incorporated into the curricular development of the MHL offerings so that they can be continuously developed and adapted to the current needs of students. As a result of the need for low-threshold counselling services frequently expressed in the interviews, for example, training was organized for mental health first aiders, in which various LUH employees and student assistants are trained to support students as the first point of contact in mental and psychological crisis situations. A central element of MinCa is the curricular innovation of the micro degree “Mental Health Literacy”, which is composed of flexibly assignable, competence-oriented micro credentials. This enables LUH students to follow individual learning paths in the field of MHL. The aim is to establish the course across all degree programs at LUH and to open it up to further education and training, e.g. for teachers, in line with the third mission concept. MinCa thus offers great social potential through the promotion of MHL both at the individual level of LUH students and at the organizational-structural level of LUH in the form of the SHM or even an LUH-wide university health management and thus a high level of sustainability through the structural anchoring of the offerings. Other universities, such as Osnabrück and Bochum, have already recognized the need to promote MHL and have established their services with the “Health Campus Osnabrück” and the SHM Bochum and anchored them sustainably in the organizational structures of the universities.

The high complexity of implementation, which requires good coordination of all LUH stakeholders, is addressed by the established steering committee. The changing student body and the constantly changing conditions at the university are challenges for long-term impact measurement, just as scalability and transferability to other international universities is still open. However, the European Commission has already adopted a recommendation on a “European approach to micro credentials for lifelong learning and employability” (The Council of the European Union [EU Council], 2022) in 2022. This aims to ensure “quality, transparency, cross-border comparability, recognition and transferability” of micro-credentials, as an “effective culture of lifelong learning [...] is key to ensuring that all people have the knowledge, skills and competences they need to succeed in society, in the labor market and in their personal lives” (EU Council, 2022).

5. Conclusions

Universities need to live up to their responsibility to create a health-promoting environment. The MinCa project is pursuing this goal at LUH through a combination of individual support for MHL, curricular integration, structural development of an SHM and the development of an innovative micro degree system. In the long term, this can help to prevent students from dropping out, reduce mental stress and improve student health. Based on the sustainable curricular integration and innovative structure of the micro credentials and the micro degree, in combination with the topic of participative, student MHL and its management at institutional level in the form of a SHM within the framework of the setting approach, a current topic is created that has a high social and practical relevance. In this way, MinCa also addresses current social and political issues, such as the shortage of teaching staff and skilled workers, for example by providing individual support for MHL to prevent students from dropping out of their studies (Wyrwal & Zinn, 2018). The concrete added value of MinCa therefore lies in the short term in the promotion of students' individual MHL, in the medium term in the representation of interests at an organizational-structural level in the form of the SHM and in the long term in the form of the continuation of the offerings via the micro degree “Mental Health Literacy” both LUH-wide for all students and in the form of further and continuing education within the framework of the third mission, analogous to the general demand for lifelong learning and lasting employability.

References

Antonovsky, A. (1991). Meine Odyssee als Stressforscher. Jahrbuch für kritische Medizin. *Argument Sonderband, 193*, 112-130.

Banek, N., Gillen, J., Michele, J., & Steuber, A. (2025). Mentale Gesundheit von Studierenden – die Hochschule als Setting für Gesundheitskompetenzförderung. In R. Meyer & S. Hiestand (Eds.), *Lernen im Prozess der Arbeit* (pp. 51-53). Bielefeld: EUSL bei wbv Publikation.

Brock, T., Einig, N. N., Gostmann, N. N., Hildermeier, L., Özden, N. N., Schuhr, N. N., Steffens, N. N., & Basner, T. (2024). Blickpunkt: Student Mental Health im digitalen Hochschulstudium. Handlungsempfehlungen für die Lehr- und Hochschulgestaltung. *Hochschulforum Digitalisierung.* Retrieved April 18, 2025, from https://hochschulforumdigitalisierung.de/wp-content/uploads/2024/07/HFD-Blickpunkt_Student-Mental-Health-im-digitalen-Hochschulstudium.pdf

The Council of the European Union (EU Council) (2022). *Council Recommendation of 16 June 2022 on a European approach to micro-credentials for lifelong learning and employability* (2022/C 243/02). Retrieved April 18, 2025, from: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32022H0627(02)

Flick, U. (2017). *Qualitative Sozialforschung. Eine Einführung*[8]. Reinbeck bei Hamburg: Rowohlt.

Kompetenzzentrum Gesundheitsfördernde Hochschulen (2024). *Studentisches Gesundheitsmanagement.* Retrieved April 18, 2025, from https://www.kompetenzzentrum-gesunde-hochschulen.de/studentisches-gesundheitsmanagement

Okanagan Charter (2015). *An International Charter for Health Promoting Universities and Colleges*. Retrieved April 18, 2025, from https://xn--gesundheitsfrdernde-hochschulen-idd.aau.at/wp-content/uploads/2021/07/Okanagan-Charta-2018-DE.pdf

Sørensen, K. et al. (HLS-EU). Consortium Health Literacy Project European (2012). Health literacy and public health: A systematic review and integration of definitions and models. *BMC Public Health Ausgabe, 12*, 80. https://doi.org/10.1186/1471-2458-12-80

Techniker Krankenkasse (2020). *Gesundheitsförderung an Hochschulen.* Retrieved April 18, 2025, from https://www.tk.de/resource/blob/2096542/1d075e15516172ff8321c34b72d539e2/201103barrierefrei-tk-gfanhs-data.pdf

Techniker Krankenkasse (2023). *Gesundheitsreport 2023. Wie geht's Deutschlands Studierenden.* Retrieved April 18, 2025, from https://www.tk.de/resource/blob/2149886/e5bb2564c786aedb3979588fe64a8f39/2023-tk-gesundheitsreport-data.pdf

Wihofszky, P., Hartung, S., & Narimani, P. (2020). Ethische Reflexion in der Gesundheitsförderung: Partizipation und Partizipative Gesundheitsforschung. In A. Riedel, & S. Lehmeyer (Eds.), *Ethik im Gesundheitswesen.* Springer Reference Pflege – Therapie – Gesundheit. Berlin: Springer. https://doi.org/10.1007/978-3-662-58685-3_89-1

Witzel, A. (2000). Das problemzentrierte Interview. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research, 1*(1), 22, 1-13. https://doi.org/10.1007/978-3-8349-9441-7_29

Wyrwal, M., & Zinn, B. (2018). Vorbildung, Studienmotivation und Gründe eines Studienabbruchs von Studierenden im Lehramt an berufsbildenden Schulen. *Journal of Technical Education, 6*(2), 9-23. https://doi.org/10.48513/joted.v6i2.127

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

THE TRAINER PROFILE IN INCLUSIVE EDUCATION (EXAMPLES FROM BULGARIAN EDUCATION SYSTEM)

Vanya Dobreva
Department "Culture, historical heritage and tourism", ULSIT/ Sofia (Bulgaria)

Abstract

One of the main issues for the development of inclusive education is related to the training and qualification of the teacher/trainer. Examples from the Bulgarian education system show that inclusive education has yet to be analysed and rethought in the light of the new role of the teacher in the implementation of his/her tasks. In the Preschool and School Education Act, adopted in Bulgaria in 2016, the topic of inclusive education receives its initial treatment. Additionally, another normative document specifies the principles of inclusive education through the introduction of a state standard. If in theoretical terms the term "inclusive education" does not raise any particular objections, in practice - at least in Bulgaria - there are a number of unresolved issues. Alongside the understanding of how to form a natural school environment that is inclusive of every student, regardless of their social or ethnic background, the law introduces the obligation to educate children with varying degrees of health problems - mild but also severe illnesses - in mainstream schools. This reflects on a change in the meaning of the figure of the teacher, the new sense of value in the realization of his educational role, as well as on the actualization of historical experience and good practices, affirming the new character of inclusive education. In this context, and the revival of humanities knowledge as a basis for the formation of empathy, moral and value orientations.

Keywords: *Inclusive education, trainer, education, humanities, culture.*

1. Introduction

In recent decades, the education system has begun to interpret in terms of societal inequalities. Data from global organisations such as UNESCO, for example, show that inequalities are now profoundly affecting various aspects of human life. There are growing economic and social disparities between different parts of the planet, between different regions, between developed cities and lagging small settlements, and so on. Inequalities extend to people's health status, gender and religious identity, ethno-cultural characteristics (UNESCO, 2025).

2. Inclusive education: General conditions

Statistical data show that the existing environment of inequalities reflects on the formation of the personality, deeply affecting its future possibilities for realization. In search of a solution to the problem of social inequalities in the 20th and early 21st centuries, a number of philosophers updated the Enlightenment view of the determining importance of the environment in shaping the individual, deducing in accordance with modern realities the importance of its cardinal change - transformation from an environment that isolates differences into an environment that includes every individual (Foucault, 2016).

In the first decade of the 21st century, these concepts of inclusive environments began to be more closely linked to educational guidelines. The view was substantiated that the school also creates a micromodel of a social environment of peers, which should not reject, but include children and students of the same age, regardless of their social, mental, intellectual, health, ethnic, religious conditions. Thus, the concept of the new role of education in the 21st century as inclusive education was formed: the individual is given the opportunity, even in his early years, to socialize in the natural environment of his peers in order to reveal the potential inherent in him (Ainscow et al., 2006).

In some studies, a distinction is made between the understanding of education in the 20th century – mainly integrative, and the understanding of education in the 21st century – inclusive. In the first case – integrative education is a process in which conditions are created for the individual to adapt to the school and its various forms. In inclusive education, by definition, an equal environment is created that includes the individual, developing his/her strengths. (Baksanskii, & Safonicheva, 2015).

The question of the profile of the teacher/trainer in inclusive education is relevant. According to general statements, this teacher should possess both solid theoretical scientific competence and be endowed with additional qualities such as understanding and empathy for students, a psychological sense of a way out of conflict situations, as well as an approach to encouraging students. (Todorova, 2020) Among the skills that the teacher in inclusive education must form is mastering knowledge of how to assess and diagnose the abilities of students. And also how the teacher can direct each of his students to those specialists - psychologists, speech therapists, social workers, etc., who will solve the issue of identified deficits in the student's behavior/knowledge (Lozanova, 2023).

Therefore, the teacher in inclusive education does not work alone, but in an interdisciplinary team of other specialists. This team, thanks to the competencies of individual specialists, has the task of solving individual problems of students, overcoming obstacles of a personal and social nature (Stancheva, 2021). Since inclusive education refers to the inclusion of children and students with health problems in the traditional school environment, the teacher must also have the ability to work with medical specialists, who should also be involved as part of the team for the personal development of the individual child or student.

3. Aspects of the Bulgarian education system: Historical experience and contemporary challenges

Examples from the Bulgarian education system attest that the educational policy in Bulgaria is aimed at providing quality education for every student, regardless of their social, religious, or ethnic status. And this is a practice that has been established in the Bulgarian environment since the founding of secular education in 1835.

For historical reasons, Bulgarian society as a social construct has been egalitarian since the 19th century. This is the reason why education is perceived as an equal opportunity for all Bulgarians – boys and girls – to acquire secular knowledge in order to develop themselves as individuals. After the liberation of Bulgaria in 1878 and the development of the independent state, education has preserved its public character, distinguished by general accessibility and equal conditions for the education of children and students. The public character of education in Bulgaria is expressed in the establishment of the mass public school, which is state-run and integrates students, regardless of their social, ethnic or religious affiliation. As for children and students with health problems, specialized schools are beginning to be built for them. However, there are also practices, albeit sporadic, of isolating children with special needs from direct contact with other students. (Mincheva, 2019).

3.1. Historical aspects in the development of Bulgarian education

A strong impetus for the development of educational processes was given in the second half of the 20th century, a period of building the industrialized Bulgarian state, defined as a welfare state. The school network was expanded, schools were opened in every Bulgarian village - general education and/or vocational, related to the regional economic situation. Additionally, an educational policy was implemented that improved the traditions of general education and vocational schools. In just a few decades, illiteracy was completely eliminated, and in a number of reports by UNESCO from the 80s and 90s, Bulgaria was given as an example of a well-implemented cultural and educational policy and a successfully developed educational system.

Within certain parameters, it can be said that during this period an accessible educational environment was established, which played a significant socializing role. It is expressed, first of all, in the conceptualization of education primarily in terms of educational tasks, related also to the formation of values such as industriousness, solidarity, patriotism, socialist belonging. In connection with this and the emphasis that education in Bulgaria places on the development of humanitarian knowledge and culture (Atanasov, 1984).

From the point of view of historical experience, Bulgarian education developed a wide network of schools in the second half of the 20th century. In the general education school, additional extracurricular forms of work with students – the clubs – were also formed. Competition between individual schools was also stimulated through the competitive principle: each school worked on various cultural events – performances, concerts, sports competitions, etc. Schools for gifted pupils are also established: music and art schools, as well as schools for pupils with outstanding sporting abilities (Simeonov, 2025).

As an organic part of Bulgarian education, the system of vocational education is also developing, crystallized in a variety of school types - specialized vocational training, technical school and vocational school. The specificity of this type of training lies in the mastery of a type of profession, or of a part of a profession. In current terms, vocational education develops competencies and skills appropriate to the economic environment (Chavdarova, 1996).

In the 20th century, specialized schools for children with health problems were established. In the capital city of Sofia, a special school for visually impaired and hearing impaired students is still successfully functioning (**Special** school for visually impaired students). Here, specialized programs for the education of students were developed and implemented, which through preliminary diagnosis determined the stages of individual development of each child and each student. And other schools for children and students with severe health problems were established in the decades of the 20th century in Bulgaria. Many of them also operated as boarding schools. These children are mainly cared for by medical professionals, in parallel with pedagogues, as far as the condition of the pupils allows to reach a certain educational level.

An essential part of the educational policy in the 19th and 20th centuries in Bulgaria was related to the training of teachers, both the formation of sustainable theoretical-scientific knowledge, but also the acquisition of pedagogical skills, conditioning their educational role. Teacher training also corresponds to the educational situation: for the different levels of education, teachers receive different training: for primary (grades 1-4) and junior secondary (grades 5-7) education, teachers with a high school education and pedagogical qualifications are appointed, while teachers with higher education, some of them assistants in higher education institutions, work in secondary schools (grades 8-12).

The requirements for teachers in schools for gifted children are, along with teachers in general education, to appoint teachers with specialized skills characteristic of the school's profile - very often these are prominent musicians, artists or athletes. The same is the requirement for teachers in vocational schools - here too, along with teachers in general education disciplines, teachers with knowledge and training in individual professions, special for the respective school, are appointed. Therefore, the figure of the teacher - at least the Bulgarian experience shows this - has been a fundamental factor in the development of education and the formation of the individual for decades.

Teacher training, for the most part, is also related to the acquisition of humanitarian knowledge, which further stimulates the teacher's values and cultural profile.

3.2. Contemporary aspects of the education system: the practice of inclusive education

The current state of education in Bulgaria reflects the societal processes that occurred after the changes in 1989, when the country began a new period of development. There are several significant changes. First of all, vocational education began to lose its specific features: only one type of vocational school was established - vocational high schools, which today do not enjoy much public prestige. Secondly, boarding schools for children and pupils with health problems of varying severity are being closed, and these children and pupils are being directed to mainstream schools. Thirdly, the new environment is changing the leading role of the teacher in the education system, assigning his educational functions to parents. The teacher is established as the bearer of theoretical knowledge. But he - such is the accepted theoretical concept and existing practice, and not only in Bulgaria - loses his fundamental role as a central educational factor in the educational system and is transformed into one of the many pedagogical specialists who implement educational policies in pre-school and school environments.

In 2016, Bulgaria adopted the Pre-school and School Education Act. This normative act stipulates - albeit generically - the development of inclusive education. It should be clarified that inclusive education - at least this is its reception in the Bulgarian environment - is perceived as a process of inclusion in mainstream school of children with special educational needs, i.e. children and students with different degrees of health problems. Gifted pupils and children are also included in mainstream school.

The law regulates the creation of teams of psychologists, speech therapists, social specialists with the task to support the personal development of children and students. Especially, for pupils with special educational needs it is written that an individual plan relevant to their abilities and needs should be prepared. The law also indicates the need to develop an additional sub-normative act on inclusive education. However, it is noteworthy that the Act does not treat the profile of the teacher/trainer in inclusive education. And this gives the impression that - at least at the normative level - the traditional teacher training is also suitable for the tasks of inclusive education (Pre-school and School Education Act, 2016).

The next act, developed in 2017 and completed in 2024, is the Inclusive Education Regulation. It introduces the content characteristics of inclusive education, formulating a state standard for its implementation in Bulgarian conditions.

Inclusive education in the Regulation is interpreted as a process of awareness, acceptance and support of the individuality of each child and student, by using a variety of resources to remove obstacles to learning and create opportunities for the development and participation of children and students in all aspects of life.

On the other hand, the substantive characteristics of the state standard are: the terms and conditions for providing general support for the personal development of children and students; the terms and conditions for providing additional support for the personal development of children and students and its provision; the terms and conditions for the participation of the student's parent in the procedure for imposing sanctions, as well as the specific terms and conditions for imposing these sanctions; the structure, terms and conditions for approving individual curricula and individual curricula for students with special educational needs and students with outstanding talents; the terms and conditions for admission and organization of education of children and students with special educational needs in special schools for the education and support of students with sensory disabilities; the terms and conditions for the education of children and students in a center for special educational support; the terms and conditions for directing students with special educational needs to continue their education in profiles and specialties of professions (**Regulation** on inclusive education, 2017). The issue of the trainer/teacher in inclusive education is not subject to separate treatment in the Regulation.

Understanding inclusive education as a new stage in the development of education in general requires a reconceptualization of the role of the teacher (Mincheva, 2019) First of all, the teacher should be seen again as a fundamental factor for the development of education. That is, in addition to a mastered theoretical apparatus, the teacher should also be characterized by formed educational skills. Current practice, for example, shows that the teacher/trainer in inclusive education concentrates primarily on working either with children/students with special educational needs, or with children/students of a different ethnic or religious background from other children/students, or with a different mother tongue. And this is at the expense of other pupils who lack such problems. These pupils fall behind and their results are unsatisfactory.

4. The erosion of humanities knowledge and its revival through the new role of the teacher in inclusive education

One of the consequences of the accelerated technological and communication development of humanity is related to the erosion of humanitarian knowledge. Rather, it has to do with attempts to reformat and introduce knowledge about the nature of man, cultural diversity and the development of identity (individual and national) into a matrix system. This necessitates the search for new approaches through which humanities knowledge can be revived and prioritized in both education and society.

The above also applies to the preparation of the teacher/trainer in inclusive education. The humanities, the individual's occupations with literature, history, philosophy, culture, on the one hand stabilize traditional social attitudes, values and ethical understandings. (Chantova, 2008) In such an aspect, the teacher/trainer in inclusive education acquires skills to understand and respect cultural differences, to contribute to the creation of a fair and supportive educational environment. Empathy, which through the acquisition of humanitarian knowledge, develops in the teacher, is also of essential importance. This means that through the educational process the teacher will have the opportunity to educate students in respect and appreciation of the dignity of each person, to establish himself as a moral role model.

However, everything said so far suggests a new concept of the teacher's role in inclusive education, as well as the affirmation of the introduction of a variety of school forms through which students receive more adequate prospects for the manifestation of their abilities. It is worth turning to historical experience and rethinking those good practices that we can revive in accordance with the new tasks of inclusive education.

5. Conclusion

Inclusive education is associated with overcoming various obstacles. But it also requires the formation of a new view of the role of the teacher as the main driving factor in the implementation of the tasks of the time. The teacher is the traditional bearer of modern scientific knowledge, but he is also the main factor on which the upbringing of future generations in ethical values, in respect and observance of human dignity, in the preservation and development of ancestral and national historical memory depends.

Acknowledgements

Special thanks to the Scientific Research Fund of the Ministry of Education and Science of Bulgaria for the support of the research under the project "**Model for assessing the effectiveness and quality of inclusive education, training and lifelong learning", contract № KP-06-H80/1** of 07.12.2023.

References

Ainscow, M., Booth, T., & Dyson, A. (2006). *Improving Schools, Developing Inclusion.* London: Routledge.

Atanasov, J. (1984). *History of Bulgarian Education*. Sofia: Kliment Ohridski University

Baksanskii, O. E., & Safonicheva, O. G. (2015). Philosophical and Methodological Principles of Inclusive Training. *European Journal of Philosophical Research*, *4*(2), 56-65. https://web.archive.org/web/20180602213256id_/http://ejournal17.com/journals_n/1433432553.pdf

Chantova, Y. (2008). The foreign language lesson as a communicative act: a semiotic analysis. *Works of the Specialized Higher School of Library Science and Information Technology, 7*, 529-540. Sofia: For the Letters - O pismenekhь.

Foucault, M. (2016). *Genealogia na modernostta* [Genealogy of modernity]. Sofia: Iztok-Zapad.

Lozanova, L. (2023). Evfliutzia na poniatieto „priobstavasto obrazovanie" v mezhdunarodnite dokumenty. *Educational and social studies, 6*(2), 20-32.

Pre-school and School Education Act. (2016). https://lex.bg/bg/laws/ldoc/2136641509

Regulation on inclusive education. (2017). https://lex.bg/bg/laws/ldoc/2137177670

Simeonov, I. (2025). *Discovering and training gifted children in sport*. Sofia: Kliment Ohridski University.

Special school for visually impaired students. (n.d.). https://suunz.org/

Stancheva, S. (2021). *Pedagogical support for students with special educational needs*. "Education and Society" Collection, Plovdiv: Paisii Hilendarski University.

Todorova, V. (2020). The professional profile of the modern teacher in the conditions of inclusive education. *Pedagogy, 92*(4), 514-524.

UNESCO. (2009). *Policy Guidelines on Inclusion in Education.* Paris: UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000177849

UNESCO. (2025). What is the global situation concerning education and gender equality? Paris: UNESCO. https://www.unesco.org/en/gender-equality/education/need-know

MULTIFUNCTIONALITY OF RURAL SCHOOL IN THE LOCAL COMMUNITY

Liga Paula, & Anda Grinfelde
Institute of Social Sciences and Humanities, Latvia University of Life Sciences and Technologies (Latvia)

Abstract

Latvia is facing major demographic changes that threaten the existence of local schools in rural communities. According to the priorities set by the Ministry of Education and Science, rural municipalities are implementing the school network reform by closing small rural schools. This process affects not only children and teachers but also the whole community: it increases social inequality, makes it difficult to provide qualitative education as close as possible to where children live, and promotes further depopulation of rural areas. Transforming schools into multifunctional community centres can help preserve schools and strengthen the quality of life of local communities. OECD research envisage that local schools can be developed according to different scenarios. In this study the authors believe that scenario related to more opened schools that experiment with different forms of learning in collaboration with the community is suitable for small rural schools in Latvia. The paper aims to explore the opportunities for rural school multifunctionality in local communities, taking into account their needs as well as to develop recommendations to promote sustainable development of local schools. The authors examine the main challenges and opportunities of adapting rural schools to the different cultural, social and economic needs of local communities. The paper presents the results of the case study analysis of Garoza elementary school in Jelgava County (Latvia). The study was completed in two phases during April and May, 2025. Firstly, a literature review was conducted as a desk-research, and, secondly, the focus group with school management, teachers, and local government representatives was organized to collect views of the local stakeholders on the possibilities for adapting schools to community needs and the necessary support mechanisms. The results show that the multifunctionality of rural schools can be an important solution for their sustainable development and strengthening local community. By adapting schools to the different needs of the local community, while simultaneously using the advantages of the rural environment and small schools, it is possible to ensure their existence and promote regional development. To achieve this, strategic cooperation between school management, municipalities and the local community is necessary.

Keywords: *Rural schools, multifunctionality, community, education policy, sustainability.*

1. Introduction

Latvia is facing major demographic changes that threaten the existence of local schools in rural communities. To maintain a small school with a small number of children and ensure high quality teaching is complicated. Therefore, according to the priorities set by the Ministry of Education and Science, all municipalities but especially in rural areas are implementing the school network reform by closing small local schools. After the administrative territorial reform in Latvia, since 2021, 38 schools were closed in total and 142 schools were reorganized or merged with the other school (IZM, 28.12.2024.). The process often is full of emotions and protests; however, some municipalities seek a compromise. The process of school network optimization affects not only children and teachers but also the whole community: it increases social inequality, makes it difficult to provide qualitative education as close as possible to where children live, and promotes further depopulation of rural areas or in other words - "slow death" of local community (e.g., Koroleva et a., 2017; Svendsen, 2009). Based on empirical evidence, Svendsen (2009) points out that "multifunctional centers should ideally contain public services (e.g., school, kindergarten, library, health care), private enterprises [..], and "facilities for local voluntary associations [..]" (Svendsen, 2009; 3). Transforming *schools into multifunctional community* centres can help preserve schools and strengthen the quality of life of local communities. Research conducted in Latvia by Supule (2019) indicates that "rural schools and municipalities positively evaluate the approach of community schools with extended functions"; however, extended functions and the community school model is not enough strong argument

for keeping a school open as it rather is “a form of competition between municipalities”. OECD research envisage that local schools can be developed according to different scenarios. In this study the authors believe that scenario “Schools as learning hubs” where “diversity and experimentation are the norm”; “opening the “school walls” connects schools to their communities”, and “favouring ever-changing forms of learning, civic engagement and social innovation” indeed is a key (OECD, 2020:49).

The paper aims to explore the opportunities for rural school multifunctionality in local communities, taking into account their needs as well as to develop recommendations to promote sustainable development of local schools. The authors examine the main challenges and opportunities of adapting rural schools to the different cultural, social and economic needs of local communities.

2. Methodology

The study was completed in two phases during April and May, 2025. Firstly, a literature review was conducted as a desk-research, and, secondly, the focus group with school management, teachers, and local government representatives (six participants in total) was organized to collect views from the local stakeholders on the possibilities for adapting schools to community needs and the necessary support mechanisms. Qualitative research approach was applied and particularly case study methodology (Yin, 2003) was selected to analyse multifunctionality of Garoza elementary school and its role in local community which is Salgale parish (Jelgava County, Latvia). The advantage of this methodology is that a case is investigated deeply as a united and integrated entity by using several data collection methods (Creswell, 2007). The focus-group was conducted in the school, it was 1 hour and 30 minutes long and was recorded. The researchers followed the respective ethical guidelines: all invited discussion participants were informed about the aim of the discussion, informed consent was received, participation was completely voluntary with an opportunity to withdraw anytime, participants were asked permission to record the discussion. Before the discussion, participants were introduced with the main topics and questions. Focus-group took place in a friendly and cordial atmosphere; the participants were quite insightful and interested in the topic, and elaborated on each other’s ideas. Later, the audio recording was transcribed with the tool *Transkriptor.com*. After revision, the focus-group data were coded and analysed according to the main discussion topics. They are: 1) the role and interaction of Garoza elementary school with local community of Salgale parish; 2) community needs and multifunctionality of a local school; 3) sustainable development and future perspectives of local rural school.

3. Results

The school in Garoza parish was founded in 1886, so it has a long and rich history. In 2026, it will celebrate its 140th anniversary. The school survived, despite the consequences of the First World War, when it turned into ruins. In 1926, the school was renovated and during the Second World War it remained intact until today (Skolas vēsture; Štelmahere et al., 2016). Contemporary exterior of the school and its main buildings are shown in the Figure 1.

Figure 1. Garoza elementary school, Spring 2025 (author of the photos: Liga Paula).

The number of pupils has varied from approximately 70 to a little bit over 100 from year to year. Besides the elementary schooling program, the school has pre-school unit providing Montessori education what the school is very proud of. During some period after 2000, the school was renovated and its infrastructure was greatly improved according to contemporary requirements combining historical

buildings with new amenities and infrastructure. During its rich history, the school has changed its name several times (Štelmahere et al., 2016); now it is Garoza elementary school.

Regarding the role and interaction of Garoza elementary school with local community, the focus-group discussion revealed a number of links and activities. The school has strong networks with local community groups especially children's families and their parents. Even more, children with behavioural and learning disabilities from near Jelgava city are accepted in the school as it has inclusive learning policy. As school representative stated: "*Children from Jelgava and the surrounding area are transported to the school by Salgale parish school bus, because the school in Garoza provides an individual approach, works with children who did not do so well in big forms of a city school, implements inclusive education. What cannot be achieved in the city, small schools do it, you could say they do the work that city schools did not do*."

The school representatives named a number of local organizations and activities where school is involved. Amongst the other, cooperation with the local motorcycle trial club was mentioned. The club offers various creative activities for pupils and educators (e.g., career education). Through sport children learn the importance of sports, increase their purposefulness; in sport camps organized in the open-air they acquire certain survival activities in the forest, etc. Cooperation with local churches was also emphasized, e.g., pastor came to address children at Christmas service. Garoza elementary school has strong cooperation with the Music and Art School and with the local library. Also, local entrepreneurs were mentioned as cooperation partners: "*There is an excellent cooperation with an entrepreneur next to the school, who was engaged in berry farming and shares his experience with students about practical knowledge and skills useful for life.*"

A number of activities and events take place at Garoza elementary school, in which the residents of Salgale parish also get involved: Easter celebration, National Day concerts and balls, disc golf, motorcycle rides, sports festivals, march on Lāčplēsis Day (Novemebr 11) to the Vareļi Monument and much more. The overview of the school's multifunctionality is presented in the Table 1.

Table 1. Overview of Garoza elementary school's multifunctionality in the context of local community.

No	Community school's function	Implementation level	
		Currently	Intentions for the future
1	Educating school children families (events, lectures)	community level	will be continued
2	Course organizing (computer training for seniors)	community level	will be expanded
3	Organizing local culture events (concerts, balls)	community level	will be continued
4	Organizing sport events and training	community level	will be expanded
5	Organizing children camps with specialization	limited opportunities	solutions must be developed
6	Specialist consultations (psychologist, speech therapist)	school level	will be expanded
7	Centre for interest-related education (after-school activities, etc.)	community level	will be expanded
8	Extended day program (two groups)	school level	will be continued
9	Offering preschool education (Montessori education)	community level	will be expanded
10	Availability of workshops (design and technologies)	school level	solutions must be developed
11	Tourism destination (heritage oak tree (*Senču ozols*), museum)	community level	will be continued
12	Eco Garden (in strong cooperation with pupils' parents)	community level	will be continued
13	Cooperation with community library	community level	will be continued
14	Cooperation with a local music and art school (Salgale parish)	community level	will be continued
15	Inclusive education for children with special needs	community level	will be continued
16	Latvian plain air painting camps during summers	community level, national level	will be continued
17	Memorial procession on November 11 to local Vareļi monument	community level	will be continued
18	Offering boating to Ozolnieki village, camping sites in summers	idea to be implemented	will be continued

The school is very proud of its Eco Garden program which is part of the international project. The aim of the programm is indoor and outdoor classes that promote pupils' interest in a healthy and environmentally friendly lifestyle, encourage them to acquire knowledge about organic, environmentally friendly cultivation and use of crops in the household, as well as smart, sustainable collection, use and protection of wild plants that are friendly to the environment and people (Kraukle-Veisa, "n.d.").

The program has defined number of objectives (Kraukle-Veisa, "n.d.") such as 1) learning to classify, compare, generalize, and apply the knowledge acquired in natural science, informatics, home

economics, visual arts, and foreign language classes; 2) learn the basics of organic cultivation of crops, the principles of collecting, wisely using, researching, and protecting wild plants in the natural environment; 3) practically use IT technologies, Latvian and foreign languages; 4) get to know the climate and natural environment of their country in comparison with the natural environment of other countries, promote and seek solutions together with foreign students for a modern, healthy, environmentally friendly and sustainable lifestyle.

Next to the school building, there is a garden (Figure 2.) where each form and group from the pre-school unit has their own plot and greenhouse where they grow different crops. After crops are harvested, children together with their parents and teachers cook together, prepare preserves for the winter or use products for school lunch meals.

Figure 2. Eco Garden in Garoza elementary school, Spring 2025 (author of the photos: Liga Paula).

During discussion the participants shared slightly different opinions about multifunctionality of school and its future as a community center. Executive of local community was quite skeptical: *"A school must be visible in today's society and it is visible in Salgale parish, but this requires constant advertising, which takes away the strength and energy of the school to carry out its basic tasks what is teaching."* One of the teachers, however, responded: *"I agree that it is necessary to earn money and think about financing, but the school attracts families who earn money, pay taxes, which go to the municipality, so the school must be more open and multifunctional."*

Asked about the challenges that small rural schools face and respective decisions what local authorities should make in order to optimize school network in municipality territory according to the national education policy guidelines, the representative of municipality (decision-making authority) acknowledged that this is also parents' responsibility whether local school will exist and develop or not. He put it this way: "*Community residents must take responsibility for driving past the school, but of course they have the right to educate their children in Jelgava, where their work.*"

When speaking about the future vision of the school, its principle mentioned: *"The school is very well located geographically, so it can attract interested parties outside the community. We want to create the first school in Latvia as an example of good practice. A school where the main focus, in parallel with studies, would be directed towards the acquisition of social skills by students in order to gain competence in completely independent self-education, to acquire survival skills."* Therefore, her plan is to attract entrepreneurs who would be interested in helping to create an appropriate place and invest in the material and technical base, so that children could develop respective professional skills, as well as acquire various household skills. School staff plan to work towards creating a partnership between the municipality and entrepreneurs to develop a school what prepares children from the community and surrounding communities for their first work skills and to start an independent life. This is closely in line with the ideas presented in the OECD research and the scenario "Education outsourced" (OECD, 2020).

The results show that the multifunctionality of rural schools can be an important solution for their sustainable development and strengthening of the local community. By adapting schools to the different needs of the local community, while simultaneously using the advantages of the rural environment and small schools, it is possible to ensure their existence and promote regional development. To achieve this, strategic cooperation between school management, municipalities and the local community is necessary.

4. Conclusions

Due to the critical demographic indicators of Latvia, rural schools can exist by supplementing educational services with multifunctional and diverse activities that meet the needs of the local territorial community. Rural school can be considered strong if it has good educational quality and close ties with the local community, however, they cannot compete with city schools. The Garoza elementary school has proven its ability to work with students who are not accepted into a city school due to low achievement, however, showing progress and student development dynamics in smaller school.

Although Garoza elementary school already offers a wide range of valuable multifunctional activities for the local community, educators show great interest, encouraging new, creative ideas and readiness for various experiments, just to maintain the sustainability of the school. The school is currently focused on the goal of the Eco Garden program - to promote students' interest in a healthy and environmentally friendly lifestyle and the ability to use knowledge and skills to solve problems in changing real-life situations.

The executive of the local community is more skeptical of the school's efforts to become a multifunctional community center than the decision-making units of a County, indicating that teachers should deal with the educational service offer and not invest energy in ensuring other activities. Both the political decision-makers and the executive of the local community confirm that there would be no risks in future maintaining the school's infrastructure if the heating system were replaced with a more economical solution.

The local community and the school management agree that children must learn to survive in today's rapidly changing world and be ready to self-organize in diverse and unexpected situations in the future, therefore, they see an increasingly close cooperation with entrepreneurs from the local community who would be interested in material and spiritual investments in the Garoza elementary school as a challenge for school development.

References

Creswell, W. J. (2007). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches* (2nd ed.). Thousand Oaks, London, New Delhi: SAGE Publications.

IZM. (28.12.2024). *Reorganizētās, slēgtās un dibinātās izglītības iestādes* [Reorganized, closed and founded educational institutions] Retrieved April 29, 2025, from https://www.izm.gov.lv/lv/reorganizetas-slegtas-un-dibinatas-izglitibas-iestades

Koroleva, I., Karklina, I., & Aleksandrovs, A. (2017). Rural Schools as Multifunctional Centres: Alternative for School Survival and Flourishing Communities. *Social Sciences Bulletin*, *1*(24), 7-29.

Kraukle-Veisa, V. (n.d.). Eco Garden. Retrieved May 13, 2025, from https://www.garozaspamatskola.lv/pirmsskola/interesu-izglitiba/eco-garden/

OECD. (2020). *Back to the Future of Education: Four OECD Scenarios for Schooling*, Educational Research and Innovation. Paris: OECD Publishing. Retrieved April 29, 2025, from https://doi.org/10.1787/178ef527-en

Skolas vesture. [School History] (n.d.). Retrieved May 13, 2025, from https://www.garozaspamatskola.lv/par-skolu/skolas-vesture/

Supule, I. (2019). Community School Model: Is It an Alternative for School Closures in Rural Territories? *Eastern European Countryside, 25*(1), 171-194.

Svendsen, G. L. H. (2009). Multifunctional Centers in Rural Areas: Fabrics of Social and Human Capital. In C. Frisiras (Ed.), *Rural Education in the 21st Century* (pp. 1-31). USA: Nova Science Publishers, Inc.

Štelmahere, D., Vāvere, I., Cīrule, M., & Helviga, S. (2016). *Mana skola gadu simteņos*. [My School through the Centuries], Rīga: Avots. Retrieved May 13, 2025, from https://drive.google.com/file/d/14-3JzXMAHjyqZAs3tIEOUY-noTqGk32u/view

Yin, R. K. (2003). *Case Study Research: Design and Methods* (3rd ed.). Thousand Oaks, CA: SAGE Publications

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

FACTORS THAT CONTRIBUTE TO PREJUDICE AGAINST FEMALE LEADERSHIP IN ZIMBABWE'S TERTIARY INSTITUTIONS

Rosina Mavunga[1], & Siphokazi Kwatubana[2]
[1]Mkoba Teachers College, UZ Associate (Zimbabwe)
[2]Faculty of Education, NWU (South Africa)

Abstract

Worldwide, women who have succeeded in leadership are often disfavoured, suffer discrimination and are challenged by their male counterparts. In addition, a challenging environment for women aspiring to leadership positions in under-developed countries is exacerbated by deep-rooted patriarchal norms which often manifest as a culture of hegemonic masculinity. This research focused on factors that contribute to prejudice against women in leadership positions in Zimbabwe tertiary institutions. A qualitative research approach guided by an interpretivist paradigm was used. The sample consisted of one female principal, one vice principal, fifteen female heads of departments and eight female members of the student council (n=25). The participants were selected from three colleges in Zimbabwe. Data was gathered through individual interviews, focus group interviews and document analysis. The findings revealed that the manifestation of prejudice against female leaders was a result of a number of factors including domination of hierarchal structures by males, negative influence of a patriarchal culture, gender roles and socialization of women, deprivations and Christianity. Intervention strategies are proposed to pave the way for greater acceptance of female leadership in institutions of higher learning.

Keywords: *Prejudice, female leadership, multiple deprivations, prejudice against females, female leaders in education.*

1. Introduction and background

Zimbabwe's entrenched patriarchal system, characterised by hegemonic masculinity, presents significant obstacles for women pursuing leadership roles (Shepherd & Mupa, 2022). Research indicates that male dominance and limited gender awareness actively prevent the recognition of women's leadership potential (Chitsamatanga et al., 2018). Female leaders encounter multiple forms of discrimination, including stereotypes, mockery, and negative labelling, all of which diminish their leadership credibility and impede their professional progress. While some studies explore prejudice against female leadership in higher education (Chisholm-Burns et al., 2017), they often focus on developed countries or specific institutions (e.g., China). Although existing studies on Zimbabwean education leadership (Hlatywayo et al., 2014) and affirmative action initiatives (Chitsamatanga et al., 2020) provide important perspectives, they fail to fully examine the specific factors that contribute to prejudice against female leaders within Zimbabwe's tertiary education.

Zimbabwe's patriarchal system, deeply rooted in both pre-colonial and colonial influences, continue to entrench male dominance across societal structures (Shepherd & Mupa, 2022). This system assigns distinct gender roles where men are socialised as decision- makers and leaders, while women are predominantly confined to domestic and caregiving responsibilities. Such norms manifest in discriminatory practices and perpetuate women's marginalisation. The existing societal biases against female leadership may limit their access to opportunities. Research points to the lack of women in leadership roles in education. The underrepresentation of women in leadership positions across Zimbabwe, including in universities and colleges, is a cause for concern.

Despite women constituting the majority in the teaching profession, their representation in leadership remains low. A study by Chabaya et al. (2009) found out that men occupy 96.3% of secondary head posts, with women holding only 3.7%. According to the Zimbabwe Ministry of primary and secondary education report, there was 29,2 percent female primary school representation for principals, while in secondary schools the female representation for female principals is 16,4 percent (Zimbabwe Ministry of Primary and Secondary Education report, 2022). In Zimbabwe, in 2022 there were only two out of 21 Universities headed by female vice-chancellors (Anderson et al., 2023). This underrepresentation

exacerbates the lack of role models and mentorship for aspiring female leaders. Despite growing recognition of women's qualifications for leadership roles, prejudice against female leadership persists. While research confirms the underrepresentation of women leadership position, the study therefore sought to examine the factors that contribute to prejudice against female leadership in tertiary education in Zimbabwe.

2. Methodology

A qualitative research approach guided by an interpretivist paradigm was used. The sample consisted of one female principal, one vice principal, fifteen female heads of departments and eight female members of the student council (n=25). The participants were selected from three colleges in Zimbabwe. Data was gathered through individual interviews, focus group interviews and document analysis. Data was analysed using content analysis method. The role congruity theory was used to understand the data.

3. Results and discussion

The results showed that the hierarchical structure within institutions, patriarchal culture, gender roles, deprivations and Christian religion are factors that contributed to prejudice against female leadership in tertiary education.

3.1. Manifestation of prejudice within the hierarchical structure

Tertiary institutions, as with many other organisations have hierarchical structures with different levels of leadership positions. The results revealed definite hierarchical structures in tertiary education colleges under study. The structures showed levels, that is, from a lower to higher level. The progression is hierarchical, showing a clear path between the structures. It was also noted during the focus group interviews that the SRC positions were also hierarchical with the position of the president being the top position. The results also revealed the dominance of males in top leadership positions in the participating tertiary institutions. *Yeah, of course we may talk and say that it is balanced, but in my view it is not. Because for years I've been here since 2009. It's now more than ten years. There's never been a female SRC President. And I do not remember having even vice who is female.* (C3HoD2) Out of the three sampled colleges there was only one female principal. Even though the progression was clear, less than half of the women were principals. Furthermore, in all the sampled colleges the position of SRC president was occupied by a male student. This male dominance in leadership limits the visibility of female role models, potentially discouraging young women from pursuing leadership goals and hindering personal growth and career progression for women in these institutions. The findings by Ademe and Singh (2015) also affirm that a lack of role models is a barrier stifling women from assuming leadership positions.

The data showed a lack of transparency in decision making regarding appointments and demotions. *I don't think I had been regarded as good in my work. But I never got a written warning or even a verbal warning and I am not doing well. It was like do this, maintain this and then I was only told at the end that you are demoted* (C3 HOD3). Women were sometimes the unfortunate targets as they were demoted, and their position given to a male counterpart without being given any opportunity for defence. This lack of involvement in decision making, particularly in matters affecting them suggests that their ideas and perspectives were not valued, leading to frustration among female staff. The exclusion from decision-making processes can affect women at all levels of the organisational hierarchy (Oliveira et al, 2012).

3.2. Patriarchal culture and manifestation of prejudice against female leaders

The results revealed cultural tendencies which show masculinity. This patriarchal culture which focuses on men being the head is also dominant at the workplace where men believe that they should be the leaders. *...because of our cultural background of this patriarchal society, lecturers or authorities seemed to take time to realise that there is equal footing upon the male and female in leadership. So, I think that is where our prejudices start because of patriarchal background.* (C1 HoD3) *Men dominate and men head… patriarchy still exists.* (C1 FG). Patriarchal culture has a negative influence on women's participation in leadership positions. It emanated from the patriarchal ideologies which tended to favour men as the male child was valued more in societies. Additionally, this marginalisation and silencing of women in such cultures perpetuated prejudice, leading to direct and indirect discrimination.

The manifestation of prejudice was also a result of patriarchal socialisation. The participants revealed that the basis of prejudice was on how women were socialised. *... prejudice is mainly founded on patriarchy. It is beliefs that women are supposed to be subordinate to men and in most cases, they are looked down upon. They are not seen as people who can be creative, and strong but are regarded as people*

who are emotional and not supposed to be really speaking in front of men. At this institution there is a history of men who have been in leadership positions and very few ladies have been in such positions, so I consider patriarchal socialisation as a major factor. (C1 HOD 5). Women were culturally socialised to believe that they were not competent to lead. Patriarchal society confined women to positions of mothers and wives at home, taking care of the family and subordinate to men. Through socialisation, a girl is groomed to become a wife, mother, and a provider of food from an early age (Choge, 2015). Female leaders at these colleges were evaluated as weak and emotional people who cannot stand up against men.

The results also displayed the patriarchal hegemony which disrespected women and feminised some leadership posts. *… female students will come as secretary, which is also a stereotype in a trait, I am concerned that you find that women are scribed to these post Secretary and at times treasurer. That's where you find them sitting.* (C3 HOD2) *… sizabona izintu zobomama lapha (we will see women's way of doing).* (C2 HoD2). Leadership roles such as that of SRC secretary and treasurer were feminised, reinforcing stereotypes that women's traits only suit certain positions, while higher roles like president remained male- dominated. This reflects a societal belief in male superiority in leadership, as seen in the gender-imbalanced SRC compositions where men predominantly held to positions, reinforcing traditional notions of male leadership (Heilman, 2012). More so, the feministic comments were meant to demean, show distrust against female leaders to undermine them. These comments showed disapproval, disrespect, and doubt of women's leadership capability.

The finding on patriarchal socialisation and cultural norms resonates with that of Melka et al. (2022) that cultural factors limited women's aspirations, making it difficult to access leadership positions. From childhood, women are conditioned to accept subordinate positions, with leadership seen as inherently male, leading to their authority being undermined in professional settings. Male subordinates often resist female leadership, reflecting the societal belief that men should hold power, as evidenced by the feminisation of lower-ranking roles like secretaries and treasurers while top positions remain male-dominated. Disrespectful comments and insubordination further marginalise women. Similar findings by Dlamini and Adams (2014) revealed that in institutions of higher education women experience male supremacy, disempowerment, and disrespect.

3.3. Gender roles and manifestation of prejudice

The research results clearly showed the women's position as subordinates hence they were given minority roles. *It will show you that women have always been given a minority role in whatever they do. Even in the home, they are a minority. The woman cannot be above the man, for instance the role of women is in the kitchen, and their place is in the home. Therefore, they cannot be seen in the workplace, taking up roles to lead both men and women.* (C3 HOD2). The gender roles reflect that woman were in minority and subordinate to men. The kitchen remained their operational place. The gender roles such as cooking, being mothers and wives and taking care of children were ascribed to women. The Role Congruity Theory ascribes them to communal roles caring for the welfare of others (Eagly & Karau, 2002). Gender role socialisation starts at home at an early age. They are embedded from childhood to adulthood and are accepted by society. The girl child is socialised into roles centred around childcare and domestic duties effectively limiting their aspirations and vision of what they can achieve beyond becoming wives, mothers and caregivers. In other words, the girl child is groomed to become a wife, mother and a provider of food from an early age, creating a limited vision of their potential (Choge, 2015). This conditioning can lead girls to internalise the belief that women should occupy subordinate positions compared to men

Adherence to gender roles resulted in the development of low self-esteem, rejection and role conflict which impacted negatively on women's professional advancement. *Lack of confidence is caused by low self- esteem which is a result of being consistently told that you cannot do this … mostly coming from men … If your close acquaintance tells you that you cannot do this, you develop low self-esteem.* (C3HoD1) *… I was offered a promotion to be a vice principal at another college, but I rejected the offer because it meant leaving my family and I am about to retire… I would rather remain here as head of department.* (C1HoD2). Continuous reminder of where female leaders belonged in the patriarchal system resulted in the development of low self-esteem. Adherence to gender roles also contributed to women being rejected by other women in their career progression through promotion. Internalised bias and societal conditioning where women unconsciously believe that men are better suited for leadership roles, disadvantage women from seeking promotion. Women found that the conflict between work and home expectations was such that they rejected promotion. Ppeople's perceptions of individuals are shaped by their alignment with societal expectations of their social roles (Eagly & Karau, 2002). Moreover, patriarchal socialisation thus entrenches male dominance in leadership while marginalising women, sustaining systemic gender inequality in both familial and institutional spheres. However, findings by Choge (2015) revealed that cultural practices and stereotyping may have influenced male perceptions to women in the past, but that good leadership is not specific to gender but one's leadership qualities.

3.4. Deprivations associated with prejudice against female leadership

The research results revealed that women suffer multiple deprivations including lack of induction, female underrepresentation, early childhood gender deprivations, lack of material resources and human support. On lack of induction the participants related their experiences as follows: *When we came in, we were not inducted … we had been promised to be inducted... so I had to use my experience gained from working with my former principals to chat my way through. I also had to consult other colleagues… I worked in the vice principal's office sometimes we would be acting in the principal's office but because of no induction I had to play it by ear and do a lot of consultation.* (C1 P1). W*e went for a meeting with the vice principal and the principal. We were just given a written constitution of what was required from us to do.* (C1 FG). Thus, female leaders were systematically denied proper induction despite its importance for role clarity and effectiveness. Left without guidance, they struggled in their positions, often relying on self-learning or facing resistance when consulting male predecessors, particularly when those men were professional competitors. Student leaders were also not inducted. This deprivation of induction and mentorship opportunities known to boost leadership skills and confidence left women disadvantaged and reinforced workplace gender inequalities.

Leadership involves accomplishing organisational goals and material resources are a necessity to achieve these goals. Female leaders were challenged by lack of material resources. *You are running an institution, you have to collect fees, and sometimes resources are not enough to do some of the things that you feel you want to do as a leader, you take your project, it will take you two years to even start on it because we are trying to build the resources, sometimes manpower that is supposed to drive the institution for some time it is not there, so sometimes when you fail, it is not really your fault because certain things were lacking… (C1 P). ...rightfully there are resources which are supposed to be yours that is being allocated a vehicle or residence at the college, ……Yes, I was denied for some time, and I believe it was because I am a woman… if I was a man no one would have questioned… It is also coming from home, even those leaders who are depriving us a lot of things because of their upbringing.* (C2VP1). Female leaders faced significant challenges due to resource shortages exacerbated by the country's economic crisis. Projects were delayed, and women struggled to fulfil their potential, while male leaders disproportionately benefited from available resources. Their shortcomings are often attributed to lack of resources, reinforcing stereotypes that linked material deprivation to lower capability (Eagly & Karau, 2002). Additionally, resource allocation was often gender- biased, with patriarchal norms denying women access to essential tools, undermining their leadership and perpetuating workplace prejudice.

Female leaders at times experienced a lack of moral support in their decision making. There was a 'cutting down' of successful women, but at times support was given out of sympathy. *Sometimes if a woman passes a decision, they don't simply take it like a suggestion that is positive, they tend to crush that. If a woman doesn't defend that at the end of the day your view or suggestion is thrown out and their voices are always louder than female voices.* (C2HoD3). The decisions of females were undermined, criticised, and opposed by male subordinates. They felt that there was a bias towards views from men and a female decision was not considered relevant. Additionally, men did not fully support female leadership as they doubted their decision-making capability. Perhaps the reason was based on perception that females lack decisiveness and assertiveness. According to theory, individuals are more likely to accept and support leaders who exhibit characteristics and behaviours traditionally associated with leadership roles, such as decisiveness, assertiveness and confidence (Eagly & Karau 2002).

Early childhood deprivation of opportunities to participate in decision making was a source of prejudice and a cause of women's marginalisation in leadership positions. Women were not given the opportunity to make family decisions in the home. Gender roles from childhood disadvantage women in leadership, as girls are socialised to prioritise domestic duties while boys are groomed for leadership. This early deprivation of leadership opportunities carries into adulthood, making it difficult for women in tertiary education to confidently assume leadership roles.

3.5. Christianity and prejudice against female leadership

One of the factors that also emerged which contributed to the manifestation of prejudice was religion. This is what the participants said: *Women generally have not been taken as leaders but have been taken as people who should bow down to men, probably this started biblical[ly] when man have always told themselves to be the head, and this has been taken to organisations* (C2HoD4). Data gathered from the participants revealed the aspect of religion as a contributor to the undermining of females. The indication in the Bible that women are helpers to men was perceived as giving them a leading position. The results showed discrimination and undermining of women in some church organisations where women are not allowed to preach. Men may use this biblical aspect at the workplace to make female colleagues their subordinates.

The study highlights how religious interpretations reinforce gender-based prejudice, with biblical teachings often cited to justify male dominance and female subordination in leadership roles. Despite women forming the majority in religious communities, doctrines emphasising 'man as the head' systematically exclude them from preaching, decision- making, and leadership positions. This religiously sanctioned patriarchy intersects with cultural norms to perpetuate inequality, as evidenced in tertiary institutions where such beliefs persist. The findings by Essien and Ukpong (2012) revealed that religion and cultural prejudice against women are drivers of patriarchy and inequality.

4. Conclusion

The manifestation of prejudice against female leadership is a result of a number of factors which include hierarchical structures, patriarchal culture, gender roles, deprivations and religion. The factors limit the progression of women to leadership position, hence there is underrepresentation of women leadership in tertiary education in Zimbabwe. The study propels key recommendations which include implementing institutional gender policies to ensure transparent recruitment and 50/50 representation, alongside leadership development programs like mentorship (both formal and informal) and role modelling to empower women. Accordingly, Oyeniran and Lili (2020) also recommended a transformation of structures together with policies which increase recruitment on female leadership. To counter patriarchal norms, awareness campaigns, using media, posters, and SDG focused discussions are proposed to promote gender equality. In addition, institutions should foster inclusive decision-making by involving women in committees and creating women friendly workplace cultures that support work-life balance. Collectively, these measures aim to dismantle systemic barriers, challenge stereotypes, and create equitable leadership opportunities for women in tertiary education.

References

Ademe, G. & Singh, M. (2015). Factors affecting women's participation in leadership and management in selected public higher education institutions in Amhara Region, Ethiopia. *European Journal of Business and Management, 7*(31),18-29.

Anderson, E. A. B., Nonterah, N. K., Tayviah, M. M., Sally Opoku Agyeman, S. O. & Rufai Mahami. (2023). "It seems the women are taking over": Stereotyping around women in top-level leadership positions in Ghana's universities. *Agenda:* 1-15. DOI:10.1080/10130950.2023.2251814

Chabaya, O., Rembe, S. & Wadesango, N. (2009). The persistence of gender inequality in Zimbabwe: factors that impede the advancement of women into leadership positions in primary schools. *South African Journal of Education, 29*(2), 235-251. doi:10.15700/saje. v29n2a259

Chisholm-Burns, M. A., Spivey, C.A., Hagemann, T. & Josephson, M. A. (2017). Women in leadership and bewildering glass ceiling. *AM Journal of Health-SYST Pharmacy, 74*(5), 312-324.

Chitsamatanga, B. B., Rembe, S. & Rembe, N. S. 2020. Does the implementation of affirmative action promote female academics to positions of leadership? Evidence from two state universities in Zimbabwe. *e-BANGI*, *17*(2), 171-185.

Choge, J. R. (2015). Gender factor in decision making: challenges facing women leadership development in primary schools; management in Kenya. *Journal of Education and Practice, 6*(12), 30-37.

Dlamini, E. T. & Adams, J. D. (2014). Patriarchy: A case of women in institutions of higher education. *Perspectives in Education*, *32*(4), 121-133.

Eagly, A. H. & Karau, S. J. (2002). Role Congruity Theory of prejudice towards female leaders. *Psychological Review*, *109*(3), 573-598.

Essien, A. M. & Ukpong, D. P. (2012). Patriarchy and gender inequality: The persistence of religious and cultural prejudice in contemporary Akwa Ibom State, Nigeria. *International Journal of Social Science and Humanity*, *2*(4), 286-290.

Heilman, M. E. (2012). Gender stereotype and workplace bias. *Research in Organisational Behaviour*, 32, 113-135.

Hlatywayo, L., Hlatywayo, S. & Muranda, Z. A. (2014). The extent to which females occupy leadership positions in teachers' colleges. *IOSR Journal of Humanities and Social Sciences*, 19 (9), 28-36.

Melka, T. L., Warkineh, T. Z. & Sperandio, J. (2022). Promoting female primary school leadership in Ethiopia: countering culture. *International Studies in Educational Administration (ISEA), 50*(1), 1-24

Oliveira, P. D., Guimond, S. & Dambrun, M. (2012). Power and Legitimizing Ideologies in Hierarchy-Enhancing vs. Hierarchy-Attenuating Environments. *Political Psychology, 33*, 867-885.

Oyeniran, R. & Lili, Z (2020). How do females deal with hindrances in school headship? Evidences from the Ivorian context. *European Journal of Educational Sciences, 7*(2), 116-136.

Shepherd, G. & Mupa, P. (2022). The impact of culture on promotion of women in Secondary Schools in Chirumanzu District. Zimbabwe. *Indiana Journal of Humanities and Social Sciences, 3*(2), 49-55.

SOUTH AFRICAN SCIENCE CURRICULA INTENTIONS AND ENACTMENT IN RESPONDING TO GENDER INEQUALITIES

Lydia Mavuru
Department of Mathematics, Science and Technology Education,
University of Johannesburg (South Africa)

Abstract

The South African science curricula aim to equip learners, from all socio-economic or cultural backgrounds, with essential knowledge, skills, and values to meaningfully participate in their communities as informed citizens. Furthermore, the curricula stipulate that issues of inequality and social justice, such as gender inequality, should be addressed in science classrooms. Historically, the female child has been marginalised when tackling fundamental life challenges which require STEM-related knowledge and skills. Learners' interests in science-related subjects also remain a critical issue in South African schools, more so for females as they are often demotivated and find science challenging. Previous studies have blamed the curricula for lack of explicit guidance to teachers, resulting in poor curricula implementation. The present study argues that poor female learners' participation and performance, and lack of interest in science, emanate from the curricula silence on how gender inequalities can be addressed in science classrooms. The study sought to determine the extent to which the science curricula guide teachers to respond to gender issues in their classrooms. This paper reports on the extent to which science curricula deliberately guide teachers on what gender issues they need to address, why they should address them and how they can do this, whilst teaching science topics. The study is guided by critical social theory as theoretical framework. In a qualitative case study, data was collected through analysis of curricula documents for the three science domains: Natural, Physical and Life Sciences, in terms of how content should be taught in relation to gender issues. Data collected were subjected to content analysis. Findings revealed that science curricula documents show superficial relationships between content and gender issues. There is a lack of guidance to teachers on how to enact gender responsive teaching. One example is the superficial reference shown in the Life Sciences curriculum on the importance of a balanced diet for different genders, and human population growth and gender distributions. The findings provide implications for both science curricula designers and policy makers on the need to articulate gender matters in the science curricula and also provide guidance on how science teachers may implement gender responsive teaching and learning in their classrooms to reduce or eradicate inequalities. The author acknowledges the study's limitations in portraying gender as binary rather than as a continuum.

Keywords: *Gender inequality, gender stereotypes, science classrooms, social justice.*

1. Introduction

Despite incremental progress in women's representation in some countries and not others (Miller, Eagly, & Linn, 2015), Science, Technology, Engineering, and Mathematics (STEM) fields continue to be male dominated, as persistent gender disparities in participation and leadership roles remain evident (Kerkhoven et al., 2016; UNESCO, 2015). In the South African context, the national science curricula purport to empower learners, irrespective of socio-economic or cultural background, with the knowledge, skills, and values necessary to engage meaningfully in their communities (Department of Basic Education [DBE], 2011). These curricula also claim to prioritise issues of inequality and social justice, including gender inequality. However, such aspirations often remain theoretical rather than practical. Historically, girls have been systematically excluded from opportunities that demand STEM competencies, with this marginalisation deeply rooted in both societal norms and educational practices.

Crucially, female learners continue to report lower interest and confidence in science, which contributes to their underperformance and disengagement in the subject. This is not merely a reflection of individual aptitude or preference, but rather the result of a structural failure: the science curricula's silence on how teachers should explicitly confront gender inequalities in the classrooms. While policy rhetoric gestures toward inclusivity, its lack of practical, gender-sensitive pedagogical strategies renders it

ineffective. This study therefore argues that the underrepresentation and underperformance of female learners in science is not an incidental occurrence but a systemic issue, stemming from a curricular void that fails to offer actionable guidance on how to dismantle gender biases in science education. If science classrooms are to become really inclusive, curricula must do more than mention gender inequality but rather equip teachers with the tools to meaningfully address it.

1.1. Purpose of study

The purpose of this study was to critically examine the extent to which the South African science curricula explicitly guide and support Life Sciences, Physical Sciences (Grades 10-12), and Natural Sciences (Grades 7-9) teachers in addressing gender issues within their classrooms. This analysis aimed to identify the degree of alignment between curricula expectations and practical teaching strategies for promoting gender equity, with a particular focus on how these curricula enable teachers to recognise and challenge gender biases, create inclusive learning environments, empower all learners to fully participate in science education. Therefore, the study sought to answer the following research question: How do the South African science curricula address gender issues within the classrooms?

2. Literature review

Different STEM curricula around the globe continue to articulate issues of inclusivity to ensure diverse learners are catered in the classrooms. Inclusivity in this case refers to the provision of opportunities for underrepresented learners to receive quality education through not only the creation of conducive learning environments but also by equipping them with the knowledge and skills to be successful (Lynch, et al., 2018). Lynch et al. (2018) argued that such STEM-focused curricula require well prepared STEM teachers. In this study I argue that the preparedness of STEM teachers should not only be viewed in terms of subject matter knowledge but also in terms of pedagogical knowledge and skills that help teachers to transform the knowledge so that it becomes more accessible to diverse learners.

In essence gender inclusivity and sensitivity should be a priority of the curriculum if gender responsiveness is to be realised. In a study to determine how teachers employed gender responsiveness to attain gender equality among the learners and the gender-responsive teaching strategies used in delivering science lessons and learning activities, Canuto and Espique (2023) pointed out that gender responsiveness start with lesson preparation then the teaching and learning materials, the gender responsive language used till the teaching and learning strategies and activities used to implement the lesson. Based on this point, it means that the curriculum should be articulate in the way it guides teachers to teach the different content topics if gender responsive science classrooms are to be realised.

Notably, gender matters such as biases, stereotypes, inequalities, gaps and discrimination manifest in classrooms (Hernandez & Cudiamat, 2018). Researchers such as Wigati (2019) have a positive view of schools as significant systems to alleviate gender disparities. An important question arises that, if schools and science classrooms are to address gender issues, what do the science curricula say with regards to how this should be done. Is this left in the hands of the science teachers and school management to design what they consider as gender responsive teaching and learning? If there are guidelines stipulated in the curricula, are they explicit to ensure teacher proof?

2.1. Theoretical framework

As a way of unravelling the sociohistorical inequities that are prevalent in societies, the current study is framed by critical social theory (Kincheloe & McLaren, 2011). In essence critical social theory links and explains social reality with practical aims to address social injustices. Kincheloe and McLaren (2011) argue that societal inequality persists not merely because of overt structures of power, but because those who are oppressed often internalise their subjugation as natural or inevitable. This acceptance becomes the most insidious tool of oppression, allowing privilege to be reproduced without resistance. By framing dominance as normal, the status quo is maintained, and critical questioning is silenced. Kincheloe and McLaren's critique challenges teachers and researchers to expose and disrupt these internalised hierarchies, rather than passively accepting them as fixed realities. In the current study the injustices relate to the lack of gender responsive science curricula or the lack of guidance on how to design gender responsive teaching and learning environments in the science classrooms.

3. Methodology

This was a qualitative case study which involved the analysis of the South African curricula documents for the three science domains: Natural Sciences, Physical Sciences and Life Sciences. The analysis process involved identifying the following aspects related to gender as a way of ensuring

inclusivity in the science classrooms: 1. The curricula intention to addressing gender matters; 2. How gender responsive teaching and learning should be implemented; 3. Topics where gender is incorporated or mentioned; and 4. Examples of activities or strategies to address gender in terms of how content should be taught in relation to gender issues. Data collected were subjected to content analysis.

4. Research findings

4.1. South African science curricula general aim and principles related to gender

The broader science curriculum, as part of the National Curriculum Statement Grades R-12, operates under foundational principles of inclusivity and sensitivity to diversity, including gender (including the Natural, Life, and Physical Sciences). This aims to ensure equal educational opportunities for all learners irrespective of gender, but this is a general principle of the curriculum's design and implementation rather than a specific articulation of gender issues within most subject content areas. Teachers are guided to use curriculum differentiation strategies to address diversity, which could implicitly include considering gender. While the curricula clearly articulate the principle of gender inclusivity as part of the broader curriculum's commitment to social justice, equal opportunity, and addressing diversity, they do not provide explicit examples or stipulations on how gender-responsive teaching and learning should be implemented within the specific content or activities of all the science disciplines.

Examples of gender inclusivity in the CAPS FET Life Sciences and Physical Sciences Grade 10-12 curriculum are encapsulated in the foundational principles and aims of the National Curriculum Statement Grades R-12, rather than in specific content topics or practical activities outlined. The CAPS was designed as an effort to bring transformation aimed at redressing educational imbalances of the past and ensure equal educational opportunities for all learners from diverse backgrounds. To place the imbalances in context, before attaining democracy in 1994, South African education system followed a curriculum where the majority Black populace received education that was ‘inferior’ to the education received by the white minority populace.

Among other issues, the current National Curriculum (NCS) explicitly endeavours to equip learners, irrespective of their gender, with the knowledge, skills, and values necessary for self-fulfilment to allow meaningful participation in society. In this way the NCS demonstrates DBE’s commitment to gender equality in terms of access to education. In essence due to its reference to gender, human rights, inclusivity and social justice, the curriculum outlines the need to be sensitive to issues of diversity such as gender. Thus said, by considering issues of gender and social justice, the curriculum therefore addresses the United Nation Sustainable Development Goals (SDGS) for example quality education (SDG 4), gender (SDG 5), and reduced inequalities (SDG 10). Because inclusivity is central to teaching and learning, this requires teachers’ understanding of how to recognise and address barriers to learning, and how to plan for diversity, gender included.

The following sections provide an analysis of each of the three science curricula to assess how matters of gender are articulated. Specifically, the analysis focuses on the topics where gender matters have been mentioned, how gender is articulated in those topics, and to determine how teachers are guided to address gender issues related to those topics.

4.2. Gender inclusivity in life sciences curriculum

The topics, practical activities, and assessment requirements in Life Sciences focus on mostly scientific concepts and skills. These are presented without specific instructions or examples related to gender-responsive pedagogy or content differentiation based on gender. Therefore, the examples of gender inclusivity provided in the sources are the foundational principles, aims, and mandated approaches to teaching and planning for diversity that apply to the Life Sciences curriculum as a whole, rather than specific instances of how gender is addressed within the subject's content or teaching methods itself.

The topics in the CAPS FET Life Sciences Grades 10-12 curriculum that explicitly mention aspects about gender or males and females are primarily found where the biological differences between sexes are central to the subject matter or when discussing factors influencing biological processes in humans. The curriculum refers to gender in the topics that follow.

4.2.1. Grade 11: Human nutrition. Within the discussion on Human Nutrition under the "Life Processes in Plants and Animals" strand 1, the content specifies discussing "the importance of a balanced diet and changing requirements due to age, gender and activity levels" (DBE, 2011, pp. 44). This clearly shows that nutritional needs differ based on gender.

4.2.2. Grade 12: Reproduction in vertebrates (specifically human reproduction). Under the "Life Processes in Plants and Animals" strand for Grade 12, the topic "Reproduction in Vertebrates" is listed, with a specific focus on human reproduction. This topic inherently involves the biological structures, functions, and processes specific to males and females, such as testes, ovaries, copulation, ejaculation, ovulation, and menstruation, which are distinct aspects related to male and female biology.

While other topics (e.g., mitosis and meiosis) discuss fundamental biological processes that occur in both sexes, and in other concepts such as endocrine system, which involves hormones, including sex hormones (not explicitly), the curriculum content shows the distinction of males and females or mention gender-specific requirements primarily in the context of human reproduction and human nutrition. The curriculum does not provide topic-specific examples for this beyond the biological necessities of human reproduction and the nutritional point in human nutrition.

4.3. Gender inclusivity in natural sciences curriculum

Analysis of CAPS Senior Phase (Grades 7-9) Natural Sciences curriculum identified aspects about gender or males and females primarily within the Life and Living knowledge strand, specifically when discussing Human Reproduction and Systems in the human body. The details follow.

4.3.1. Grade 7: Life and living. Within the topic of sexual reproduction, under the sub-heading of human reproduction, the curriculum mentions the biological roles of males and females in reproduction. It states that "the main purpose of reproduction is for the sperm (male sex cell) and egg (female sex cell) to combine... and produce a baby" (DBE, 2011, pp. 20). This section also covers puberty, describing it as the stage “in the human life cycle when sexual organs mature for reproduction” (pp. 20). It further details the distinct structures involved, listing the male and female reproductive organs. The content also links puberty to the release of sex hormones (testosterone and oestrogen) from the testes and ovaries, respectively, and indicates that these hormones cause secondary sexual characteristics.

4.3.2. Grade 9: Life and living. The topic systems in the human body include the reproductive system. The dedicated topic of Human reproduction in Grade 9 reiterates the purpose (gametes combining) and puberty. It also highlights the role of the pituitary gland triggering testes and ovaries to release sex hormones (testosterone and oestrogen), causing secondary sexual characteristics. It also lists and describes the male reproductive organs and female reproductive organs as stages of reproduction.

4.4. Gender inclusivity in physical sciences curriculum

The Physical Sciences curriculum does not mention specific teaching methods or content adjustments aimed at making the teaching and learning ‘gender-responsive’ beyond the general principles of inclusivity for all diverse learners.

5. Discussions

The findings show a clear superficial of treatment of gender issues within science curriculum documents. Although the Department of Basic Education (DBE, 2011) nominally acknowledges gender by stating that every learner, regardless of gender, should be supported to reach their full potential, this reference is relegated to the curricula's general aims and principles, lacking any meaningful integration into the actual content or pedagogical guidance. A closer examination of the Life Sciences curriculum reveals only a token mention of gender within the context of human nutrition, a gesture that falls short of meaningful engagement. Beyond this isolated instance, the Life Sciences and Natural Sciences curricula mirror the Physical Sciences curriculum in their complete silence on gender.

This absence of explicit gender considerations and pedagogical strategies for inclusivity undermines efforts to promote equality in science education. Crucially, it contradicts the assertion by Lynch et al. (2018) that STEM-focused curricula must be underpinned by teachers who are not only well-prepared but also equipped to navigate and address gender dynamics in their classrooms. The current science curricula fail to provide such guidance, thereby implicitly upholding the gender biases it claims to challenge. This signals a critical oversight in curriculum design and teacher support, one that perpetuates the marginalisation of gender issues in science education rather than dismantling them. An inclusive curriculum should embed gender responsiveness within its structure, content, and instructional expectations. Considering the social critical theory, this mirrors what Kincheloe and McLaren (2011) lamented as the institutionalisation of these ill practices which may end up as normal, yet they are not.

6. Conclusions

Considering the analysis made, it shows that the three science curricula do not stipulate any gender responsive teaching and learning. Whilst in principle the curricula commit to responding to the needs of all learners from diverse contexts, gender included, it does not guide teachers on how they should do it. It is silent on the implementation strategies which leaves the teachers to do as they see fit. The findings provide implications for both science curricula designers and policy makers on the need to articulate gender matters in the science curricula and provide guidance on how science teachers may implement gender responsive teaching and learning in their classrooms to reduce or eradicate inequalities. The author acknowledges the study's limitations in portraying gender as binary rather than as a continuum.

References

Canuto, P. P. & Espique, F. (2023). Gender equality in science classrooms: Examining the implementation of gender responsive approach and its impact on science education. International *Journal of Learning, Teaching and Educational Research, 22*(6), 659-678. https://doi.org/10.26803/ijlter.22.6.33

Department of Basic Education. (2011). *National Curriculum Statement (NCS) Grades 10–12: Curriculum and Assessment Policy Statement (CAPS) for Life Sciences.* Pretoria: Government Printers.

Department of Basic Education. (2011). *National Curriculum Statement (NCS) Grades 7–9: Curriculum and Assessment Policy Statement (CAPS) for Natural Sciences*. Pretoria: Government Printers.

Department of Basic Education. 2011. *National Curriculum Statement (NCS) Grades 10–12: Curriculum and Assessment Policy Statement (CAPS) for Physical Sciences*. Pretoria: Government Printers.

Hernandez, T. A., & Cudiamat, M. A. (2018). Integrating gender and development (GAD) in the classroom: The case of Lucsuhin National High School, Department of Education-Philippines. *KnE Social Sciences, 3*(6), 1135. https://doi.org/10.18502/kss.v3i6.2430

Kincheloe, J. L. & Mclaren, P. (2011). Reflecting on critical theory and qualitative research. In K. Hayes, S. R. Steinberg, & K. Tobin (Eds.), *Key Works in Critical Pedagogy. Bold Visions in Educational Research* (Vol. 32). Sense Publishers. https://doi.org/10.1007/978-94-6091-397-6_24

Kerkhoven, A. H., Russo, P., Land-Zandstra, A. M., Saxena, A., Rodenburg, F. J. (2016). Gender stereotypes in science education resources: A visual content analysis. *PLoS ONE, 11*(11), e0165037. https://doi.org/10.1371/journal.pone.0165037

Lynch, S. J., Burton, E. P., Behrend, T., House, A., Ford, M., Spillane, N., Matray, S., Han, E., & Means, B. (2018). Understanding inclusive STEM high schools as opportunity structures for underrepresented students: Critical components. *Journal of Research in Science Teaching, 55*(5), 712-748. https://doi.org/10.1002/tea.21437

Miller, D. I., Eagly, A. H., & Linn, M. C. (2015). Women's representation in science predicts national gender-science stereotypes: Evidence from 66 nations. *Journal of Educational Psychology, 107*(3), 631-644. https://doi.org/10.1037/edu0000005

UNESCO Institute for Statistics, Women in Science. (2015). Available at: http://www.uis.unesco.org/ScienceTechnology/Documents/fs34-2015-women%20in%20science-en.pdf.

Wigati, I. (2019). The social aspects of gender-responsiveness in schools. *Sawwa: Jurnal Studi Gender, 14*(2), 147-162. https://doi.org/10.21580/sa.v14i2.4523

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

HUMAN RIGHTS PREREQUISITES FOR MIDDLE LEADERS IN PROMOTING INCLUSION AND EQUITY IN DIVERSE SCHOOL CONTEXTS

June Monica Palmer[1], & Edwin Darrell De Klerk[2]
[1]*Professional Studies in Education, North-West University: Potchefstroom Campus (South Africa)*
[2]*Professional Studies in Education, North-West University: Mahikeng Campus (South Africa)*

Abstract

Despite being at the vanguard of converting policy into feasible workplace practices, middle leaders (MLs) are frequently seen as being in a difficult situation because of their position. MLs must balance numerous responsibilities, navigate complicated situations, and they often lack the authority to make final decisions. For MLs to initiate transformative change, they must be afforded the freedom and opportunity to engage creatively with policy and practice to advance equitable human rights cultures that are more consistent with their educational principles. This article examines how MLs can generate human rights cultures through engaging in the discursive policy arena while harnessing democratizing tactics in diverse school contexts. Applying a conceptual research design and looking through the lenses of the theory of human rights, we contend that MLs in schools are now more critical than ever to guarantee that the core principle of democracy is realized in diverse learning environments. To this end, we offer an analysis of the United Nations Educational, Scientific and Cultural Organisation (UNESCO, 2017) guide for ensuring equity and inclusion in education. From this analysis, we suggest that human rights prerequisites like *promoting equal dignity, policy actors for equality and inclusion,* and *harnessing collective responsiveness* can be applied as institutional practices to prevent human rights violations in diverse school contexts.

Keywords: *Discursive policy arena, equity, human rights cultures, inclusion, human rights prerequisites.*

1. Introduction

Middle leaders (MLs) (including senior teachers, master teachers, department heads, head teachers, senior leaders, and deputy principals) are individuals who use transformative energy to drive positive change and contribute to continual human rights leadership development in schools (Pinheiro & Alves, 2024). To drive positive change, MLs must create patterns of inquiry and establish cultures of sharing and trust amongst colleagues (Grimm, 2023), while playing a pivotal role in driving inclusive practices and creating equitable learning environments in schools (European Agency for Special Needs and Inclusive Education (EASNIE, 2014). Despite these expectations (EASNIE, 2014; Grimm, 2023; Pinheiro & Alves, 2024) and considering Carvalho and Veiga's (2024) study that investigated the role of middle leadership in promoting inclusive education policies in Portugal, a lack of articulation between policies and MLs' practices negatively influence the promotion of equity and participation in educational processes. As such, MLs should be empowered on how to engage in democratising tactics to promote inclusion and equity in education more than what has been customary (Carvalho & Veiga, 2024). In UNESCO's Global Education Monitoring Report, Sharma, Desai and Sayed (2024) appraised the role of MLs in supporting equitable teaching in India and South Africa. The authors underscored that it remains crucial to enhance MLs' skills, awareness and knowledge regarding generating human rights cultures while advancing equity to ensure the provision of inclusive, quality and equitable pedagogies in schools because a strategy for equitability appears to be completely absent (Sharma et al., 2024).

There is an indispensable need for a continuation of the dialogue regarding this phenomenon. As such, the aim of this paper was to explore possible human rights prerequisites MLs may use to promote inclusion and equity in diverse school contexts.

2. Literature review

2.1. Middle leaders' crusade for creating human rights cultures in diverse school contexts

According to the United Nations (UN, 2011), the creation of human rights cultures (HRCs) through human rights education should be based on "*knowledge and understanding of human rights norms and principles, the values that underpin them and the mechanisms for their protection…which includes empowering persons to enjoy and exercise their rights and to respect and uphold the rights of others*" (as cited in Rossouw & De Waal, 2019, p. 49). In view of this explanation of establishing HRCs, MLs are in an ideal position to engage in agentic and creative responses to policies (Ainsworth et al., 2024), to transform diverse school environments, create a culture of rights, and foster respect for human dignity. We, therefore, contend that MLs should actively provide guidance of how schools can integrate human rights characteristics and human rights nuanced care, whilst creating inclusive and equitable practices. In so doing, they are suitably positioned to facilitate mindset changes so that others understand and interact with human rights issues and promote respect thereof (*vide:* South African Human Rights Commission [SAHRC], 2023). In their crusade for creating human rights cultures in diverse school contexts, MLs become transformative agents who have the power to change the life-worlds of all stakeholders enabling them to view matters of inclusivity, equity, equality and freedom from fresh perspectives (*vide:* Rossouw & De Waal, 2019).

2.2. Human rights prerequisites for inclusion and equity

The ability to promote inclusion and equity in diverse school contexts is dependent on MLs' knowledge about the meaning of equity and inclusion, and what strategies can be employed for applying these as human rights prerequisites. Firstly, inclusion presupposes "*the spirit of identifying and appreciating differences through ensuring equality guided by sound principles*" (Tchombe, 2022, p. 8). In essence, MLs should understand that inclusion requires transformative learning experiences that aim to contribute to deep, structural shifts of feelings, actions and thoughts – prerequisites necessary to promote self-confidence and self-worth (*vide:* Tchombe, 2022). Secondly, equity assumes the expansion of individuals' opportunities so that they can enjoy a life valued to live (Ward, 2020). To understand such a view of equity, MLs are required to have agency, capacity and creativity so that they lead the way in developing "*to the maximum the individual, social, intellectual, cultural, and emotional capacities of individuals*" (De los Santos et al., 2020, p. 1). Drawing on the Organisation for Economic Co-operation and Development (OECD, 2023), MLs' understanding of equity and inclusion may assist in reducing differences, through the creation of human rights cultures and practices, and the implementation of policies that eliminate prevailing human rights hurdles in diverse school contexts.

2.3. UNESCO's guide for ensuring equity and inclusion in education

UNESCO's (2017) guide for inclusion and equity was developed to assist individuals in finding ways to ensure equal educational opportunities for all, provide support to countries in entrenching equity and inclusion in educational policy and suggest transformative ways to overcome educational barriers while ensuring that all learners are respected and engaged equally. To achieve the latter goal (UNESCO, 2017), school leaders [also MLs] must have a strong understanding of equity and inclusion as fundamental human rights. In line with this paper, MLs must understand that while inclusion is regarded as "a process that helps to overcome barriers limiting the presence, participation and achievement of learners", equity aims to "*ensure that there is a concern with fairness, such that the education of all learners is seen as being of equal importance*" (UNESCO, 2017, p. 7). We argue that an application of selected texts in the UNESCO (2017) guide for inclusion and equity can assist MLs to develop a strong sense of agency (Ball, 2021), while they acquire the necessary skills and competencies to meet the growing need for human rights action in the educational setting.

3. Theoretical framework

This paper considered Sen's (2004) version of a theory of human rights which holds that human rights create justifications for action for those who can help in promoting underlying freedoms. In this regard, freedoms are privileged and identified in the interpretation of specific rights. Sen (1985) explains freedoms as the ability to choose between options, but also the value of those options and the ability to live a life that can be regarded as valuable. For example, equity as a freedom requires that people admit that everyone is differently privileged, skilled and abled, therefore, their differences must be considered toward expressing equality (*vide:* Sen, 1985; 2004). Drawing from Sen (2004) on the elements of a theory on human rights, we considered the following questions as guiding criteria in analysing selected texts in UNESCO's (2017) guide for inclusion and equity in education:

- How are the identified human rights prerequisites explained?
- What can MLs do to advance the identified human rights prerequisites?
- How MLs ensure that the identified prerequisites contribute to equity and inclusion in diverse school contexts?

Drawing from Sen (1985; 2004), an application of a theory of human rights was useful because it guided us to understand and justify why MLs play an important role in promoting equity and inclusion in diverse school contexts.

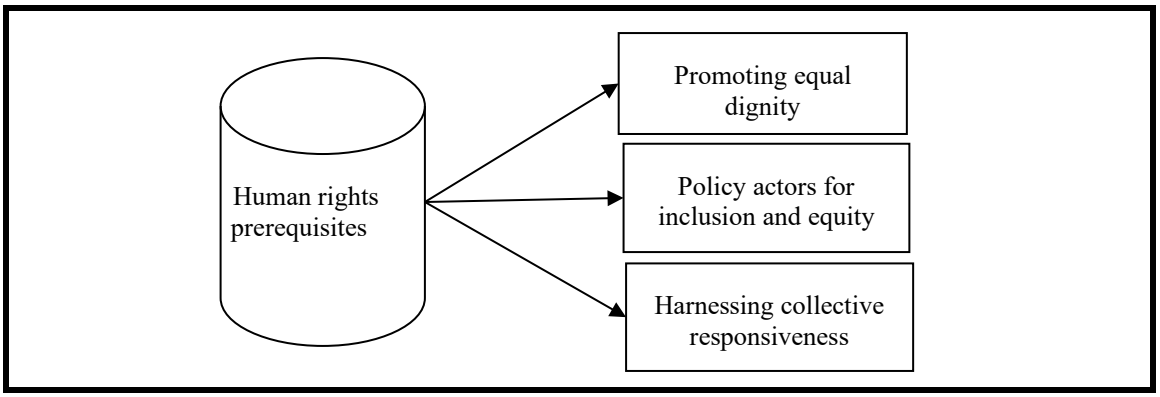
4. Methodology

This conceptual paper followed a qualitative approach to understanding meanings of selected texts in UNESCO (2017) regarding the promotion of inclusion and equity in diverse school contexts. A qualitative approach was useful because we were able to collect data from a relevant document without relying on the views of human beings as participants (Bowen, 2009; Vargo & Koskela-Huotari, 2020).). We employed a conceptual research design (CRD) because such papers "*are often critical engines for exploring new ideas*" (Moorman et al., 2019, p. 3) and it "*offers a unique freedom, allowing researchers to explore new ideas beyond conventional boundaries*" (Heinonen & Gruen, 2024, p. 2). We based our exploration on an analysis of selected texts in UNESCO (2017) to find a novel approach to the promotion of inclusion and equity in diverse school contexts. Firsly, we examined the document to familiarize ourselves with relevant texts that hold potential meanings about inclusion and equity. Secondly, we selected texts with the strongest association with the phenomenon being studied. Thirdly, we employed coding to inspect a coherent portion of the selected texts and labelling it with words or phrases that summarize their content (*vide:* Linneberg & Korsgaard, 2019). Next, we identified four themes that served as human rights prerequisites for MLs in promoting inclusion and equity in diverse school contexts. These themes include *promoting equal dignity, policy actors for equity and inclusion,* and *harnessing collective responsiveness*. During the analysis of selected texts in the UNESCO (2017), we employed the questions outlined in the theoretical framework as guiding criteria.

5. Discussion

We propose the following human rights prerequisites that can guide MLs in fostering inclusion and equity in diverse school contexts (Figure 1).

Figure 1. Human rights prerequisites.



5.1. Promoting equal dignity

UNESCO (2017) advises that is necessary to articulate "*principles and rights that is needed for creating a framework for inclusion, and for reforming those elements in the existing system that may constitute major barriers to equity*" (p. 23). Ainscow (2020) contends that the creation of a framework for inclusion and equity should be based on an inclusive turn, implying the fostering of a culture where differences are celebrated, and equal dignity is promoted. Equal dignity presupposes a "*a state full of life and vigour; comfort and happiness, to grow and augment; to thrive*" (Ogilvie, 1882, as cited in Logan, Berman & Prescott, 2023, p. 4). Thus, to promote equal dignity, we recommend that MLs create opportunities for relationship building, facilitate dialogues so that everyone can understand constitutional theories about inclusion and equity and facilitate activities toward the collective realisation of human potential.

5.2. Policy actors for inclusion and equity

UNESCO (2017) is adamant that "*education policy can influence and support inclusive thinking and practices by establishing the equal right of every individual to education, and by outlining the forms of teaching, support and leadership that lay the foundation for quality education for all*" (p. 12). The influential and supportive role of education policy paves the way for the search of solutions to educational challenges and the establishment of strong educational relationships (Fan & Popkewitz, 2020). In this regard, MLs should act as policy actors - individuals who decipher meanings [of inclusion and equity] in policies (Maguire, Braun & Ball, 2015) and translate policy ideas [about inclusion and equity] into contextualised practices (Braun, Maguire & Ball 2010).

5.3. Harnessing collective responsiveness

To harness collective responsiveness, action should be taken to "*bring together practitioners' ideas, the insights of students and their families, and the knowledge of academic researchers so as to challenge assumptions, stimulate new thinking within a school*" (UNESCO, 2017, p. 36). This statement (UNESCO, 2017) reflects the notion of collective responsiveness to past and present challenges that may hinder inclusion and equity. Therefore, MLs should articulate policy ideas into simpler rules that can be communicated and applied consistently (Lunn, Timmons & Robertson, 2025) to promote an understanding of inclusion and equity. In so doing, MLs can stay abreast of developing practices and implementation strategies related to creating inclusive and equitable learning, whilst becoming the forerunners for the enactment of human rights cultures in diverse school contexts.

6. Conclusion

The aim of this paper was to examine how MLs can generate human rights cultures through engaging in the discursive policy arena while harnessing democratizing tactics of inclusion and equity in diverse school contexts. The literature review revealed that MLs are ideally positioned to respond to policy ideals about inclusion and equity, thus improving the lives of all stakeholders in diverse school contexts. To be agents of transformative change, MLs' must understand how the application of inclusive and equitable practices can assist them in reducing human rights violations in diverse school contexts. We analysed selected texts in UNESCO (2017), proposing human rights prerequisites that may assist MLs in acquiring the necessary competencies to meet the growing need for human rights action in their educational system.

The analysis revealed three pertinent human rights prerequisites. Firstly, to promote *equal dignity*, MLs must be active in building relationships and foster dialogues so all the stakeholders can understand how to contribute to fostering inclusive and equitable learning environments. Secondly, MLs should act as *policy actors*, individuals capable of searching for and understanding meanings about inclusion and equity so that policy ideas can be converted into executable human rights practices. Thirdly, MLs must harness *collective responsiveness* and articulate policy ideas into easy-to-follow instructions that can be conveyed and implemented uniformly to promote an understanding of inclusion and equity.

This conceptual paper did not include the voices of the relevant educational stakeholders; therefore, we recommend that future research should focus on how they perceive and act on human rights prerequisites in pursuit of inclusive and equitable practices in diverse school settings.

References

Ainscow, M. (2020). Promoting inclusion and equity in education: lessons from international experiences. *Nordic Journal of Studies in Educational Policy, 6*(1), 7-16. https://doi.org/10.1080/20020317.2020.1729587

Ainsworth, S., Da Costa, M., Davies, C., & Hammersley-Fletcher, L. (2024). New perspectives on middle leadership in schools in England – Persistent tensions and emerging possibilities. *Educational Management Administration & Leadership*, *52*(3), 541-555. https://doi.org/10.1177/17411432221086847

Ball, S. J. (2021). *The education debate* (4th ed.). Bristol: Policy Press.

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal*, *9*(2), 27-40. https://doi.org/10.3316/QRJ0902027

Braun, A., Maguire, M., & Ball, S. J. (2010). Policy enactments in the UK secondary school: Examining policy, practice and school positioning. *Journal of Education Policy, 25*(4), 547-560. https://doi.org/10.1080/02680931003698544

Carvalho, A. E., & Veiga, A. (2024). The role of middle leadership in promoting inclusive education policies through the participation of the educational community in Portugal. *International Journal of Educational Leadership and Management, 12*(3), 225-247.

De los Santos, P. J., Moreno-Guerrero, A., Marín-Marín, J., & Costa, R. S. (2020). The term equity in education: A literature review with scientific mapping in Web of Science. *International Journal of Environmental Research and Public Health, 17*, 1-18. https://doi.org/10.3390/ijerph17103526

European Agency for Special Needs and Inclusive Education (EASNIE). (2014). *Organisation of provision to support inclusive education – Summary report*. Odense, Denmark: European Agency for Special Needs and Inclusive Education. Retrieved from https://www.european-agency.org/sites/default/files/Organisation%20of%20Provision%20Summary%20Report.pdf

Fan, G., & Popkewitz, T. S. (Eds.). (2020). *Handbook of education policy studies: Values, governance, globalization, and methodology.* Volume 1. Springer Open.

Grimm, F. (2023). Teacher leadership for teaching improvement in professional learning communities. *Professional Development in Education, 50*(6), 1135-1147. https://doi.org/10.1080/19415257.2023.2264286

Heinonen, K., & Gruen, T. (2024). Elevating conceptual research: Insights, approaches, and support. *AMS Review, 14*, 1-6. https://doi.org/10.1007/s13162-024-00283-9

Linneberg, M. S., & Korsgaard, S. (2019). Coding qualitative data: a synthesis to guide the novice. *Qualitative Research Journal*, *19*(3). 259-270. https://doi.org/10.1108/QRJ-12-2018-0012

Logan, A. C., Berman, B. M., & Prescott, S. L. (2023). Vitality revisited: The evolving concept of flourishing and its relevance to personal and public health. *International Journal of Environmental Research and Public Health, 20*, 1-15. https://www.mdpi.com/journal/ijerph

Lunn, P., Timmons, S., & Robertson, D. (2025). Promoting a nationwide collective response: lessons from the social activity measure during the COVID-19 pandemic. *ESRI Research Series, 204*, 1-3. https://www.esri.ie/system/files/publications/RB202506.pdf

Maguire, M., Braun, A., & Ball, S. (2015). Where you stand depends on where you sit: The social construction of policy enactments in the (English) secondary school. *Discourse: Studies in the Cultural Politics of Education, 36*(4), 485-499. https://doi.org/10.1080/01596306.2014.977022

Moorman, C., Van Heerde, H. J., Moreau, C. P., & Palmatier, R. W. (2019). Challenging the boundaries of marketing. *Journal of Marketing, 83*(5), 1-4. http://dx.doi.org/10.1177/0022242919867086

Organisation for Economic Co-operation and Development (OECD). (2023). *Equity and inclusion in education: Finding strength through diversity*. OECD. https://www.oecd.org/content/dam/oecd/en/publications/reports/2023/01/equity-and-inclusion-in-education_e8cfc768/e9072e21-en.pdf

Pinheiro, G. & Alves, M. (2024). Middle leadership in educational teams: Practices and effects on the development of learning communities. *International Journal of Educational Leadership and Management, 13*(3), 271-295. http://dx.doi.org/10.17583/ijelm.13618

Rossouw, J. P., & De Waal, E. (eds.). (2019). *Human rights in diverse education contexts. NWU Education and human rights in diversity series*. Volume 1 (pp. i–356). Cape Town: AOSIS.

Sen, A. (1985). Well-Being, agency and freedom: The Dewey lectures 1984. *The Journal of Philosophy, 82*(4), 169-221. http://www.jstor.org/stable/2026184?origin=JSTOR-pdf

Sen, A. (2004). Elements of a theory of human rights. *Philosophy & Public Affairs, 32*(4), 315-356. https://jenni.uchicago.edu/WJP/papers/Sen_2004_v97_n4_elements.pdf

Sharma, G., Desai, D., & Sayed, Y. (2024). *Supporting equitable teaching and teachers: The role of middle tier leadership in India and South Africa*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000391533

South African Human Rights Commission (SAHRC). (2023). *Revised SAHRC strategic plan 2020-2025*. South Africa: Government Printer. Retrieved from https://static.pmg.org.za/SAHRC_Revised_Strategic_Plan_2020_-_2025_as_at_7_March_2023.pdf

Tchombe, T. M. S. (2022). The philosophy of inclusion in education. *Revista UFG, 22*(22), 1-27. https://doi.org/10.5216/revufg.v22.74068

United Nations (UN). (2011). *United Nations declaration on human rights education*. New York, NY: United Nations.

United Nations Educational, Scientific and Cultural Organisation (UNESCO). (2017). *A guide for ensuring inclusion and equity in education*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000248254

Vargo, S. L., & Koskela-Huotari, K. (2020). Advancing conceptual-only articles in marketing. *AMS Review, 10*(1-2), 1-5. http://dx.doi.org/10.1007/s13162-020-00173-w

Ward, C. (2020). Theories of justice underpinning equity in education for refugee and asylum-seeking youth in the U.S.: considering Rawls, Sandel, and Sen. *Ethics and Education, 15*(3), 315–335.

WORKSHOPS

Designed by Freepik

FAST-TRACK YOUR RESEARCH WITH GENAI: ESSENTIAL TOOLS AND BEST PRACTICES FOR RESPONSIBLE USE

Jeroen Lievens[1], & Björn Sjödén[2]
[1]Faculty of Engineering Technology, University of Leuven (Belgium)
[2]School of Education, Halmstad University (Sweden)

Abstract

Higher education faculty often juggle an array of tasks, including teaching, student support, administrative tasks, and research—a workload that GenAI tools could help streamline. This workshop zooms in onto the research applications of GenAI. It sets out to explore which GenAI tools can increase productivity at every stage of the research process, while also paying due attention to concerns regarding responsible use. The aims of the workshop are: a) to explore and experiment with dedicated GenAI tools such as Google NotebookLM, Elicit, Perplexity, Consensus, Semantic Scholar, Research Rabbit, Scite, LitMaps, Scholarcy, Inciteful, Quillbot, Writeful, Connected Papers, ChatPDF, TLDRthis, Jenni and scispace AI; b) to determine where they best fit in the research workflow (brainstorming, scoping, finding and screening literature, summarizing, writing, revising and publishing); c) to canvas and evaluate the tools on essential criteria such as usability, reliability, cost, and adaptability; and d) to consider best practices for responsible use focusing on such concerns as data privacy, publishers' guidelines and bias. Through guided and hands-on activities, participants will collectively build a matrix of tool-specific use cases, pros and cons of each tool, and a set of best practices for responsible and effective GenAI integration. By the workshop's end, attendees will be equipped to incorporate GenAI tools thoughtfully into their research, maximizing benefits while navigating potential risks.

Keywords: *Artificial Intelligence, Generative AI, research, responsible use, GenAI.*

1. Introduction

Higher education faculty often struggle to live up to their many daily tasks, including teaching, student support, administrative work, and research—a balancing act that has become increasingly challenging in recent years. While all these responsibilities compete for limited time and attention, research activities in particular require sustained focus and systematic effort across multiple stages: from initial literature review and hypothesis formation to data collection, analysis, and manuscript preparation. The emergence of Generative Artificial Intelligence (GenAI) tools presents a potential opportunity to streamline these research workflows and enhance productivity (Bolaños et al., 2024; Wagner et al., 2021). However, their integration into research practices raises important questions about responsible use, academic integrity, and the maintenance of scholarly standards. Faculty members need guidance on how to leverage these tools effectively without disregarding ethical principles and institutional policies.

This workshop addresses this critical need by examining several GenAI tools across the research lifecycle. The tools under review include Google NotebookLM, Elicit, Perplexity, Consensus, Semantic Scholar, Research Rabbit, Scite, LitMaps, Scholarcy, Inciteful, Quillbot, Writeful, Connected Papers, ChatPDF, TLDRthis, Jenni and scispace AI. Through collaborative assessment, attendees will apply a systematic protocol to evaluate each tool's usefulness, usability, accessibility, adaptability, reliability, and privacy/security features.

2. Review protocol

Step 1: Preparation

1. Access the Tool
   Visit the tool's website or platform and sign up/log in if required.
   Ensure you can access all features available under the free version (if applicable).
2. Familiarize Yourself
   Read the tool's description, purpose, and features.

Watch any introductory videos or browse FAQs/tutorials for a basic understanding.

Step 2: Evaluate Usefulness

1. Task Alignment
   Identify which stage(s) of the research workflow the tool targets (e.g., brainstorming, literature review, writing).
   Test whether the tool fulfills this role effectively using a simple research task. Example: Use a brainstorming tool to generate ideas for a specific topic. Use real cases from your research field.
2. Value Addition
   Does the tool provide a clear benefit over "traditional" methods?
   Are its features relevant and unique for researchers in your field?
   Compare output quality to human baseline performance.
   Assess time saved versus time invested in learning/using the tool.
4. Limitations
   Note any features that are missing or underwhelming.
   Document any (discipline-specific) limitations.

Step 3: Assess Usability

1. Interface and Navigation
   Is the interface intuitive? Can you perform basic tasks without significant guidance?
   Are menus, buttons, and features clearly labeled and easy to find?
2. Learning Curve
   How quickly did you understand how to use the tool?
   Are there any features or workflows that felt confusing or cumbersome?
3. Support
   Check if there are tutorials, user guides, or a help center available.
   Evaluate the quality and accessibility of support resources.

Step 4: Analyze Cost

1. Free vs. Paid Features
   What functionality is available for free?
   Are any critical features locked behind a paywall?

Step 5: Examine Adaptability

1. Customization
   Can you tailor the tool to suit your specific needs or preferences?
   Example: Adjusting search parameters, modifying outputs.
2. Integration
   Does the tool integrate with other research software or platforms (e.g., Mendeley, Zotero, Microsoft Word)?
   Are there export/import options for data or results?
3. Flexibility Across Disciplines
   Does the tool cater to a range of academic fields, or is it more specialized?
   Document any discipline-specific adaptations or limitations.

Step 6: Evaluate Reliability

1. Performance
   Are the results consistent when performing similar tasks?
   Note any bugs, crashes, or issues encountered during use.
2. Accuracy
   If applicable, compare the tool's output with known reliable sources to check for errors or misinterpretations.
   Test reproducibility: can you get similar results with similar inputs?
   Document any instances of AI hallucination or fabrication.

Step 7: Privacy and Security

1. Data Usage
   What personal or research data does the tool request or collect?
   Are data usage terms transparent and easy to understand?
2. Compliance
   Does the tool comply with relevant data protection guidelines?

3. Security Measures
   Are there visible measures to secure user data (e.g., encryption, two-factor authentication)?

Step 8: Ethical Considerations
1. Bias Assessment
   If applicable, test for potential biases in outputs.
2. Academic Integrity
   Check alignment with your institutional AI policies and/or with the AI policy of the publisher you wish to submit your research to (e.g., the Elsevier GenAI policy: https://www.elsevier.com/about/policies-and-standards/generative-ai-policies-for-journals)

Step 9: Summarize Findings
1. Score the Tool
   Assign a score (e.g., 1-5) for each criterion based on your observations.
2. Key Insights
   Summarize the tool's strengths and weaknesses.
   Highlight one feature you found particularly useful or problematic.
3. Use Case Analysis
   Identify specific scenarios where the tool excels.
   Document situations where the tool may not be appropriate.
4. Recommendations
   State whether you would recommend the tool for specific research tasks or users.
   Include cost-benefit analysis for different user types.
   Suggest optimal use cases and potential alternatives.

3. Knowledge gained, shared and maintained

The protocol and results are shared through an online collaborative spreadsheet, to which all participants will continue to have access after the workshop. This living document provides a comprehensive overview of available GenAI tools and it will help researchers make informed decisions – both from a practical and an ethical perspective – about which tools might benefit their specific workflows. As new tools emerge and existing ones evolve, our aim is to make this a collaborative resource of "best practices" which continues to grow and inspire the research endeavours of the participants.

Acknowledgements

The GenAI tool Claude AI by Anthropic served as a valuable assistant, supporting the drafting and writing process of this document. The authors assume complete responsibility for the final manuscript's content.

References

Bolaños, F., Salatino, A., Osborne, F., & Motta, E. (2024). Artificial intelligence for literature reviews: Opportunities and challenges. *arXiv:2402.08565*. Retrieved January 13, 2025, from: https://arxiv.org/abs/2402.08565

Wagner, G., Lukyanenko, R., & Paré, G. (2021). Artificial intelligence and the conduct of literature reviews. *Journal of Information Technology, 37*(2), 209-226.

p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-35728-8-7 © 2025

DEVELOPING TEACHERS' PROMPTING COMPETENCE USING CHATGPT: A COLLECTIVE ANTI-SHORTCUT APPROACH

Björn Sjödén[1], & Jeroen Lievens[2]
[1]School of Education, Halmstad University (Sweden)
[2]Faculty of Engineering Technology, University of Leuven (Belgium)

Abstract

The use of generative AI (GenAI) such as ChatGPT highlights the need for educators to develop critical competencies in order to harness its gains and limit its weaknesses for learning and productivity. This workshop aims to engage participants in a collective effort to define what makes for good "prompting competence", that is, how instructions to the GenAI should be formulated by the user to generate desirable outcomes. A starting point is that what is desirable from an educational perspective differs notably from that of production; whereas productivity gains with GenAI are quick, human learning is slow and requires time for reflection and adaptation. Recent research suggests that extensive use of GenAI encourages users to take "cognitive shortcuts" – favoring fast and optimal solutions over slower and less practical ones – which negatively affects users' cognitive abilities. We aim to explore effective countermeasures to such risks. In taking a deliberate "anti-shortcut" approach, participants will carry out a routine pedagogical task (grading a short text) using step-wise instructions (prompts) in ChatGPT. First, participants are presented with some concrete examples of effective/ineffective prompts. Second, small teams will "compete" in prompting ChatGPT to perform as well as possible, compared to a set benchmark (a human professional assessment of the text). Once the "winner" is determined, we will collectively "reverse engineer" what made the winning team's prompting successful and reflect upon its implications for developing crucial competencies (e.g. critical thinking, analysis). The workshop is intended primarily for teachers in higher education with elementary experience of ChatGPT.

Keywords: *Generative AI, digital competence, higher education, ChatGPT, prompting.*

1. Introduction

It would be an understatement to claim that generative AI, or GenAI, is changing educational practices. However, users are still in the adaptation phase of embracing the technology – some with more hesitation than others – and it is becoming equally apparent that the extent and types of uses of GenAI vary widely between different academic institutions, as well as by individual teachers and students within the same institution. The academic literature can hardly keep up to date with this development. Some practice-oriented books quickly followed the unprecedented success of ChatGPT 3.5 (e.g. Hunter, 2023; as the author notes in the introduction, ChatGPT took five days to reach one million users; Instagram took 2.5 months and Netflix took 14 months). An emerging core competence is so-called "prompt engineering" – that is, how instructions to the GenAI can be effectively formulated and improved – which inspired our present proposal for increasing teachers' prompting competence in relation to student work (which itself may involve using GenAI). Considering that presented examples of outcomes and limitations may become outdated already at the time of publication as the technology advances, we hold that any prescribed guidelines should be combined with actual training sessions to maintain their relevance and applicability. Therefore, rather than presenting empirical findings from our own work, or a ready-made recipe for teachers to follow, we chose a process-oriented approach in the form of a workshop, which aims to develop the participants' current knowledge of the present technology (in this case, the most used version of ChatGPT) in relation to a benchmark set by human professionals. Here, we outline the structure of such a workshop, intended primarily for teachers in higher education, but which may be modified both in length (considering a minimum of 40-45 minutes) and educators on other levels who face similar tasks.

There are two points we find particularly worth considering for conducting a workshop of this kind. First, we hold that human teachers remain the experts in their field, but that they may learn how to use GenAI, such as ChatGPT, for carrying out certain educational tasks, such as assessing a student text, more effectively, while maintaining their professional standard and integrity. To achieve this, teachers must learn how to prompt properly. Second, we must consider the pitfalls associated with achieving deceivingly quick results with technology that could mislead users to taking shortcuts and by-pass their critical thinking (Zhai et al., 2024). That is, we need to think before we act. The idea of a "collective anti-shortcut approach" warrants some elaboration before we describe how it may be implemented in the actual structure of the workshop.

2. The problem of shortcuts (and how to make them problem-free)

We believe that people – teachers and students included – are entitled to take shortcuts in known territories, in order to reach their goals faster and in the service of others. For students, this could mean using ChatGPT for explaining a concept they did not understand from the teacher, rather than having to ask the teacher again (if at all possible). For teachers, it could mean using ChatGPT for constructing or making an assessment, to free up their time and resources for helping students learn rather than just assessing them. In both cases, it is assumed that the user already has the required skill (asking for help, constructing a test) which has been preceded by much longer learning (going to school, taking a research degree). Importantly, what is being produced (knowledge) must not be confused with the process of production (learning).

Whereas productivity gains with GenAI can be quick, human learning is slow and requires time for reflection and adaptation. There is overwhelming evidence that humans resist mental effort when they can, and that hard thinking is generally associated with negative affect (David et al., 2024). This fact itself may explain what Zhai et al. (2024) refer to as users' tendency to take "cognitive shortcuts", or heuristics, when using AI, in the face of ethical issues and at the risk of a negative impact on their cognitive abilities. A core risk that applies to students and teachers alike is an over-reliance on the AI output, without proper questioning and verification (including factors such as AI hallucination, algorithmic bias, plagiarism, privacy concerns, and transparency issues, and how over-reliance impacts decision-making, critical thinking, and analytical thinking). In short, taking shortcuts with AI may lower educational quality (Ahmad et al., 2023), unless careful attention is given to such issues. In our case, we specifically target how teachers may avoid taking invalidated shortcuts to assessment by carefully examining and reconstructing their prompts, while acknowledging that AI can be highly useful for this kind of task. For example, good prompt engineering has been highlighted as critical to avoid and mitigate the weaknesses of using GenAI, with reference to ChatGPT specifically (Johnson, 2024).

Our idea is that the collective knowledge of the participants is best captured and developed by "reverse engineering" prompts which yield the result most closely matching that of a set human benchmark. That is, we start from a proven, functional end result (the prompting that generated the best assessment according to a predetermined, high human standard) and then analyze its structure and method, rather than starting from the basics of how to formulate prompts (and gradually work one's way up towards a hopefully functional result). Hence, by first engaging together in slower, possibly effortful but rewarding thinking, we aim to clear the thickets of the current GenAI use, such that educational practices can move forward, ethically, mindfully and practically, and with a clearer goal in sight. This anti-shortcut approach to learning better prompting may thus properly prepare teachers to create the shortcuts they truly need and wish for, without the cost of losing track of the terrain.

3. Workshop structure

The present protocol is intended for a full workshop of about 45 minutes, in five steps.

3.1. Brief introduction (5 min)

Quick overview of prompting competence and why it matters.

- The anti-shortcut approach: Avoiding over-reliance on AI by understanding how to prompt effectively – and avoiding pitfalls from learning it not too quickly.
- The challenge: Using ChatGPT to grade an (excerpt from an) essay as accurately as a human.

3.2. Effective vs. ineffective prompts (10 min)

Participants review three different grading prompts:

- A basic/ineffective prompt
- A suboptimal prompt
- A highly effective one

Group discussion: What makes some prompts work better than others?

3.3. Team-based prompting challenge (15 min)

Teams (3-5 people) compete to create the "best" prompts in ChatGPT for a given task (assessing/grading a short student text):

- The teams iterate and refine their prompts for better AI responses.
- Goal: Match or exceed a human-provided assessment benchmark.

Teams submit their final prompts.

3.4. Reverse engineering the "best" prompt (10 min)

The winning prompt is analyzed step by step:

- What made it work?
- How did it structure instructions?
- How can these principles apply reliably, for different texts and assessment criteria (e.g. are there possible sources of errors humans would not do)?

Teams adjust their own prompts based on these insights.

3.5. Rapid reflection & takeaways (5 min)

Participants discuss:

- What can you learn from this prompting approach in your pedagogical practice?
- What are the risks of taking AI shortcuts for pedagogical tasks, such as this?

Summary of best practices and final Q&A.

Acknowledgments

The GenAI tool ChatGPT by Open AI served as a valuable assistant, supporting the drafting and writing process of this document. The authors assume complete responsibility for the final manuscript.

References

Ahmad, S. F., Han, H., Alam, M. M., Rehmat, M., Irshad, M., Arra.o-Mu.oz, M., & Ariza-Montes, A. (2023). Impact of artificial intelligence on human loss in decision making, laziness and safety in education. *Humanities and Social Sciences Communications, 10*(1), 1-14.

David, L., Vassena, E., & Bijleveld, E. (2024). The unpleasantness of thinking: A meta-analytic review of the association between mental effort and negative affect. *Psychological Bulletin, 150*(9), 1070-1093.

Hunter, N. (2023). *The Art of Prompt Engineering with ChatGPT*. Nathan Hunter: Independently published.

Johnson, W. L. (2024). How to harness generative AI to accelerate human learning. *International Journal of Artificial Intelligence in Education, 34*(3), 1287-1291.

Zhai, C., Wibowo, S., & Li, L. D. (2024). The effects of over-reliance on AI dialogue systems on students' cognitive abilities: a systematic review. *Smart Learning Environments, 11*(1), 28.

AUTHOR INDEX

Adam-Cervera, I. ***397, 560***
Aguilar Rangel, G. ***57***
Aiger, M. ***239***
Alles, S. ***335***
Alonso-Rivera, A. ***130***
Amado, P. ***482***
Amadoro, A. ***521***
Armenta, S. ***397***
Arnold, P. ***47***
Asensio Peral, G. ***496***
Atanassova, E. ***125***
Bakali, M. ***613***
Balceraite, L. ***361***
Banek, N. ***627***
Barbas, M. ***584***
Baş, T. ***603***
Batista, M. ***120***
Bautista Hernández, O. ***57***
Bautista, P. ***156***
Bell, J. ***115***
Bellacicco, R. ***176***
Belyova, S. ***402***
Bennett, C. ***8***
Bouwels, L. ***13***
Bowden II, H. ***153***
Branco, P. ***584***
Bravo-Pacheco, J. ***161***
Braz, R. ***329***
Butvilas, T. ***358***
Cabori, D. ***125***
Capone, F. ***176***
Caraceni, L. ***43***
Carella, G. ***467***
Carratalá, R. ***23***
Casañ-Pitarch, R. ***416***
Castillo, M. ***23***
Catalán, S. ***23***
Céline Martin, J. ***416***
Cervera, M. ***397, 560***
Chagas, L. ***463***
Charlot, J.-M. ***214***
Chatzipanagiotou, P. ***166***
Chica-Paez, Y. ***618***
Cirilli, E. ***243***
Clavero, T. ***13***
Conte, M. ***467***
Costa, A. ***416***
Coutinho, C. ***482***
De Klerk, E. ***598, 652***
Delplancq, V. ***416***
Dhurumraj, T. ***593***
Di Gennaro, D. ***521***
Di Martino, V. ***176***
Diamantopoulou, G. ***258, 298***
Díaz-Pareja, E. ***407, 556***
Dobreva, V. ***632***
Duarte, C. ***120***
Eftimova, S. ***402, 564***
Elboj, C. ***38***
Enebe, N. ***622***
Engblom, J. ***574***
Enlund, E. ***608***
Enríquez-Ortega, K. ***453***
Esteban-Romero, S. ***161***
Eways, J. ***491***
Farag, S. ***268***
Farmosi, A. ***181***
Fattum, A. ***101, 219***
Fehérvári, A. ***344***
Fernández-Martínez, F. ***161***
Fidalgo, S. ***416***
Fleckenstein, J. ***338***
Forrest, R. ***526***
Gambary, P. ***91, 171***
García Pérez, L. ***200***
García-Balaguer, P. ***397, 560***
Garcia-Garcia, D. ***511***
Garcia-Sanoguera, D. ***511***
García-Zambrano, L. ***618***
Gavira-Duron, N. ***130***
Genova, T. ***402, 564***
Gerasimenko, V. ***273***
Gil, M. ***341, 347***
Gilabert-Cerdá, A. ***18, 81***

Gillain, R. ***416***
Gil-Martín, M. ***161***
Glotzbach, R. ***382, 531***
Goodman, J. ***214***
Gottfried, R. ***440***
Govender, D. ***448***
Griffin, O. ***307***
Grinfelde, A. ***637***
Guardabassi, V. ***43, 148, 243, 303***
Haggis-Burridge, M. ***13***
Hänsel, S. ***332***
Hassreiter, S. ***13***
Haugen, T. ***229***
Helander, N. ***293***
Hellsten, P. ***487***
Herráez, A. ***234***
Hilf, N. ***139***
Honzíková, J. ***28, 323***
Horverak, M. ***229***
Hourdakis, A. ***96***
Ieronymakis, Y. ***96***
Iliško, D. ***536, 579***
Inbar-Furst, H. ***440***
Ingaramo, M. ***516***
Ivorra-Martinez, J. ***511***
Jambor, T. ***33***
Jaumot-Pascual, N. ***411, 491, 569***
Jiménez Preciado, A. ***130***
Jordán Soriano, Á. ***496***
Kaila, E. ***3, 61, 574***
Kakana, D. ***367***
Kalaitzi, C. ***367, 546***
Kalobo, L. ***205***
Käpylä, J. ***458, 608***
Karameri, K. ***613***
Kari, S. ***293***
Kartasidou, L. ***258, 298***
Kassai, R. ***344, 355***
Kemka, V. ***352***
Kende, A. ***344***
Kepka, M. ***352***
King, A. ***115***
Kirby, D. ***248***
Knudsen, J. ***372, 411***
Kohlegger, M. ***392***
Krotký, J. ***28, 323***
Kugel, L. ***139***
Kwatubana, S. ***642***
Kyriakidou, E. ***258, 298***
Langeland, G. ***229***
Lara-Meloy, T. ***372, 411, 491, 569***
Lazo, R. ***209***
Leonidou, P. ***258, 298***
Levin-Güracar, E. ***372, 411, 491***
Levy, M. ***440***
Lievens, J. ***659, 662***
Lin, X. ***516***
Llorent-Vaquero, M. ***407, 556***
Lokkila, E. ***3, 61***
Lothamer, J. ***224***
Lozano, R. ***38, 239***
Ļubkina, V. ***361***
Luís, A. ***329***
Machowski, A. ***224***
Madár, L. ***344, 355***
Mainerová, N. ***501***
Makhubalo, P. ***387***
Mancini, G. ***148***
Manoni, E. ***148***
Maramai, A. ***66***
Maranesi, A. ***43, 243, 312***
Martínez-Gil, F. ***341, 347***
Martín-Fernández, I. ***161***
Martins, A. ***253***
Matthew, T. ***153***
Mauri-Aucejo, A. ***560***
Mavunga, R. ***642***
Mavuru, L. ***387, 541, 647***
McGivern, K. ***326***
Meyer, M. ***185, 209***
Michele, J. ***627***
Miranda, J. ***120***
Miranda-Pinzon, M. ***511***
Mkhwebane, L. ***387, 541***
Mohottala, H. ***224***
Mollo, P. ***76, 205***
Montanes, N. ***511***
Monzón, I. ***23***
Morales Cerda, M. ***278***
Morales-Rubio, Á. ***397, 560***

Moscato, M. ***176***
Mqondisi, B. ***551***
Mudadigwa, S. ***598***
Muselinović, S. ***477***
Mwambakana-Mutombo, J. ***317***
Myers, J. ***307***
Myllärniemi, J. ***293***
Nhlumayo, M. ***52***
Nicolini, P. ***43, 148, 243, 312***
Nkohli, T. ***205***
Noel, H. ***115***
Noël, L. ***214***
Notshweleka, U. ***593***
Nusheva, K. ***472***
Ochoa-Luna, J. ***209***
Ogegbo, A. ***435***
Orejudo, S. ***38, 156***
Ortega-Tudela, J. ***407, 556***
Paas, K. ***288***
Pais, S. ***463***
Palmer, J. ***622, 652***
Patrikakou, E. ***143***
Paula, L. ***637***
Pavlina, A. ***477***
Pavlina, K. ***477***
Pechlivanidou, D. ***546***
Peña Estrada, C. ***57***
Penn, M. ***588***
Pereira, J. ***416***
Perera, A. T.-M. ***13***
Pérez-Vázquez, E. ***18, 81***
Piangiamore, G. ***66***
Pillay, R. ***283***
Pinto, M. ***584***
Pippig, M. ***332***
Pires, A. ***463***
Platsidou, M. ***258, 298***
Ploder, C. ***392***
Polipowski, A. ***214***
Poutanen, J. ***608***
Quiles-Carrillo, L. ***511***
Rafanan, K. ***372, 411, 569***
Raho, F. ***176***
Ramezani, D. ***71***
Ramirez-Culebro, C. ***130***
Richards, L. ***307***
Ruchti, W. ***8***
Ruiz-Roqueñi, M. ***618***
Rytilahti, J. ***3, 61***
Saastamoinen, K. ***574***
Sabin, J. ***115***
Sáez-Hernández, R. ***397, 560***
Sanches, T. ***120***
Santos, T. ***253***
Sari, E. ***229***
Saul, K. ***115***
Sawid, F. ***101***
Schmid, R. ***392***
Sethole, K. ***387, 541***
Sharif-Rasslan, A. ***101, 219***
Sierra, J. ***350***
Silva, A. ***253***
Sincuba, L. ***377, 551***
Sjödén, B. ***659, 662***
Smargiassi, B. ***243***
Solundwana, O. ***377***
Sondlo, A. ***52***
Sorrentino, C. ***176***
Sorri, K. ***487***
Souka, M. ***96***
Spiess, T. ***392***
Stervinou, S. ***214***
Steuber, A. ***627***
Stevens, H. ***411***
Stokes, T. ***443***
Suñol, J.-J. ***430***
Supranaviciene, U. ***358***
Sztandera, L. ***135***
Taar, J. ***288***
Teke, N. ***603***
Thamae, L. ***536, 579***
Tomás, V. ***23***
Tomášková, T. ***28, 323***
Torres-Gastelú, C. ***453***
Trokana, A. ***258, 298***
Trueblood, P. ***338***
Ulyanova, M. ***273***
Umair, M. ***224***
Valero, S. ***239***

Valero-Tapia, S. ***156***
Vänt, T. ***288***
Velázquez García, L. ***57***
Vendramin, V. ***111***
Veneruso, U. ***521***
Ventura, J. ***341, 347***
Vidal-Marti, C. ***421***
Vieira, A. ***584***
Vukeya, T. ***541***
Wagner, M. ***71, 263***
Wendland, M. ***86***
Williams, L. ***106, 195***
Xaba, N. ***52, 190***
Xi, H. ***506***
Yankova-Hadzhieva, B. ***472***
Zhang, W. ***536, 579***
Zizka, L. ***425***
Zugelder, B. ***307***
Zurlo, F. ***467***