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*Original scientific paper*

# THE IMPORTANCE OF EDUCATING YOUNGER GENERATIONS ABOUT RAW MATERIALS AND THEIR USES IN OUR DAILY LIFE

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A b s t r a c t: Raw materials are of great importance for humankind as they enable the development of technology, drive industry and economy, and overall the lifestyle we know today. The paper is addressing the topic of interactive learning about the mineral raw materials, i.e. metals and non-metals. Due to population growth and consequently increased global demand for raw materials, there is a need to educate younger generations about the raw materials and their properties and origin, so they would know from an early age where the mineral products they use come from and how purchase decisions affect the social environments of people who live in countries with resources exploitation. Today's trends in mining are oriented towards more sustainable exploitation and management, taking into account the economic, social and environmental aspects. An example of such is exploitation of secondary raw materials from tailings and heaps. But in some countries, mining is stuck in the past, using obsolete technologies causing increased pollution and strongly present linear economy approaches of take-use-dispose attitudes or even unethical approaches, such as children being exploited as a cheap workforce, people being abducted, tortured and even killed over minerals (minerals being exploited in such way are called blood or conflict minerals). Further, due to the potential negative impacts on health and safety, due to the emissions in air, water and surface disturbance, the public perception of mining is still perceived as negative in most cases. School curriculums most often lack description of current situations in the global mining. Therefore, within the EIT RawMaterials BRIEFCASE and 3D BRIEFECASE projects the project partners provide the comprehensive view of the issues of today's mining and use of raw materials. The paper presents the description of both projects and the non-conventional teaching methods — the hands-on and digital tools for pupils and teachers, i.e. the briefcases, the "Briefcase of mineral applications" game, workshops and the supporting materials. The main objective of projects is to raise the pupils' awareness about the utility and indispensability of minerals and mining and the consequences of their uses and production systems, which would increase in the long term the awareness about the social and environmental consequences of raw material production.

**Key words**: raw materials; mining; pupils and students; non-conventional teaching tools; BRIEFCASE; 3D BRIEFCASE; curricular planning; EIT RawMaterials

## 1. INTRODUCTION

Mining has played a substantial role in the development of modern civilizations. In fact, everything we depend on, is either made from minerals or relies on minerals for its production and distribution. Raw materials, an unprocessed or minimally processed materials, obtained as mineral ores, natural oil or agricultural product, that undergo a transformation for creating a finished product, are of great importance for humankind. One group of raw materials is the mineral raw materials which include metals (e.g. iron, copper, aluminium), and non-metals (e.g. salt, gypsum, clay, sand, phosphates). Mineral raw materials are vital elements used for building and construction, vehicle manufacturing, computers, electronics, communications, medical equipment and dentistry, food production, energy production and transmission, and many more. Furthermore, mining also creates jobs and is a direct contributor to our economic prosperity and quality [1].

In recent decades, the importance of minerals has increased. Due to the growing needs of new

growing economies (i.e. China, Brazil) the mineral consumption has risen globally [2, 3]. 150 years ago, Europe dominated the mining industry, but over the years, its influence has declined rapidly. The EU industry depends heavily on imported mineral raw materials, which makes Europe the World region that outsources the largest part of resource extraction required to produce goods for final demand. One of the most important raw materials for Europe are so called critical raw materials (CRMs) which are of the high-risk associated with their supply [4].

New mining technologies, e.g. digitalization, automatization, sensor technology and robotics, use of biological substances (biological or bacterial leaching) in the extraction of raw materials, can provide many benefits for the society, like better environmental management, creation of new green jobs, etc. Furthermore, beside society and environment also mining companies benefit from high technological solutions because they provide more profitable operations.

Mining is becoming a growing part of modern industry and its societal and environmental impact can be mitigated by implementation of near zero waste mining principles (i.e. recycled or re-used material) as part of the circular economy, ensuring sustainable mineral extraction, by not endangering the supply of future generations. Today, in many countries, there is a lack of skilled personnel, e.g. mineral engineers and miners. The present workforce is aging and companies have difficulties recruiting young talented people that in general are not very interested in working in the mining industry [5, 6, 7].

Since almost everything around us is made of minerals – from our smartphones, the chair, the coffee cup, makeup products, shoes, bicycle, batteries, etc., it is impossible to imagine living without minerals. Educating younger generations about raw materials is very important because children need to learn the value of products made from different minerals in order to change their views on purchasing decisions, of the sustainable exploitation of those non-renewable resources, raise their awareness about non-sustainable production, and learn about new technologies and progress in mining (e.g. underground and underwater/deep sea mining).

In some European countries, mining is not even integrated in the regular lessons of the pupils. In others, some schools' curriculums are out-dated addressing past/historical ways of mining and old technologies, human (child) labour, and highlighting only the negative impacts of mining (e.g. pollution, risks for health and environment, landscape degradation, environmental accidents). This leads to general opposition to the mining in local communities under the name "not in my backyard" (NIMBY), and, in summary, offering a dirty perspective of the mining activities based on out-dated knowledge. Therefore, the content should be updated in a sense of presenting the mining in a whole new light, as new technologies have developed, new ways of mining as a socially acceptable form of intervention in the environment, to highlight the importance of secondary raw materials and circular economy. Mining should be presented as sustainable as it is practised in Europe in order to be preferred by comparison to the non-sustainable mining practises applied in countries with internal conflicts where, in addition, the minerals trade finances armed groups and encourages human rights abuses.

But the content that needs to be updated is usually too challenging for the teachers who frequently struggle with the lack of proper knowledge about the topic and publicly available teaching resources that are specifically developed for young pupils. This task needs to be carried out by interdisciplinary team of experts who can select appropriate up-to-date data and information on the contemporary mining as well as on the problems of (mis)use of raw materials in daily life and thus provide teachers with new contents and teaching ideas that can be used in various ways for different learning subjects. The BRIEFCASE [8, 9, 10] and 3D BRIFECASE projects [11], funded by the EIT RawMaterials, follow this general perspective and are addressing selected topics to raise awareness in the society about the utility and indispensability of minerals and mining, as well as on the consequences of their uses and production systems.

At the same time, projects that are based on the inclusion of content innovations in curricula or in the pedagogical process, open up at least two relevant questions – how to deal with the impermanent nature of information and knowledge in the context of school knowledge and teaching of young pupils in particular [12], or how to encourage teachers to explore appropriate learning strategies that maintain their teaching role and at the same time enable pupils to learn as actively as possible with involvement of solving their everyday problems [13]. Since the pedagogical and didactic issues of the BRIEFCASE project are not the main topic of this article, we will only briefly touch on the idea of teacher's curricular planning.

## 2. THE BRIEFCASE'S BEGINNINGS AND ITS POPULARIZATION

The BRIEFCASE is an innovative tool that has been successfully used since 2003 by the Spanish Geological Survey (IGME, Madrid, Spain) during the school visits to the Geo-Mining Museum to educate young visitors about minerals. The original tool was part of its educational program dedicated to pupils and students, which includes proactive activities such as workshops for the recognition of fossils and minerals, or recognition of rocks and minerals during a walk in the city. The initial "briefcase" idea was to raise the awareness of knowledge about minerals (identifying minerals and ore elements), mineral application (identifying everyday objects made from minerals) and mining activities among children during their visits to the museum. The original briefcase contains 10 minerals and 10 objects. The general aim of this activity is to familiarize pupils with the mineral ores with which these everyday objects have been manufactured. The ore minerals are cinnabar, kyanite, sphalerite or blende, fluorite, galena, lepidolite, magnetite, malachite, wolframite and feldspar. Pupils need to relate these minerals with everyday objects, such as a thermometer, a horseshoe, a coffee dish, a fishing line, a mobile battery, a zinc plate, a soda can, a light bulb, electrical cables and an empty tube of toothpaste.

In 2018 the BRIEFCASE project [11, 14] – "Learning the uses of minerals through non-conventional teaching tools" (EIT RawMaterials grant no. 18115, Figure 1), was branded under the EIT RawMaterials Academy (Figure 2), complimenting other EU Raw Materials initiatives and EU funded projects such as Minerals 4EU, SusCritMat, Better Geo, CircleLAB, WEEE4Future, MIN-GUIDE or RM@Shools, but providing an additional behaviour approach. The consortium focused on the list of minerals that show a double aspect — "strategic minerals" useful for many purposes and, at the same time, minerals whose extraction and processing raise complex social, moral and ecological problems, such as gold, diamond, cobalt, tungsten, tin and platinum. The previous minerals' profiles were considered to be potentially included in the briefcase according to their importance and social impact. The "Responsible Research and Innovation (RRI)" approach was applied in order to select the most promising minerals for a great impact. RRI is an approach that anticipates and assesses potential implications and societal expectations with regard to research and innovation, with the aim to foster the design of inclusive and sustainable research and innovation. It is based on the following pillars: public engagement, open access, gender equity, ethics and science education [15, 16].

The BRIEFCASE project is focused on the ethics pillar, deepening in the consequence of our decisions and habits for the people living in places where active mining are on-going activities. The mineral selection was assessed considering the four dimensions of the RRI [15] (anticipation, reflexivity, inclusion and responsiveness) in order to decide the most promising minerals in terms of the potential actions that can be implemented in the pupils' daily lives. With the aim to consider the ethical aspects of the RRI and the background methodology to transfer the knowledge in a participative way ("I see and I remember"), the selected minerals to be considered in the briefcases were eventually gold, cobalt, tin and minerals of the platinum group.

During 2019, the BRIEFCASE project developed new physical briefcases covering sensitive aspects of the mining activities with the focus on the primary schools' pupils (6–14 years old) and their teachers. The project, led by the Spanish Fundación Gómez Pardo (FGP), has generated practical and theoretical contents for the physical briefcases which cover the minerals, i.e. cobalt and the batteries, gold and the conflict minerals, platinum and its applications, tin and the importance of recycling, and an extended version of the daily uses' minerals briefcase. Beside mentioned primary raw materials, the BRIEFCASE project also addresses the secondary raw materials (SRM) which includes waste material from tailings and heaps and processing of secondary raw materials like slags, ashes, skimmings, cakes or sludges, materials removed during production, such as scraps, and all the materials that have reached their life cycle end and can be used repeatedly in production as starting material. In order to bring the secondary raw materials' topic closer to pupil various everyday objects from recycled materials are used (e.g. recycled paper and recycled plastics).

With the purpose of increasing the impact of the idea, in 2019 the BRIEFCASE project also launched an open and public digital game dedicated to the pupils and focused on the identification of some of frequent and important minerals. The game was translated to English, Spanish, French, Italian, Slovenian, German and Greek languages.


**Fig. 1.** The BRIEFCASE logo.


**Fig. 2.** EIT RawMaterials Academy logo


**Fig. 3.** The 3DBRIEFCASE logo

The 3DBRIEFCASE project [11, 17, Figure 3] – "Learning the use of minerals through non-conventional and digital tools" (EIT RawMaterials grant no. 19010) with the duration between 1.1.2020 and 31.12.2021 is the BRIEFCASE's follow-up project. The project aims to improve the virtual tool into an augmented reality (AR) application to attract students up to 18 years and to adapt the tool for a 3D-application to play with 3D-glasses for permanent usage in science museums and educational centres, and for the general public. Additionally, new briefcases have been developed, covering the minerals exploited by mining partners, helping them to gain acceptance in the surrounding communities and demonstrating the effectiveness of the tool.

In the 3DBRIEFCASE project 18 project partners participate (public, private, professional and educational sectors) from 10 countries – Spain, Belgium, Slovenia, United Kingdom, Austria, Greece, Slovakia, Czech Republic, Italy, United Kingdom (Fundación Gómez Pardo, Zavod za gradbenistvo Slovenije, Instituto Geológico y Minero de España, Coventry University, Fundación Tecnalia Research & Innovation, Montanuniversität Leoben, Technical University of Kosice, Universidade Nova de Lisboa, Università degli Studi di Milano – Bicocca, Monolithos Ltd, Magnesitas Navarras S.A., Geoalcali, Orovalle Minerals, European Association of Mining Industries, Metal Ores & Industrial Minerals, Colegio Oficial de Ingenieros de Minas del Sur de España, Ayma Mining Solutions SL, Association of Research, Extraction, Mining-Metallurgical, Auxiliary and Service Transformers, Masaryk University.). They have their technical background and expertise in geology, mining, metallurgy, environmental sciences, chemistry [18]. With anthropology, pedagogic and other social and humanistic sciences, the consortium aims to bring mineral raw materials and mining closer to society as a whole. New non-conventional teaching tools and new physical briefcases with content on potash and the 2030 agenda for sustainable development, lead and zinc, magnesite and its manufacturing, the importance of the exploration activities and the minerals in our phones, and industrial minerals and their application, serve as a professional basis for teachers which can be pedagogically presented to pupils in many ways. Furthermore, it can be used for pupils from an early age to students.

The virtual "Briefcase of mineral applications" game was developed in two levels — one dedicating for younger pupils and the other for the older pupils. The game is translated to Czech, Dutch, Bulgarian, Polish, Romanian, Portuguese, Slovak, Euskara, Swedish, Norwegian, Catalan, Galician, Macedonian, Arabic, Japanese and Vietnamese. Finnish, Chinese, Estonian, Tamil and Hindi will come during 2021. Another virtual briefcase was launched to the market focused on teachers and their didactic resources needed not only for their own learning but also specific material developed for pupils to be used by teachers during their lesson. Mentioned material is available for free to the academic centres and educative community and can be found on the project website [11].

Finally, the project is working in the new innovative 3DBRIEFCASE tool — the 3D experience combined with augmented reality (AR) in order to increase the impact of the tool to pupils between 12 and 16 years of age who will enjoy an innovative virtual experience visiting several mines with the 3D glasses.

## 3. THE NON-CONVENTIONAL TEACHING METHODS

In this section, we provide detailed description of the physical and digital non-conventional tools used on the workshops and individually on-line.

### *Hands-on tools*

Hands-on experience is one of a kind opportunity for pupils, where they can take the minerals

(ores) in their hands for close and detailed observation, e.g. colour, weight, comparison between minerals, crystal structure, etc. Hands-on experience with thematic briefcases provides additional value to learning as a whole since it has positive effects on the child's memory. The more avenues there are to receive data through the senses, the more connections the brain can make and the better a child can understand a new idea [19].

Within the BRIEFCASE and 3DBRIEFCASE projects partners made copies of the original physical briefcase "Daily uses minerals briefcase" (Figures 4 and 5), prepared upgraded versions of the original briefcase and have developed new thematic briefcases focusing on: the gold and conflict minerals, tin and the importance of recycling, platinum and its applications, cobalt and batteries, secondary raw materials, and the minerals in our phones [20]. Additionally, partners have prepared thematic briefcases focusing on the most representable minerals in partners' countries, e.g. industrial minerals and their applications, potash and the 2030 agenda for sustainable development, lead and zinc, magnesite and its manufacturing, and on the importance of the exploration activities (Figures 6–13).

Depending on the pupils' age the "Daily uses minerals briefcase" can be adapted, e.g. for younger pupils in the primary school only basic minerals are used, meanwhile older pupils/students (secondary school) work with the whole briefcase


**Fig. 4,** Samples of minerals (ores) and products from the "Daily uses minerals briefcase"

**Fig. 5,** Example of "Daily uses minerals briefcase": mineral malachite with belonging products based on the malachite mineral

**Fig. 6.** The secondary raw materials briefcase: SRM and items made from SRM (e.g. construction products)

**Fig. 7.** The secondary raw materials briefcase: SRM and items made from SRM (e.g. asphalt)

**Fig. 8.** The magnesite briefcase

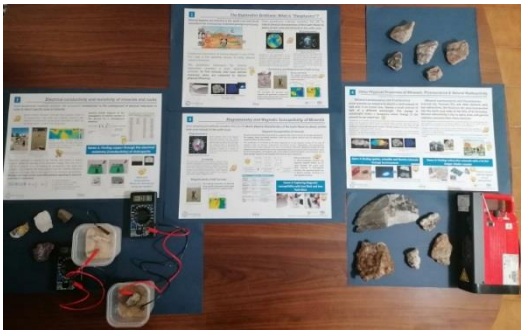

**Fig. 9.** The exploration briefcase


**Fig. 10.** The potash briefcase


**Fig. 11.** The lead and zinc briefcase


**Fig. 12.** The industrial minerals briefcase (products).


**Fig. 13.** The industrial minerals briefcase (minerals)

*Workshops*

In order to emphasise the history and importance of past and present mining activities in certain countries (before the COVID-19 situation), the project partners held workshops in different parts of Europe (project partners' countries). Besides presenting different briefcases, partners also organize a unique hands-on activity called "gold panning" (Figures 14 and 15), where pupils use a pan and water to rinse the river (quartz) sand from the pan in hope of finding valuable minerals like pyrite, magnetite, and other heavy minerals. Gold panning is usually carried out in nature by the river side. However, it is also demonstrated in the classroom or in the schoolyard using sand and water filled containers instead of a river bed.

**Fig. 14.** Gold panning experience outdoors

**Fig. 15.** Gold panning experience in the classroom

### *Digital tools*

Digital tools and use of smartphones, tablets and computers play an important role in our daily lives. They provide a fast source of information and knowledge, entertainment and social communication. The growth and spread of Information and Communication Technology (ICT) will continue to become a crucial part of our lives also in the future. Digital education has spread widely over the past years and is still rising. On-line classes (E-learning) provide many benefits for its users, especially since they can be tailored to individual students: they are self-paced, can support a range of learning styles, attendance is easier – they can be accessible anytime and anywhere or can be scheduled individually which creates a comfortable learning environment without geographical barriers – are less prone to distractions and obstacles, can increase interaction level (e.g. for introverted people), offer more learning options, and, increase technical or computer skills. Many children already use on-line training tools at an early age as part of their learning experience [21].

Within the BRIEFCASE and 3DBRIEFCASE projects, partners have developed an application called the "Briefcase of mineral applications" game where users can learn about the minerals on-line. The Briefcase game is modified for pupils aged 6 to 9 years (Figures 16 and 19) [22] and for pupils aged 10 to 14 years (Figures 17 and 20) [23] and is already translated into 21 languages (Spanish, English, Slovenian, Italian, Greek, German, French, Czech, Dutch, Bulgarian, Galician, Polish, Romanian, Portuguese, Slovak, Euskara, Swedish, Catalan, Macedonian, Arabic, Japanese and Vietnamese, Norwegian, and further Estonian, Tamil, Finnish, Chinese and Hindi). In both versions, pupils discover what minerals are used for in the manufacture of everyday objects, and need to match an element/mineral with an object that is made from this element. In the game for younger pupils the objects (i.e. toothpaste, wire, soda can, mobile battery, fertilizer, rings, and fridge magnet) need to be properly matched with the elements/minerals (i.e. copper/malachite, potassium/potash, lithium /lepidolite, aluminium/kyanite, gold/native gold, iron/magnetite and fluorine/fluorite). In the version for older pupils the objects (i.e. fireworks, solar panels, galvanized steel, X-ray protection vest, cup, automobile catalyst, paint, battery, rings, dental tools, thermometer, wind turbines, wire, horseshoe, can toothpaste, wrapping foil and fertilizer) also need to be properly match to the elements/minerals (i.e. magnesium/magnesite, iron/magnetite, lead/ galena, magnesium/talc, platinum/sperrylite, gold/ native gold, silicon/quartz, fluorine/fluorite, lithium/lepidolite, zinc/sphalerite/tinc blende, tin/cassiterite, copper/malachite, aluminium/kyanite, aluminium and silicon/feldspar, mercury/cinnabar, tungsten/wolframite, potassium/potash and cobalt/skutterudite).

The game includes a set of clues (4 clues for each element and object) to help players to identify the mineral/element to the belonging item. Finding out without clues brings players 5 points, but finding out with one clue brings 4 points, etc.

The game itself does not only provide players to learn which object is made from specific element/mineral but it also provides more information on the element/mineral itself. Description includes the information about the mineral from which this element is manufactured, main European deposits, its main properties, usage and interesting facts. Along with the game there is an explicative video made which serves as a guide on how to play [24].


**Fig. 16:** Kids Briefcase of mineral application logo


**Fig. 17.** Pupils Briefcase of mineral application logo


**Fig. 18.** Teachers Briefcase of mineral application logo


**Fig. 19**. The Briefcase of mineral application [22] game for younger pupils, 6–9 years (entrance to the application)


**Fig. 20.** The Briefcase of mineral application game [23] for older pupils, 10–14 years (entrance to the application).

*Supporting material*

Since there is a lack of clear and understandable material for education of students, teachers and also general public in the field of sustainable modern mining the consortium of projects offer free on-line didactic resources (Figure 18) to teachers for their self-training [20]. These materials, accessible in English language, gathers the necessary information on how to use the different Briefcase tools,

provides additional information of the briefcases, includes working materials (e.g. quizzes, questionnaires, etc.) and promotional material (leaflet, poster). Additionally, the website includes interactive books covering important matters like the contributions of the mining activities to the sustainable development goals or the contribution to the climate change mitigation and adaptation. Furthermore, a collection of public sources, offering didactic resources developed for the young students and teachers, has been compiled and is available in several different languages [25].

Similar as in game the "Briefcase of mineral application" also the "Daily uses minerals briefcase" contains cards with a set of clues (4 clues for each element and object) which helps pupils to identify the mineral/element to the belonging item. In the classroom pupils can be divided into two groups and compete with each – guessing the right answer without clues brings the group more points than using the clues.

For better illustration and understanding the content the "Daily uses minerals briefcase" it also includes the maps of the World and Europe, where the biggest mineral deposits of selected minerals can be found. Furthermore, some briefcases also include the country's map so pupils can learn the names of specific mines of the most important minerals in their country.

The workshops are also dedicated to teachers for the "teach the teachers" demonstration on how to use the toolkits and other hands-on materials. The idea is that training can contribute to spreading the knowledge about the raw materials. It can do so by providing the tools and adequate message to the teachers that can use the BRIEFCASE tool with the new generation of children in an autonomous way.

## 4. THE BRIEFCASE AND 3DBRIEFCASE IN THE CONTEXT OF CURRICULAR PLANNING

The following chapter briefly outlines the starting point for reflection on the educational potential of the BRIEFCASE and 3D BRIEFCASE projects. The chapter does not focus on identification of individual aspects of the projects (i.e. goals and aims, didactic aids, role of teacher and students, didactic environment, etc.) and their didactic evaluation (i.e. what in the project is didactically appropriate and useful, what would be good to improve, etc.), but rather in exploring a wider perspective, which is how the general idea of the projects (i.e. a comprehensive view of the issue of today's mining and use of raw materials) can be understood as a thematically rounded learning content and which the teacher can reflect in the context of achieving various operational goals in their lessons. In other words, the issue of preliminary phase in the school curricular planning of the learning content of the projects needs to be explored. This is a regular part of the pedagogical process, however, when additional and complex learning content is brought to the curriculum, teacher's didactic analysis must be done thoughtfully, for only in a clearly structured approach to lesson planning can the teacher achieve educational goals of selected learning content.

There are many models of curricular planning and they are very diverse [26]. According to projects' aim, the model developed by Wolfgang Klafki seems to be very useful, as it places the learning content and exploration of its educational potential at the center of the teacher's planning [27]. Namely, Klafki designed his model of didactic analysis as a planning process in which the teacher continues to comprehensively reflect the educational substance of a certain learning content and only in the next step plans its methodological implementation. He designed five interdependent key questions (with sub-questions) that the teacher asks him/herself about the topic in the preliminary phase of their instructional preparation, after getting acquainted with project's objectives, materials and teaching tools, and workshops. In the diagram on Figure 21, Klafki's original questions are slightly adapted in order to make a meaningful reference to the planning context within the themes on which the projects are based.

Although reading these questions and placing them in the context of the projects as a thematically rounded whole, the answers seem almost self-evident, it should be noted that Klafki's model does not yet offer the teacher definitive answers to what and how to realize this content in class. Namely, in his/her planning the teacher must also connect this content aspect to special didactic questions and the concrete circumstances in which he/she performs the act of teaching. However, such a network of questions is useful because it can help the teacher to more thoroughly think about the problems of modern mining and the use of raw materials as part of the goals and contents of various learning subjects (i.e. in natural science, social sciences and humanities as well), in interdisciplinary connections

or as a completely independent learning content within the framework of whole school approaches.

On the other hand, the presented set of questions shows how the themes of the projects can be conceptualized in terms of didactic theory and curricular planning, which in the future could provide a necessary methodological follow-up within the projects if we want to integrate these contents more closely into education.

**1. What wider or general sense or reality does the learning content of the raw materials and their uses in a daily life exemplify and open up to the pupils? What basic phenomenon or fundamental principle, what law, criterion, problem, method, technique, or attitude can be grasped by dealing with this content as an example?**

a) What does a planned topic exemplify, represent of typify?

b) Where can the knowledge to be gained from this topic be picked up on and used later, either as a whole or as individual elements?

**2. What current significance does the raw materials and their uses in a daily life have for pupils? What significance should they have from pedagogical point of view?**

**3. What future significance does the raw materials and their uses in a daily life have for pupils?**

**4. How is the learning content of the raw materials and their uses in a daily life structured?**

a) What are the individual elements of the content as a meaningful whole?

b) How are these individual elements related?

c) Is the content layered? Does it have different layers of meaning and significance?

d) What is the wider context of this content?

e) What peculiarities of the content will presumably be more or less difficult for pupils to grasp?

**5. How can the structure of the content of the raw materials and their uses in a daily life become interesting, stimulating, approachable or vivid for pupils?**

a) Which experiences are appropriate for exciting in the pupils' minds an interest in the topic?

b) What pictures, hints, situations, stories, experiments, models etc. are appropriate to stimulate the pupils to the search for independent answers?

c) Which practical assignments are appropriate for pupils to realize the practical value of the content?

**Fig. 21.** Diagram with adapted Klafki's model of didactic analysis as a planning process for the Briefcase projects

## 5. CONCLUSIONS

The importance of minerals in our everyday lives can be recognized all around us, almost everything we use is a mineral resource. Mining is known from the ancient time and ever since, it has provided base for the technological and economic development. Despite many positive aspects, there is still a widespread concern from the general public about the negative effects of mining. Current public perception is shaped mostly on the past mining technology, negative impact on the health and environment, and unethical mining in some countries. Today, the global mining industry tends to reduce the environmental impact, by using more clean and green technologies, implementation of zero waste mining as part of circular economy and make its practices more sustainable.

Population growth, increased global demand for primary and secondary raw materials, issues concerning sceptic public perception of the mining industry, lack of expertised work force and other issues needs to be addressed not only by general public but also by younger generations. The mining industry needs to raise the awareness and provide the holistic knowledge about the utility and indispensability of minerals and mining and the consequences of their uses and production system to general public and pupils in simple and understandable way. School curriculums most often lack description of current situation on mining and teachers struggle when preparing the content on raw materials, mining and minerals in general therefore, through the BRIEFCASE and 3DBRIFECASE projects offer an effective, interactive and interesting learning and teaching tools for pupils and teachers about the mineral raw materials. All this can help pupils to understand the real value of the minerals and the products, and consequently can change their view on purchasing decisions of themselves and their parents.

*About the EIT RawMaterials*

Activities mentioned in this paper are supported by the European Institute for Innovation and Technology (EIT) established in 2008, as an independent body of the European Union. Its main task is to foster cooperation between business, education and research institutions (the knowledge triangle), thus creating an appropriate environment for innovation and entrepreneurship in Europe. The Institute currently has eight Knowledge and Innovation Communities (KICs) that focus on current social challenges: climate, digital technology, health, nutrition, innovative energies, raw materials, urban mobility and manufacturing. The community for raw materials is EIT RawMaterials, with an ambitious mission, to change the dependence on raw materials into Europe's strategic power. This should be achieved by fostering the competitiveness and the growth of the European raw materials sector, in particular through radical innovation and entrepreneurship. The most important areas are: (a) research and assessment of the potential of European raw materials, (b) mining and demanding environments and innovative, sustainable mines, (c) increased material efficiency in mineral and metallurgical processes, (d) substitution of critical substances in products and their optimization, (e) the recycling and optimization of value chains for better products, and (f) the planning of circular economy products and services.

The community is made of core, associated and project partners. Institutions and companies may also apply for funding even if they are not part of the EIT RM community by liaising with one of the core or associate partners and participating in EIT Regional Innovation Scheme (RIS) projects as partners to carry out individual project tasks (task partners).

More information on the EIT RawMaterials community is available at: https://eitrawmaterials.eu/



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## ВАЖНОСТА НА ЕДУКАЦИЈАТА НА ПОМЛАДИТЕ ГЕНЕРАЦИИ ЗА МИНЕРАЛНИТЕ СУРОВИНИ И НИВНАТА УПОТРЕБА ВО НАШИОТ СЕКОЈДНЕВЕН ЖИВОТ

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**Клучни зборови:** минерални суровини; рударство; ученици и студенти; неконвенционални наставни алатки; актовка; 3Д актовка; планирање на настават; ЕИТ минерални суровини

Минералните суровини се од големо значење за човештвото бидејќи овозможуваат развој на технологијата, ги движат индустријата и економијата и севкупниот начин на живот што го знаеме денес. Трудот се осврнува на темата интерактивно учење за минералните суровини, т.е. метали и неметали. Како резултат на порастот на населението и како резултат на зголемената глобална побарувачка на минерални суровини, се јавува потреба од едукација на помладите генерации за суровините и нивните својства и потекло, за тие уште од рана возраст да знаат од каде потекнуваат минералните производи што ги користат и како одлуките за нивно купување влијаат врз социјалната средина на луѓето кои живеат во земји со експлоатација на минерални ресурси.

Денешните трендови во рударството се ориентирани кон што поодржливо искористување и управување, земајќи ги предвид економските, социјалните и аспектите на животната средина. Пример за нешто такво е експлоатацијата на секундарните минерални суровини од јаловина и одлагалишта. Но, во некои земји рударството е заглавено во минатото, користејќи застарени технологии што предизвикуваат зголемено загадување и силно присутни линеарни економски пристапи на ставови за употреба-располагање, па дури и неетички пристапи, како што се деца кои се експлоатираат како евтина работна сила, луѓе се киднапирани, мачени, па дури и убивани за минерали (минералите што се експлоатираат на тој начин се нарекуваат крвави или конфликтни минерали). Понатаму, поради потенцијалните негативни влијанија врз здравјето и безбедноста, како резултат на емисиите во воздухот, водата и нарушувањата на површината, јавната перцепција за рударството сè уште се смета како негативна во повеќето случаи.

Наставните програми на училиштата најчесто не содржат опис на моменталните ситуации во глобалното рударство. Затоа, во рамките на проектите EIT RawMaterials BRIEFCASE и 3D BRIEFECASE, партнерите во проектот обезбедуваат сеопфатен преглед на прашањата за денешното рударство и употребата на минералните суровини. Трудот го претставува описот на два проекта и на неконвенционалните наставни методи – практични и дигитални алатки за ученици и наставници, т.е. актовките, играта „Актовка на минерални апликации“, работилници и придружни материјали. Главната цел на проектите е да се подигне свеста на учениците за корисноста и неопходноста на минералите и рударството и за последиците од начинот на нивната употреба и системот на производство, што долгорочно ќе ја зголеми свеста за социјалните и еколошките последици од производството на минералните суровини.