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Open and Citizen Science in Light of New European Research Policies

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Abstract

This article discusses the meaning of open science, and in particular the concept of citizen science, in a broader socio-political and scientific context. The authors highlight the ambivalence of these concepts and the lack of critical reflection on the possible (unwanted) negative implications of the establishment of these ideas. The authors address these issues using an international comparative analysis based primarily on documentation and secondary data analysis. Research approaches in the sense of open science and citizen science can, in many cases, be useful for researchers as well as for cognitively active citizens. They can enable the enrichment of knowledge and the potential for (social) innovation. However, there are also risks and unwanted side effects that diminish the relevance and status of scientific research. It is particularly dangerous to create illusions about the potential of ad hoc citizen science projects and their outstanding, immediate results. The campaign for open science may serve as a cover-up for some of the problems and anomalies in the realm of science. The authors also see danger in the potential erosion of the autonomy of science and diverting attention from some of the more pressing problems in science.

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1 Introduction

In this text, we try to address the concept and meaning of 'open science' – and, connected with that, citizen science – in a broader socio-political and socio-scientific context. Proceeding from recent science policy on the EU level together with national adoptions and applications, we consider the dilemmas, ambivalence and a (perhaps) ideologized perception of the role of participation and openness in scientific research with respect to the general public. The notion of open science refers to several aspects:

1. greater public accessibility of scientific publications and data (data management plan);
2. significant transformation of criteria for evaluating scientific performance;
3. an effort to promote science and establish new ways of communicating science to a wider public;
4. and a push for greater public engagement in science and inclusion of non-scientists in scientific processes.

Point number 4 coincides with the conception of citizen science, especially regarding the engagement of the public in science, which is connected with wider social topics, such as the influence of the public on science policies, evaluation of scientists' work, and the democratization of (and within) science.

By addressing point number 4, and especially the concept of citizen science, which is at the forefront of the campaign for greater public engagement in science, the authors connect this concept to some well-established concepts and methods of involving non-professionals in scientific research (especially action research).

To some extent, the article discusses topics related to the first and second aspect as well, by analyzing the legal requirements regarding open science in different countries and changed criteria in scientific evaluation.

The concept of citizen science has become more popular in recent years, being heavily advertised "as a recognized, promoted and funded approach, which fosters scientific literacy and democratization of science" (ECSA, 2023). It is promoted by several international organizations and associations, notably the European Citizen Science Association (ECSA), which has also established

a catalogue of citizen science projects in Europe. This database contains over 350 projects, while a similar US database includes another 500 projects. The European Commission names citizen science as one of the eight ambitions of the EU's open science policy. On their website they specifically noted: "the general public should be able to make significant contributions and be recognized as valid European science knowledge producers" (European Commission 2019).[1]

This article starts with an overview of the development of the planned set of activities (in the sense of campaign) aiming at achieving the promotion and implementation of the concept of open science. We present some of the theoretical underpinnings of the idea of open science and, based on an analysis of documents and case studies, the evolution of guidelines and legislation in this area over the last 20 years. We point out that the guidelines (strategies) on open science – which initially referred only to free access to publications and to a data management plan – were adopted by the European Commission, and subsequently by the EU Member States, already in the period 2015–2020, or in the framework of Horizon 2020. Even before that (from 1995 onwards), there were certain initiatives in this direction, both by the institutions responsible for decision-making on research policy and by researchers. It is evident that these orientations and initiatives have been less successful.

The question we ask ourselves here is whether the current campaign for open science, in terms of engaging the public or citizen science, and especially in terms of radically changing the criteria for scientific performance, has support in science? The analysis also raises the question of whether the current campaign will deliver long-term solutions, or whether a new campaign will be needed in the next quinquennium (2025–2030)? Will the new/old changes – now already incorporated in legislation in some places – take hold in practice and actually be long-term sustainable? Namely, the authors hypothesize that implementation of the open science rules (or certain interpretations of these rules) could mean excessive and top-down intervention in the sphere of scientific autonomy.[2]

1 The content of this website changed in June 2024 and this quote is not published on it anymore. However, the quote was also included in Open Science Factsheet (2019) that we were able to download before the page content changed.

2 It can be argued that normative changes – which, by all accounts, do not respect the principles of the so-called discrete contextual intervention (Willke 1989) will put into question the autonomy and the principle of functional differentiation in the relation between the subsystems of politics – science – civil society – law? We are referring here to the excessive role of legislative procedures and the large number of acts and strategic documents, which

In the continuation of this article, we highlight the dilemma of whether science has really been closed so far and what new solutions in the field of evaluation criteria in science are foreseen in the current campaign for open science. It is questionable whether this set/system of new rules and methods of scientific action has built-in mechanisms in the sense of the feed-back loops for detecting negative or side-effects and for correcting them in the process of public discussion/re-consideration and implementation.

In chapters 3 and 4, the article presents citizen science theoretically and conceptually and relates it to long-standing and established research methods in the social sciences. In this way, the authors show the long tradition of involving non-scientists in scientific research and point out that it would be meaningful and productive to link some of the natural sciences utilizing a citizen science approach with the social sciences, especially those disciplines that traditionally practice methods such as participant observation, focus groups, action research and other forms of participation by (lay) members of the communities or organizations involved in the research.

Methodologically, the article is relying on an international comparative analysis and on a review of existing literature and secondary data analysis, namely documents from the European Commission, OECD, UNESCO and legislation of selected analyzed countries. This is complemented by re-considering examples of open science and citizen science projects (also in connection to action research) in practice.

2 Development of an Open Science Campaign

The theoretical foundations for open science (as well as citizen science) can be traced back to texts originating primarily from sociology and philosophy of science sometime after 1995. Still, it is important to note that the authors of these texts were mainly dealing with epistemological issues or the development of a new 'paradigm' that considers the integration of science within the social framework, rather than anticipating the current campaign. We are referring to concepts like the Mode 2 production of knowledge and context of application (Gibbons et al. 1994), and socially robust science (Nowotny, Scott, and Gibbons 2001). Other well-known concepts include post-normal science (Funtowicz and Ravetz 2003), the democratization of expertise (Jasanoff 2005),

create a picture of opacity and the aspect already highlighted by N. Luhmann in terms of the substitution of legitimacy by reference to (bureaucratic) procedure (Luhmann 1983).

the Triple Helix and its extension the Quadruple Helix (Carayannis and Campbell 2009) and post-academic science (Ziman 2016).

Regardless of their differences the concepts have some things in common. In our opinion, they aim to address the awareness of the impact of science on society and to locate scientific research and expertise within a new cognitive-epistemic framework. This means that, in the sense of a feedback loop, it also takes account of the influence of social factors, their knowledge and their relevant information arising from the context of application. We have in mind the process of the socialization/social contextualization of science, which is a reaction to the process of the scientization of society and the life-world. Civil society is not merely a passive recipient of scientific knowledge and technological applications. Instead, it should have a more active role, namely, one where society "speaks back to the science" (see also Weingart 2008). A new type of knowledge is thus emerging, contextualized knowledge (the aforementioned "context of application"), which is a complement, or – for some more radical proponents of open science – even an alternative, to the non-contextualized/reliable type of knowledge typical of academic or 'pure science'.

These theoretical approaches are dealing with the socialization rather than the politicization and commercialization of science. The former is based on civil society/stakeholder engagement and should exhibit the characteristics of a bottom-up process. Our thesis is that this engagement or approach has been lacking, and the campaign we are discussing here suggests more of a top-down approach (as implied by the term "campaign"). This means that we are instead dealing with politicization in the sense of the initiative being administered by science policy, while on the level of public participation and 'citizen scientists' the initiative lies in the hands of professional researchers.

The concepts mentioned above have exerted a certain impact, albeit indirectly. More directly influencing the campaign for open (and citizen) science are experiences related to the interplay of science, politics and broader society that we have witnessed in recent years. As an example, we can mention the handling of the COVID-19 pandemic. Particularly between 2021 and 2022 there was notable opposition to epidemiological measures, encompassing not only lockdowns but also preventive measures such as wearing face masks and vaccination. Many countries/governments across Europe responded to this by prematurely lifting these measures and publicly claiming that the pandemic was over or no longer dangerous (Adam and Gorišek 2022). Two things here are especially relevant for our discussion. The first is that the politics–experts relationship has been shown to be unclear/ambiguous in certain cases. Second, in this very challenging and risky situation, the pandemic further revealed the

fragmentation of knowledge and lack of systematic interdisciplinary collaboration within science, coupled with a weak capacity to resolve professional conflicts. In this setting, we may speak of a crisis of legitimacy and credibility of the scientific sphere. Conversely, we also see the rise of a post-factual (post-truth) society characterized by conspiracy beliefs and the spread of fake news or unverified information (Fischer 2017; Alaszewski 2023). The new wave of the campaign for open science is likely fueled by these for science questionable tendencies. At the same time, it seeks to demonstrate that science is not something distant and elitist but accessible to ordinary people.

In recent years, we can again observe a considerable rise in the movement or effort for open science, which is increasingly becoming one of the central ideas of research policies in Europe (and the USA and other countries). The UNESCO Recommendation on open science (2023), states that: "Open science has the potential of making the scientific process more transparent, inclusive and democratic." They add that open science "opens the process of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community." ("UNESCO Recommendation on Open Science" 2023).

The beginnings of the open science movement were largely focused on open access to scientific publications, data, and software. Several authors speak of the benefits of such data openness, like enabling diverse data analysis, verifying existing results, generating new knowledge, and promoting interdisciplinarity (Uhlir and Schröder 2007). Nearly 20 years ago, Eysenbach (2006) noted that open-access scientific publications offer advantages in terms of citation rates, accessibility to relevant actors (user uptake advantage), and the promotion of connections between disciplines (cross-disciplinary fertilization). This encouraged investments in the development of data-sharing platforms such as the European Open Science Cloud (European Research Area), a stronger focus on data management planning, and the development of national (and supranational) guidelines for open access and open science.

2.1 *From Strategic Documents to Legislative Implementation*

The first wave of such guidelines can be dated to around 2015 when many countries, following the example of the European Commission and its approach within the Horizon 2020 programme,[3] were formulating guidelines for open

3 In 2016 the Directorate-General for Research and Innovation at the European Commission published a book entitled *Open Innovation, Open Science, Open to the World – A Vision for Europe* where the direction to promote open science (mostly in terms of open access to publications) was laid out. Already in projects funded under the Horizon 2020 scheme the

access.[4] However, today we can observe a new wave of revisions to guidelines and strategies for open access. In the first half of 2023 alone, national strategies were adopted or revised in Spain, Slovenia and Romania (Science Europe 2023). More recent strategies increasingly include the aspect of public engagement in science. One example is Sweden, which is presently in the process of formulating guidelines for the "transition to open science". Among the proposed goals is the promotion of research practices involving the public where relevant for the quality and advancement of research (National Library of Sweden 2023).

What is surprising, however, is not just the observation that we have a concerted campaign within the EU framework and also on the global level. It goes beyond that: despite uncertainties and controversial interpretations with both the definition of open science and in terms of public engagement or citizen science, these approaches have become the subject of legislative implementation in certain EU member states. It is not simply about recommendations and strategic directions given that in some EU member states these instruments (even the terminology) have gained the status of mandatory instruments.

Moreover, the concept of open science and public involvement in science is hardly peripheral or alternative. In fact, it constitutes the very basis of funding from the European Commission under the Horizon programme and other less prestigious schemes. Are the initiators and promoters of open science knocking on open doors?[5]

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beneficiaries were obliged by the contract signed with the European Commission to "ensure open access (free of charge, online access for any user) of all peer-reviewed scientific publication relating to its results" (Annotated Model Grant Agreement V5.2, 2019, page 245).

4 For instance, Estonia developed principles and recommendations for the establishment of a national open science policy in 2016 (Estonian Research Council, 2024), while the Czech Republic implemented a national strategy for open access to scientific information (EOSC 2024). Similarly, in 2015 Slovenia adopted the National Strategy for Open Access to Scientific Publications and Research Data in Slovenia 2015–2020.

5 For project leadership or participation within the Horizon programme, not only licensed research organisations but also non-governmental organisations, private sector businesses, government institutions, local authorities, and other entities are eligible to apply. This sheds completely different light on the requirements for open science and initiatives to involve the public in research. In other words, most calls for proposals and consequently projects approved under the Horizon programme are structurally and potentially participatory, closely resembling the model of citizen science. The question is: what does this open approach mean in terms of the quality and transparency of scientific activity? Let us highlight the following finding which pertains to the sector that receives the most European projects within the Horizon framework. It states that in Slovenia the most successful applicants or participants come from the business sector (48% of all, with the EU average being 28%), higher education institutions comprising only 18% (much lower than the EU average of 38%), and research organisations 28%. The conclusion is: "This means that Slovenia has

A considerable portion of the drive towards open science comes from universities, research institutions, and agencies.[6] Nevertheless, the concept of open science is expanding beyond national strategies and guidelines and is increasingly reflected in national research policies as well. In this context, various practices can be observed, ranging from advocating for open access to research findings and data, to more radical ideas that practically anyone can create scientific knowledge.

France, the Netherlands and, more recently, Slovenia, serve as examples of countries where the concept of open science is deeply ingrained in national policies. Under the *Loi de programmation de la recherche* law, France introduced the Second French Plan for Open Science. The plan outlines measures like mandatory open access publication of all books and articles produced within publicly funded programmes and projects, and opening up data and software. Further, the plan aims to revise the evaluation criteria for projects and researchers to prioritize the integration of open science principles, recognize the diversity of scientific production, and also reduce the importance of the impact factor (Ministere de l'enseignement duperieur et de la recherche 2024).

In the case of France, the involvement of the public in the scientific research process is mentioned indirectly, whereas in the Netherlands it is more prominently highlighted. There, the commitment to "open access as a norm within 10 years" is even included in the coalition agreement, with 20 million euros being allocated to it. The National Programme Open Science NL lists encouraging collaboration in generating, evaluating, and communicating knowledge as among its leading principles, with *participation* also involving groups outside the traditional academic community, such as NGOs, government organizations, and citizens. The concrete goal is for participatory and inclusive research practices to be recognized as part of mainstream research and funding.

The programme posits that "the scientific community itself needs to be representative of the society it aims to serve" (National Programma Open Science 2022). The goal of the Dutch approach is that by 2030 "stakeholders

an above-average share of the economy and a below-average share of universities" (Glavič, Levičnik, and Muhič 2023, 337). On the other hand, in the European Commission/EREA bulletin entitled "Open Science in Horizon Europe" it is indicated that publishing the findings by members of Horizon consortia is not obligatory. Nevertheless, if it does take place, the publication should be in a journal certified as open access. Two questions emerge here: first, why are publications no longer required and, second, how is the quality of open access journals (going to be) assessed (if the impact factor is no longer considered relevant).

6 These have come together in various international organisations for open science, such as Advancing Open Science in Europe (EOSC) and OpenAIRE. Through their initiatives, these organisations aim to influence changes in research policy.

from across all sectors of society and all components of the Quadruple Helix have clear pathways to participate in open and collaborative processes of scientific knowledge creation, evaluation, and communication to the benefit of society and its members, in all domains of research" (National Programma Open Science 2022).

In Slovenia, the idea of open science is incorporated into national sectoral legislation, where Article 2 of the Act on Scientific Research and Innovation Activity states among its principles that scientific research activity is grounded in the principles of "open science, including open access (following the principle of being open as much as possible, closed as much as necessary) (...) and the inclusion of communities and citizen science" (Official Gazette of the Republic of Slovenia, Nos. 186/21 and 40/23).[7] Slovenia also recently adopted the *Decree on the Implementation of Scientific Research Work in Accordance with the Principles of Open Science* (Official Gazette of the Republic of Slovenia, No. 59/2023) which, in addition to mandating publication in open access for publicly funded research and involving the interested public in scientific research, addresses the evaluation and assessment of researchers, organizations, and projects in accordance with the principles of open science.

2.2 *New Criteria for Evaluating Scientific Performance*

The idea of open science has developed in the last few years from simply advocating for open and accessible data to calls for greater (or total) inclusivity in science and even a complete overhaul of scientific evaluation criteria. In 2022, 350 organizations from 40 countries signed the Agreement on Reforming Research Assessment (ARRA, facilitated also by the European Commission), which calls for a broader understanding and evaluation of research contributions beyond just scientific publications. It proposes basing scientific evaluation primarily on qualitative assessments, abandoning metrics such as the

7 More precisely, the domain of public involvement in science is addressed by the *Resolution on the Slovenian Scientific Research and Innovation Strategy 2030*. This resolution underscores open science as a goal to enhance the quality, efficiency, and responsiveness of research. In addition, it advocates the advancement of citizen science and the engagement of the public in scientific research activities as key measures to attain this objective. In line with this strategy, over the last few years the government has invested significant resources in promoting the idea of open science and citizen science. For example, EUR 4 million was allocated for the adaptation of public research organisations and the Central Technical Library at the University of Ljubljana to align their practices with the principles of open science (source: www.gov.si/novice/2023-04-24-rezultati-razpisa-prilagoditev-javnih-raziskovalnih-organizacij-in-centralne-tehniske-knjiznice-univerze-v-ljubljani-za-delo-po-nacelih-odprte-znanosti).

h-index and the impact factor, and overall reforming assessment systems (CoARA 2022). The aforementioned Slovenian decree foresees the evaluation of the content of the work rather than the place of publication, the evaluation of open access results, and the consideration of other research outputs (such as data and software, early and open sharing of research results, participation in open peer review processes, and involving citizens and civil society in research).

Certainly, the quantitative criteria currently in place exhibit many shortcomings that have to be addressed (see for example Ioannidis, Klavans, and Boyack 2018; Rowlands 2018). The current trends, however, lean towards completely abandoning them and basing evaluation processes solely on qualitative assessments, which include openness and a wider spectrum of research outputs. Nonetheless, it is not entirely clear how these processes should be structured. Is the open access aspect of research output more important than its quality? Moreover, there is a lack of consideration of the feasibility of such a qualitative system and the potential shortcomings of qualitative evaluation. The idea of open review goes a step further by involving individuals from outside academia in the review process and enabling public commentary on scientific publications (Foster Open Science 2024). This approach fails to consider the complexity of the relationship between science and the broader public.

Even in today's 'closed' system, scientific findings can lead to the emergence of conspiracy theories, especially when it comes to manipulative or inaccurate interpretations of published studies, or studies that are later retracted due to methodological flaws.[8] This raises the questions of whether *passive* openness is sufficient to bridge the gap between science and the general public, or is it also necessary to address the issue of *active* openness, i.e., the explanation and interpretation of scientific results to the general public? Who takes on this role in the case of total inclusivity? Such a lack of critical reflection on some aspects of the open science movement could trigger doubts concerning the feasibility and meaningfulness of approaches this type, which could overshadow the positive aspects of citizens being involved in scientific research.

2.3 *Has Scientific Research and Publishing Truly Been Closed until Now?*

In general, two aspects of the open science movement are clearly missing. First, there is a lack of consideration for the historical context. Many principles

8 An example of this is a study conducted by Swedish researchers that was misinterpreted as evidence that the COVID-19 vaccine can alter human DNA, thereby fuelling the spread of anti-vaccination conspiracy theories (Tulp 2022). This publication was then used by representatives of conspiracy theories as evidence of the harmful effects of the vaccine.

established by the concept of open science have long been part of the scientific community. In the social sciences and humanities, several principles of involving non-scientists in the research process have been well established for decades (see below for an elaboration of this). In addition, many organizations are already making their research findings publicly available. The question arises: who is truly *closed*, prompting the need to pour so much energy and financial resources into the campaign? Is science genuinely closed? Or does this only apply to certain disciplines? Is the campaign aimed at particular publishing houses with journals that publish articles only upon payment? Still, as mentioned, many journals already operate on an open-access model, meaning that articles can be viewed for free. Yet, authors often have to pay a significant fee for their publication to appear in a journal. Is this scientific knowledge created within private corporations? If so, how do the current trends lean towards open science address this?

Documents outlining guidelines and programmes for open science are often very general and give the impression of an ideological campaign rather than a professional consideration of solutions to the problem grounded in the scientific method. For example, the first principle of the aforementioned Dutch programme is that scientific knowledge is a public good, and access to it is a universal right. In this context, it is stated that academia must "provide equal opportunities for everyone to access, participate in, benefit and learn from, and contribute to scientific process and its outputs" (National Programma Open Science 2022).

Second, there is a lack of critical reflection and consideration of the possible unintended negative implications of such calls. It is very easy for politicians, and even institutions, to publicly support the campaign for open science, as the term *open* normally signifies a positive change, especially in eyes of the general public. However, implementation of these principles requires more than just appealing phrases. The assumption that anyone can create scientific knowledge, even without any prior knowledge, is quite naïve. To communicate effectively with a scientist, a certain level of background knowledge is already required, but this becomes even more pertinent when engaging in the scientific process. There is also insufficient consideration of the relationship between different actors when discussing full inclusivity. How to proceed if there is a conflict between actors? Who prevails and how does this affect the quality of science?

The open science movement is undoubtedly positive in terms of facilitating easier access to scientific findings and data openness. Such passive openness promotes the creation of scientific knowledge and innovations and can potentially enhance quality and efficiency (OECD 2015). Nonetheless, some

problematic aspects of this approach are emerging. Reichmann and Wieser (2022) warn that open science in its present form exacerbates inequalities within the academic community. Scientific journals have adapted to the new guidelines, often requiring a substantial fee for publishing an article in open access, which for many may be unaffordable. This means that those with greater access to resources tend to benefit more from the open science movement (Cole, Reichmann, and Ross-Hellauer 2023).

At the same time, the idea of openness chiefly focuses on outward openness, with less emphasis given to internal openness, that is, within the scientific community, particularly as concerns interdisciplinary collaboration. A more critical approach to the ideas of open science is needed, moving beyond the oversimplified understanding of open science. As Rafols, Meijer, and Gallart (2023) emphasize, "we shouldn't monitor whether there is more or less open science, but what types of open science are developed and adopted, by whom, and with what consequences".

3 Citizen Science

In general, the term "citizen science" can be described as the involvement of volunteers (the public) in the process of research and expert advice. The literature contains a whole range of definitions and translations that often are already interpretations. Definitions oscillate between a minimalist and a maximalist version of citizen science, and between the proclaimed image and the actual implementation of projects. For example, Lewenstein (2016) describes citizen science as having three parts: (1) the participation of non-scientists in the process of gathering data according to specific scientific protocols and in the process of using and interpreting that data; (2) the engagement of non-scientists in true decision-making on policy issues that contain technical or scientific components; and (3) the engagement of research scientists in democratic and policy processes.

The ECSA characteristics of citizen science (M. Haklay et al. 2020) refer to several different types of citizen involvement in the projects. Participants can have different roles, such as "identifying a research question, collecting and analyzing data to support or refute a hypothesis, monitoring environmental or health conditions for management of policy outcomes, creation of generic data within a domain to support a wide range of research questions", and "exploratory approaches that are based on qualitative knowledge production". They can be viewed as equal partners or have a limited contribution in terms of providing resources to scientists. Interestingly, even the minimal participation

of non-scientists, such as sharing their computing resources or downloading an app on their phone, could be counted as citizen science. This is in strong contradiction with the claim that 'citizen scientists' are supposed to produce knowledge comparable to that of professional scientists.

The problems of the wide definitions and the importance of terminology were already raised by Eitzel et al. (2017). The authors noted that there are different dimensions of understanding citizen science as a tool (a method, research collaboration that improves scientific outcomes and educates participants), a movement (democratizing the scientific process, restoring public trust in science), or a knowledge-producing capacity (empowering communities through scientific research – rooted in participatory action research). They found more than 15 different terms were being used to describe scientists (e.g., citizen scientist, civic educator, academic, professional, researcher, paid professional etc.) and 15 different terms to describe participants in citizen science projects (e.g., amateur, hobbyist, citizen researcher, collaborator, citizen, lay knowledge holder, layman etc.). A few years later, Haklay et al. (2021) described up to 34 different definitions of citizen science being utilized by various organizations.[9]

Eitzel et al. (2017) conclude that no single term is appropriate in all contexts and suggest that terms should be chosen carefully with their use explained. They also call for a more systematic study of terminology trends in citizen science, especially by observing how the people involved in projects themselves interpret the meaning of the terms, how interpretations translate into how participants are treated, and who determines the roles assigned to the individuals and scientists involved, and the rationale behind those decisions.

To summarize, some authors see citizen science as a new doctrine, even a paradigm, and euphorically predict a new era in the democratization of science and a strong push towards deliberative democracy. They argue that the data collected by 'citizen scientists' is of the same quality as if it had been collected by professional researchers. They also believe that this participation can be realized as project management and decision-making on all aspects of research, even methodological. The European Commission shares this

9 In some countries, even the translation of the main term *citizen science* poses a problem. In Slovenia, the primary citizen science project database from the Central Technical Library employs three distinct translations, which could be described in the sense of back translation as: *science of municipality residents, citizen science* and *participatory science*. Slovenia is not the only country to face challenges while translating the term citizen science. Similar is the case of Estonia, as Eitzel et al. (2017) note, where the same expressions used can be translated as hobby, amateur, people or lay science.

euphoric view when including this model among the eight ambitions of the open science policy.

Others are more cautious, pointing to the issue of ethical and financial responsibility and the division of labor in conducting research. Even professional scientists struggle with many of these challenges, especially if they work in a disconnected or over-specialized way. Nevertheless, the participation of interested and cognitively active citizens is certainly beneficial for both themselves[10] and the research field they are engaged in, but only in certain conditions and without ideological bias. Thus far, however, we have been dealing with quite an undefined openness. But what we do know is that breaking down all boundaries and limits leads to a loss of identity for both science and public engagement. After analyzing articles in scientific journals and research policy documents, Weingart et al. state: "… the vagueness amongst science communication scholars and science policymakers regarding the most appropriate formats, features and objectives of public engagement with science is striking" (Weingart, Joubert, and Connoway 2021, 22).

Another difference can be seen in the interpretation of the main purpose of citizen science projects. On the one hand, authors focus their discussion on the potential of citizen science to enhance communication between science and society. Wagenknecht and others (2021), for example, note that citizen science challenges the classic view of science communication as something that is separate from the research process and happens at the end of a project. They conclude that "communication in citizen science is always science communication".

On the other hand, other authors point out especially the potential of citizen science to benefit the research process, most commonly through additional data gathering, while science communication and educational aspects are seen as the consequential benefits. Fraisl and others (2022) note, that it is an acknowledged approach within environmental and ecological sciences "in which non-professional participants contribute to data collection to advance scientific research". While they point out the opportunities for citizen involvement in all stages of scientific research, the focus of discussion seems to be on how this benefits the scientific project as "social learning, behavioral change or raised interest in science and community building" are mentioned as "additional outcomes that are beyond the intended results of the project."

10 Raddick, Prather and Wallace (2019) also warn about the limitations of the educational role of citizen science. The study conducted among participants in the Galaxy Zoo citizen science project failed to establish that their involvement with the project led to increased knowledge in the field of astrophysics.

Other analysts also note the unbearable ease with which the aims and mission of citizen science are defined. Most publications on the subject are normative, descriptive and value-oriented. Only few studies could be found that put under the magnifying glass the projects carried out in terms of methodology, the communication between researchers and the citizens involved, and the impact of the latter on the course and conduct of the research (for example Vohland et al. 2021).

Here, another distinction can be made, namely between the propagated role of citizen science and the reality of the project's implementation and course. The question arises whether citizen science is mostly a *buzz word* included in proposals and grant applications for projects to appear more *open*, or does listing projects as citizen science actually influence the conduct of research? Already a quick glance at projects listed as citizen science shows that most of them are from the natural science fields, include non-scientists (or, according to EU terminology, citizen scientists) as data collectors, and could be categorized as crowdsourcing projects.

There have been a few attempts at meta-analyses of citizen science projects. Kullenberg and Kasperowski (2016) analyzed them in terms of their scientific output. They discovered that the central focal point of citizen science is composed of projects in biology, conservation and ecology. In these projects, at least in practical application, the main stress is on "a methodology for collecting and classifying data".

Some authors, such as Hecker, Garbe and Bonn (2018), have arrived at similar conclusions; namely that most projects are conducted in the life sciences, where citizens are largely involved in the data collection process and only sometimes in the project design or data analysis. In just 27% of the studies citizens were involved in a more collaborative way.[11] These findings have mainly been confirmed by newer studies (Vohland et al. 2021; Davis, Zhu, and Finkler 2023) For example, an analysis of 140 German citizen science projects shows, that most often, volunteers were involved in data collection (observing or monitoring), and in less than one third of analyzed projects were they in any way involved in developing questions, methods, or disseminating results (Moczek, Hecker, and Voigt-Heucke 2021).[12]

11 The authors distinguish different types of citizen involvement based on Shirk et. al (2012). The more collaborative way here refers to cases where "Scientists generally design projects to which members of the public contribute data but also help to refine project design, analyze data and/or disseminate findings." (Hecker, Garbe and Bonn 2018).

12 We find further evidence for this if we look at the case study of Slovenia. Most citizen science projects are conducted in the field of natural sciences, such as the "STEP CHANGE: Wildlife conservation in Slovenia" project, overseen by the University of Primorska as part

In this sense, citizen science is not a relationship between scientists and lay people so much as citizens and "well-informed citizens".[13] Schutz (1976) noted that while these (cognitively active) citizens are under no illusion that they can replace experts, they simultaneously do not agree with the vagueness and ignorance of lay people regarding issues of importance. Well-informed citizens are those who look for explanations, verify their sources of information and are interested in research-supported explanations and 'second opinions'. Yet, it is true that the European Commission and quite a few, perhaps the majority, of the proponents of open or citizen science are unfamiliar with this philosophical reflection and may not even support it given that the desire for maximum inclusion is at the forefront.[14]

4 Forgotten Tradition of Participatory Research in Some Parts of Social Sciences

It seems that the idea of involving non-professionals in science, especially in research policy, is re-emerging, even though it has been established and known for decades in some segments of the natural sciences (ornithology and ethology in general, astronomy, environmental sciences), and particularly in the social sciences (under the name of action/participatory research in sociology, pedagogy, social work etc. (see Jagosh et al. 2012; Tuhkala 2021). This collaboration has been ongoing despite not being formally categorized under the 'umbrella' of citizen science.

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of a broader European project, where citizens participate in wildlife monitoring. Those projects seem to be focused on the science–citizen relationship in terms of citizens providing data for scientists and researchers. It is also worth mentioning a different approach in the recent publication, which lists 150 authors (mostly from the social sciences, but not all from academia). However, this volume (Mlinar 2022) was mostly focused on the popularization and promotion of citizen science on a very general level of discussion.

13 There are several additional distinctions of types of knowledge. De Jong and Ferguson-Hessler (1996), for example, differentiate between situational, conceptual, procedural, and strategic knowledge that an individual can possess. Each of these types of knowledge can have different levels, structuring, automation, modality and generality. An individual who is an expert in one field is therefore a layperson in another.

14 This is further supported by the recent renaming of the largest organization in the domain of citizen science in the USA from "Citizen Science Association" to "Association for Advancing Participatory Sciences". Their explanation specifically states that "the final 's' in this string of words may be the most powerful – not the capital 'S' that designates the scientific domain, but the small one that affirms a plurality of people and practices" (Putnam 2023). The discussions in this chapter suggest that while citizen science as a concept holds significant potential to influence the process of scientific research, it mostly has only limited impact in practice.

Further, scientific or academic research is (as it has been in the past) in many cases already 'participatory' or 'community-based' as it operates as a team effort, often on an interdisciplinary basis, involving a wide range of collaborators – from technicians in the laboratory to IT specialists, assistants, young researchers and students in various stages of study. More recently, however, (post-)academic research has relied primarily on external sub-contractors (for conducting surveys or data processing), or on commercial companies or agencies specialized in the preparation of project applications (especially in the context of the Horizon programme). One could argue that these examples do not describe real participation, but only a technical division of labor in which there is no real communication between scientists and the public. Another difference is that 'pure' scientific research teams are made up of people who are paid for their work (except for students doing their internships), whereas citizen science is supposed to involve not only paid researchers and their assistants, but also external participants as volunteers – pretentiously called citizen scientists.

In the social sciences, and to some extent also in some branches of medicine, the situation is somewhat different since some methods (like focus groups, the Delphi method, biographical or in-depth interviews, long-term fieldwork in ethnology and social anthropology) presuppose a significant and, in principle, voluntary (unpaid) involvement of the public or citizens as sources of data or 'objects' of research, even though these are not citizen science projects. This means that the social sciences have accumulated a considerable amount of knowledge and experience in the organization of the research process and in the ways of communicating with people who participate as respondents, interviewees or informants.

If we add to this the tradition of action research and similar approaches, it is clear that newer approaches of participatory science, notably citizen science, which are principally carried out in the natural sciences, should better leverage this additional knowledge. Can we argue that decision-makers within research policy (and perhaps some representatives of the 'hard' sciences as well) have hijacked 'citizen science' and are now parading with it, even though they are unfamiliar with the methodological and communicative-collaborative traditions of certain social science research, notably (participatory) action research[15]?

15 Some authors are mentioning these methods, for example in a chapter in volume (Albert et al. 2021 in Vohland et al., 2021) authors point out that "participatory methods have a long legacy in the social sciences".

4.1 *Action Research – Short Overview of Its Meaning for a More Realistic Conception of Open (Citizen) Science*

In general, action research, also known as participatory action research (PAR), can be seen as a radical form of participatory observation (fieldwork method in social anthropology and sociology) in which intensive communication is established between expert/scientific knowledge and experiential knowledge held by practitioners/clients (Adam 2012). Although very similar to citizen science, action research is more focused on solving the problem, respectively creating a common plan for changes on micro level, while citizen science is more focused on cooperation itself.[16] A participatory research design can have beneficial results not only in the quality of research outcomes, as it enables scientists to incorporate knowledge from the community, but also in their transferability, as the research findings have a dimension of local applicability (Macaulay et al. 1999).

Action research has a rather rich and diverse history, especially within sociology, social psychology, and pedagogy. Action research refers to a plethora of approaches that combine the empirical research or the knowledge of experts with the cognitive interests and "logistic" support of practitioners. Based on this collaboration, the approaches seek opportunities for interventions that would contribute to desired changes within the framework where joint research takes place (see also Coghlan and Brydon-Miller 2014; Mesec 2006). These settings include work organizations, educational institutions, and local communities as well as social movements and protest groups. This has been the focus of action research from the very beginning, which is associated with the German-American social psychologist, Kurt Lewin (Adelman 1993).

His action research in the field of resolution of conflicts connected with ethnic and racial minorities at the local level in the US federal state of Connecticut, which he conducted in the 1940s, is well-known. In this work, he emphasized two key aspects of research. First, research must be cyclical and deliberate, based on a spiral or feedback loop. As Lewin states, the research design ("rational social management") must be built on "a spiral of steps, each of which is composed of a circle of planning, action, and fact-finding about the result of the action" (Lewin 1946, 38). Such an approach that studies the conditions and

16 However, we have to take into account that this difference depends on the prevailing definitions of the two concepts. In this sense there is actually no distinction. By definitions or theoretical and normative conceptions, both citizen science and action research have high expectations regarding the role of non-scientists. On the opposite, we can find the gap between the theoretical/normative definition and practical way of conducting the projects in both citizen science and action research. Unfortunately, we have at a disposal very little empirical evidence in the sense of meta-analyses.

effects of different forms of social action and how they lead to change must be well-prepared from a research standpoint. Special training is needed both for social scientists to master the research aspect, which has certain specificities, and for practitioners who must be prepared to develop experiential learning and share it in a deliberative process with other participants.

The second key aspect of action research, according to Lewin, refers to the participation of interested citizens, because without their knowledge and motivation, it would be difficult for professional scientists alone to arrive at insights and opportunities for implementing organizational and other changes. Although Lewin's article provides a rather limited description of the specific ways ethnic and racial conflicts in local communities were addressed (however, he pointed to a publication where the activities in workshops are described), it can nevertheless be seen that many consultations and workshops were organized, where ideas were exchanged both among the representatives of the local communities and among the researchers, and lastly between both groups of actors (Lewin 1946, 42). To put it differently, action research can be seen as a very demanding and complex methodological and organizational approach.

Finding common epistemological perspectives and shared interpretations remains crucial. It could be said that Lewin recognized this as a new type of research (new even for researchers), one that has characteristics of post-normal/post-academic science or Mode 2 Production of Knowledge (Gibbons et al. 1994). We cannot speak only of the concept of double hermeneutics (Giddens 1993) or first and second-order constructs (Schutz 1976); a new intermediary knowledge level or interpenetration zone (Adam 2012) is emerging (Schutz labels it as a type of knowledge that is developed by "well informed citizen" as we already noted).

To summarize, Lewin's model is based on problem solving that involves collaboration between researchers and practitioners to more effectively identify, analyze, and address dysfunctions at both structural and interpersonal or intergroup levels. These principles, even nearly 90 years later, continue to shape the purpose and methodology of action research (and similar participatory models). However, the concrete project implementation can deviate from these theoretical principles, in the sense that some projects have more accents on social or political value and not so much on scientific rigor (Stringer 2007).

Later on, particularly after 2010, the emphasis on citizen science and its popularization within natural science projects and science policy became apparent and well-supported by science policy-makers. The social sciences, however, did not play a significant role here. On the other side, research policy and some circles of researchers from hard sciences behaved rather ignorantly

and were not used to thinking in an interdisciplinary manner. This is one of the main reasons why discussions about citizen science have not included action research and other participatory traditions in the social sciences and humanities (David, 2002).

It is also worth noting that this tradition was relatively unknown to many social science researchers (especially those adhering to positivist and exclusively academic orientations). Despite being well-documented in (recent) journals like Action Research Journal or International Journal for Action Research and books (like Sage Encyclopedia of Action Research), action research has often remained a marginal topic and preoccupation within the social sciences. It should be mentioned that reputable sociologists, such as A. Touraine, W. F. Whyte, and C. Argyris, were active in performing different forms of action research. It seems to have gained the most attraction in schools, especially regarding curricular reforms, where external researchers collaborated with teachers and pupils/students (Stringer 2004) or in social work, where it is proclaimed as a central research mode (Mesec 2006).

Only in recent years have there been initiatives to connect citizen science with the social sciences through concepts such as Citizen Social Sciences or to integrate action research into citizen science (David 2002; Albert et al. 2021; Canto-Farachala and Norvoll 2023). Some authors argue that the active research tradition would enable non-professional researchers in citizen science to move beyond merely collecting data and conducting measurements, which is a common limitation of practical examples of citizen science, instead empowering them through collective learning methods and community knowledge exchange to address specific challenges in their environments (Evans-Agnew and Eberhardt 2019).

In some fields of social sciences there are already developed methodological tools that enable this. The question remains whether this is actually utilized in action research as well. However, it will be necessary to extract the best aspects of this tradition and, through a more detailed (meta)analysis, highlight weaker and less well-designed action research approaches in order to avoid methodological shortcomings or give too much attention on social and political context in the near future. This can have twofold consequences. On the one hand for action research itself which can contribute to a more clear-cut and realistic development of the open (citizen) science, and on the other hand it can make policy-makers more sensible and informed.

The following (still preliminary) conclusions can be drawn from the long-term application of action research in social sciences:

1. It is better to include non-scientists/practitioners who are motivated and cognitively active (the so-called "well-informed citizens"). To this

conclusion points the relatively extensive and apparently successful use of action research in education and social work.

2. It is important that the project leadership is in the hands of the researchers who should not only be responsive to other collaborators, but who also remain responsible for the conduct of research and other activities, at least in the sense of *primus inter pares*.
3. Action research projects are very demanding and sensitive; they are at a higher level of complexity in the methodological sense as well as in the sense of organization/communication and management of the research process.

5 Discussion

Research approaches in the sense of open science and citizen science can be beneficial in many cases for researchers as well as for cognitively active citizens. They can bring about an enrichment of knowledge and a potential opportunity for (social) innovation. Two issues in particular have proven useful in this respect. The first is the transmission of tacit (implicit) knowledge, acquired through experience, self-learning, and long-term professional practice. Such knowledge is not codified and can therefore only be transferred through contacts and interpersonal interactions (Polanyi 1969). The second issue refers to the ability of interested and cognitively active citizens to participate in the verification and interpretation of obtained data, either by argumentatively commenting or through group feedback analysis, which is closer to the social sciences (see Adam 2018).

While the authors of this article do not deny the beneficial role of this participation and collaboration, they believe it has its limits and that a radical form of openness would entail a loss of the identity of science as an autonomous social subsystem (Weingart, Joubert, and Connoway 2021). It is particularly dangerous to create illusions about the potential of ad hoc citizen science projects and their outstanding, immediate results, even though it is clear that the role of non-scientists in these projects is often minimal.

This may mean that the campaign for open science and the promotion of such projects might be used as an excuse to cover up some of the problems and anomalies in the sphere of science that are not addressed in this way. For example, we can highlight the problem of oversaturation and the expansion of science (more on this in Adam and Gorišek 2022), and above all the issues of introducing greater interdisciplinarity, dialogue between disciplines, ways of resolving disputes, and differences of opinion and interpretations concerning

scientific findings. When should science speak with one voice, and when is it justified to favor plural interpretations? However, this dilemma concerns first communication within science and then communication with the public.

Another consideration is that open science should also be more open internally in terms of addressing epistemological questions such as interdisciplinarity and communication between fields, improving the quality of databases (meta-analysis), and dialogue between representatives of different world views and doctrines in terms of "adversarial collaboration" (Clark and Tetlock 2022; Grossmann 2021). Also important are ethical issues related to the application and transfer of knowledge in terms of new technologies, whose ambivalent character has been known for some time. In some places (like Slovenia), ethical committees dedicated to the research sphere have either not yet been established or their functioning remains in its infancy, with little influence.

We believe that the social sciences and humanities should have a greater, if not a decisive, role in this context. As we identified, most citizen science projects are carried out in the field of natural sciences where non-scientists are mostly (or solely) involved in the data collection process. It is legitimate to question the high expectations of the role of non-scientists in such projects. Moreover, public involvement in the research process is not novel as it has been present in the social sciences for several decades – and also in the natural sciences, albeit less methodologically developed – in various forms and under various names. However, the documentation does not make it clear whether actors in the open science campaign have taken account of past initiatives, best practices, together with less desirable consequences and unrealistic expectations.

6 Conclusions

To sum up the answers to the issues raised throughout the text, we can see that it is very likely that the ongoing campaign of recent years will not lead to stable regulations that will attract the needed consensus. This is because the current campaign is all about immediate effects and does not proceed incrementally. On one hand, it could be defined as some kind of 'social engineering' or at least in the *ad experimentum* sense, and, on the other, as an attempt to establish a 'cultural hegemony' in the sphere of research policy.

If the trend of politicization is to continue, it may reduce scientific autonomy. In addition, within the scientific community, it may lead to the emergence of in-breeding clientelism, especially if it becomes evident that the old criteria of scientific performance no longer apply, and new ones have not yet

been established, are unclear, or lack recognition among a broader group of researchers. This leads to an anomic state that certainly does not support innovation or the exchange of ideas between research groups and disciplines.

Furthermore, we can note that the campaign is very 'self-referential' and pays little attention to those with critical views who perceive it as the politicization of science. Nevertheless, it is necessary to differentiate between the campaign originating from the institutions of the European Commission and the national approaches to managing this campaign, as there are clearly differences. However, current observations suggest that the discourse on open science tends to be normative, the campaign lacks an incremental approach, and in some cases, it is not the product of a broader debate within national contexts (at least in the case of Slovenia). This means there is little likelihood that it will entail a higher degree of self-reflection or self-correction. More (meta)analyses and cross-national comparisons on this matter are needed.

Last but not least, establishing connections between natural sciences disciplines that extensively rely on public participation or volunteer approaches and the social sciences is essential for fostering interdisciplinarity and promoting increased reflexivity. Disciplines in the social sciences and humanities have accumulated knowledge of more sophisticated methodological approaches and soft-skills knowledge such as communication with involved subjects (who act as respondents, interviewees, informants, or members of action research groups), organization of the research process, and group dynamics. In contrast, the natural sciences have more experience with teamwork in labs and wider co-authorship of articles.

References

Research Literature

Adam, Frane. 2012. "Ekspertna in Participativna Dimenzija Akcijskega Raziskovanja v Luči Sistemske Teorije (Expert and Participatory Dimension of Action Research in the Light of System Theory)." In *Kvalitativno Raziskovanje v Interdisciplinarni Perspektivi* (*Qualitative Research in Interdisciplinary Perspective*), edited by Frane Adam. Ljubljana: Inštitut IRSA.

Adam, Frane. 2018. "Citizen Science Pilot Experiment in High Schools." *Innovative Issues and Approaches in Social Sciences* 11 (2). doi:10.12959/issn.1855-0541.IIASS-2018-no2-art3.

Adam, Frane, and Maruša Gorišek. 2022. "Towards Sustained and Sustainable Management of COVID-19: An Alternative to the Simplified Return to Pre-Pandemic 'Normality'." *Sustainability* 14 (17): 10789. doi:10.3390/su141710789.

Adelman, Clem. 1993. "Kurt Lewin and the Origins of Action Research." *Educational Action Research* 1 (1). Taylor & Francis: 7–24.

Alaszewski, Andy. 2023. *Managing Risk During the COVID-19 Pandemic Global Policies, Narratives and Practices*. Bristol: Policy Press.

Albert, Alexandra, Bálint Balázs, Eglė Butkevičienė, Katja Mayer, and Josep Perelló. 2021. "Citizen Social Science: New and Established Approaches to Participation in Social Research." Chapter 7. In Vohland K. et al. (Eds). 2021. *The Science of Citizen Science*. Springer.

Canto-Farachala, Patricia, and Reidun Norvoll. 2023. *Guest Editorial of Thematic Series: YouCount: Action Research and Citizen Social Science*. *IJAR – International Journal of Action Research*. Vol. 19. Verlag Barbara Budrich.

Carayannis, Elias G., and David F.J. Campbell. 2009. "'Mode 3' and 'Quadruple Helix': Toward a 21st Century Fractal Innovation Ecosystem." *International Journal of Technology Management* 46 (3/4): 201. doi:10.1504/IJTM.2009.023374.

Coghlan, David, and Mary Brydon-Miller. 2014. *The SAGE Encyclopedia of Action Research*. Sage.

Cole, Nicki Lisa, Stefan Reichmann, and Tony Ross-Hellauer. 2023. "Toward Equitable Open Research: Stakeholder Co-Created Recommendations for Research Institutions, Funders and Researchers." *Royal Society Open Science* 10 (2): 221460. doi:10.1098/rsos.221460.

Cooper, Caren B., and Bruce V. Lewenstein. 2016. "Two Meanings of Citizen Science." *The Rightful Place of Science: Citizen Science* 2. Consortium for Science, Policy & Outcomes Tempe, AZ: 51–62.

David, Matthew. 2002. "Problems of Participation: The Limits of Action Research." *International Journal of Social Research Methodology* 5 (1). Taylor & Francis: 11–17.

Davis, Lloyd S., Lei Zhu, and Wiebke Finkler. 2023. "Citizen Science: Is It Good Science?" *Sustainability* 15 (5): 4577. doi:10.3390/su15054577.

De Jong, Ton, and Monica G. M. Ferguson-Hessler. 1996. "Types and Qualities of Knowledge." *Educational Psychologist* 31 (2). Taylor & Francis: 105–13.

Eitzel, Melissa, Jessica Cappadonna, Chris Santos-Lang, Ruth Duerr, Sarah Elizabeth West, Arika Virapongse, Christopher Kyba, Anne Bowser, Caren Cooper, and Andrea Sforzi. 2017. "Citizen Science Terminology Matters: Exploring Key Terms." *Citizen Science: Theory and Practice*. York: 1–20.

Evans-Agnew, Robin A., and Chris Eberhardt. 2019. "Uniting Action Research and Citizen Science: Examining the Opportunities for Mutual Benefit between Two Movements through a Woodsmoke Photovoice Study." *Action Research* 17 (3). SAGE Publications Sage UK: London, England: 357–77.

Eysenbach, Gunther. 2006. "The Open Access Advantage." *Journal of Medical Internet Research* 8 (2): e8. doi:10.2196/jmir.8.2.e8.

Fischer, Frank. 2017. *Climate Crisis and the Democratic Prospect: Participatory Governance in Sustainable Communities*. Oxford University Press.

Foster Open Science. 2024. "Open Peer Review." www.fosteropenscience.eu/learning/open-peer-review/#/id/5a17e150c2af651d1e3b1bce.

Fraisl, Dilek, Gerid Hager, Baptiste Bedessem, Margaret Gold, Pen-Yuan Hsing, Finn Danielsen, Colleen B. Hitchcock, et al. 2022. "Citizen Science in Environmental and Ecological Sciences." *Nature Reviews Methods Primers* 2 (1): 64. doi:10.1038/s43586-022-00144-4.

Funtowicz, Silvio, and Jerome Ravetz. 2003. "Post-Normal Science." *International Society for Ecological Economics (Ed.), Online Encyclopedia of Ecological Economics at www.ecoeco.org/publica/encyc.htm*.

Gibbons, Michael, Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter Scott, and Martin Trow. 1994. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. London: SAGE Publications Ltd. doi:10.4135/9781446221853.

Giddens, Anthony. 1993. *New Rules of Sociological Method: A Positive Critique of Interpretative Sociologies*. 2nd ed. Stanford, Calif: Stanford University Press.

Glavič, Peter, Helena Levičnik, and Maja Muhičm. 2023. "Trajnostna, Konkurenčna, Ustvarjalna in Uspešna Slovenija 2030?(A Sustainable, Competitive, Creative and Prosperous Slovenia 2030? I. Analysis of the Sustainable Development of Slovenia, II. Analysis of Higher Education in Slovenia, III. Analysis of Research and Development, Innovation and Entrepreneurship in Slovenia.") Maribor: Univerza v Mariboru: Inženirska akademija Slovenije. https://static1.squarespace.com/static/61aa6dd677f8a7121959be35/t/6492e5c4ea8d976af4b56e99/1687348697990/Analiza+1-xs.pdf.

Haklay, Mordechai Muki, Daniel Dörler, Florian Heigl, Marina Manzoni, Susanne Hecker, and Katrin Vohland. 2021. "What Is Citizen Science? The Challenges of Definition." *The Science of Citizen Science* 13.

Haklay, Muki, Alice Motion, Bálint Balázs, Barbara Kieslinger, Bastian Greshake Tzovaras, Christian Nold, Daniel Dörler, Dilek Fraisl, Dorte Riemenschneider, and Florian Heigl. 2020. "ECSA's Characteristics of Citizen Science." ECSA European Citizen Science Association.

Hecker, Susanne, Lisa Garbe, and Aletta Bonn. 2018. "The European Citizen Science Landscape – A Snapshot." In Susanne Hecker, Haklay Muki, Anne Browser, Zen Makuch, Johannes Vogel, and Aletta Bonn. 2018. *Citizen Science: Innovation in Open Science, Society and Policy*. London: University College London, 190–200.

Ioannidis, John P. A., Richard Klavans, and Kevin W. Boyack. 2018. *Thousands of Scientists Publish a Paper Every Five Days*. Nature Publishing Group UK London.

Jagosh, Justin, Ann C. Macaulay, Pierre Pluye, Jon Salsberg, Paula L. Bush, Jim Henderson, Erin Sirett, et al. 2012. "Uncovering the Benefits of Participatory Research:

Implications of a Realist Review for Health Research and Practice: A Realist Review for Health Research and Practice." *Milbank Quarterly* 90 (2): 311–46. doi:10.1111/j.1468-0009.2012.00665.x.

Jasanoff, Sheila. 2005. *Designs on Nature: Science and Democracy in Europe and the United States*. Princeton University Press. doi:10.2307/j.ctt7spkz.

Kullenberg, Christopher, and Dick Kasperowski. 2016. "What Is Citizen Science? – A Scientometric Meta-Analysis." *PloS One* 11 (1). Public Library of Science San Francisco, CA USA: e0147152.

Lewin, Kurt. 1946. "Action Research and Minority Problems." *Journal of Social Issues* 2 (4). Blackwell Publishing Ltd Oxford, UK: 34–46.

Luhmann, Niklas. 1983. *Legitimation durch Verfahren*. Vol. 6. Suhrkamp Frankfurt am Main.

Macaulay, A. C., L. E. Commanda, W. L. Freeman, N. Gibson, M. L. McCabe, C. M. Robbins, and P. L Twohig. 1999. "Participatory Research Maximises Community and Lay Involvement." *BMJ* 319 (7212): 774–78. doi:10.1136/bmj.319.7212.774.

Mesec, Bl. 2006. *Action Research. V*: Flaker, V. & Schmid, T. (Ur.). *Von Der Idee Zur Forschungsarbeit: Forschen in Sozialarbeit und Sozialwissenschaft* (*Böhlau Studienbücher BSB*). Wien: Böhlau Verlag.

Mlinar, Zdravko, ed. 2022. *Izzivi občanskega raziskovanja: izkušnje in pričakovanja iz Žirov in od drugod Challenges of citizen science: experience and expectations from Žiri and elsewhere*. Žiri: Muzejsko društvo.

Moczek, Nicola, Susanne Hecker, and Silke L. Voigt-Heucke. 2021. "The Known Unknowns: What Citizen Science Projects in Germany Know about Their Volunteers – And What They Don't Know." *Sustainability* 13 (20): 11553. doi:10.3390/su132011553.

Nowotny, Helga, Peter Scott, and Michael Gibbons. 2001. *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty*. Repr. Cambridge: Polity Press.

Polanyi, Michael. 1969. *Knowing and Being: Essays by Michael Polanyi*, edited by Marjorie Grene. Chicago: University of Chicago Press.

Putnam, Reanna. 2023. "Announcing a New Name for This Association." *participatorysciences.org*. 7. https://participatorysciences.org/2023/07/14/announcing-a-new-name-for-this-association.

Raddick, Michael Jordan, Edward E. Prather, and Colin S. Wallace. 2019. "Galaxy Zoo: Science Content Knowledge of Citizen Scientists." *Public Understanding of Science* 28 (6): 636–51. doi:10.1177/0963662519840222.

Rafols, Ismael, Ingeborg Meijer, and Jordi Molas-Gallart. 2023. "The Benefits of Open Science Are Not Inevitable: Monitoring Its Development Should Be Value-Led." *LSE Blog*. https://blogs.lse.ac.uk/impactofsocialsciences/2023/08/14/the-benefits-of-open-science-are-not-inevitable-monitoring-its-development-should-be-value-led.

Reichmann, Stefan, and Bernhard Wieser. 2022. "Open Science at the Science–Policy Interface: Bringing in the Evidence?" *Health Research Policy and Systems* 20 (1): 70. doi:10.1186/s12961-022-00867-6.

Rowlands, Ian. 2018. "Is It Time to Bury the H-Index?" *The Bibliomagician*. 32. 3. https://thebibliomagician.wordpress.com/2018/03/23/is-it-time-to-bury-the-h-index.

Schutz, Alfred. 1976. "The Well-Informed Citizen." In *Collected Papers II*, by Alfred Schutz, edited by Arvid Brodersen, 15:120–34. Phaenomenologica. Dordrecht: Springer Netherlands. doi:10.1007/978-94-010-1340-6_6.

Science Europe. 2023. "Launch of New National Open Science Strategies." 7. www.scienceeurope.org/news/launch-of-new-national-open-science-strategies.

Stringer, E. T. 2004. *Action Research in Education*. New Jersey: Pearson Merrill Prentice Hall.

Stringer, E. T. 2007. *Action research.* Third edition. Los Angeles: SAGE.

Tuhkala, Ari. 2021. "A Systematic Literature Review of Participatory Design Studies Involving Teachers." *European Journal of Education* 56 (4): 641–59. doi:10.1111/ejed.12471.

Tulp, Sophia. 2022. "Swedish Study on COVID Vaccines and DNA Misinterpreted." *AP News*, sec. AP Fact Check. www.apnews.com/article/fact-check-covid-vaccine-sweden-study-986569377766.

Uhlir, Paul F., and Peter Schröder. 2007. "Open Data for Global Science." *Data Science Journal* 6. CODATA: OD36–53.

Vohland, Katrin, Anne Land-Zandstra, Luigi Ceccaroni, Rob Lemmens, Josep Perelló, Marisa Ponti, Roeland Samson, and Katherin Wagenknecht, eds. 2021. *The Science of Citizen Science*. Cham: Springer. doi:10.1007/978-3-030-58278-4.

Wagenknecht, Katherin, Tim Woods, Christian Nold, Simone Rüfenacht, Silke Voigt-Heucke, Anne Caplan, Susanne Hecker, and Katrin Vohland. 2021. "A Question of Dialogue? Reflections on How Citizen Science Can Enhance Communication between Science and Society." *Journal of Science Communication* 20 (03): A13. doi:10.22323/2.20030213.

Weingart, Peter. 2008. "How Robust Is 'Socially Robust Knowledge'?" In *Knowledge and Democracy*, 143–56. Routledge.

Weingart, Peter, Marina Joubert, and Karien Connoway. 2021. "Public Engagement with Science – Origins, Motives and Impact in Academic Literature and Science Policy." Edited by Alessandro Muscio. *PLOS ONE* 16 (7): e0254201. doi:10.1371/journal.pone.0254201.

Willke, Helmut. 1989. *Systemtheorie entwickelter Gesellschaften: Dynamik und Riskanz moderner gesellschaftlicher Selbstorganisation.* 2. Aufl. Grundlagentexte Soziologie. Weinheim München: Juventa-Verl.

Ziman, John. 2016. *Science in Civil Society*. Andrews UK Limited.

Other Source Documents

Central Technical Library of the University of Ljubljana. 2024. Catalogue of Citizen Science Projects. www.citizenscience.si/aktivnosti/katalog-projektov. Retrieved December 20, 2024.

CoARA. 2022. "Agreement on Reforming Research Assessment." CoARA. www.coara.eu/app/uploads/2022/09/2022_07_19_rra_agreement_final.pdf.

Državni zbor Republike Slovenije. 2021. Zakon o znanstvenoraziskovalni in inovacijski dejavnosti (ZZrID) (Scientific Research and Innovation Act (ZZrID). Ur. l. RS. 186/21, 40/23, 102/24. www.pisrs.si/pregledPredpisa?id=ZAKO7733. Retrieved December 20, 2024.

EOSC. 2024. EOSC – Czech Republic. www.eosc.eu/tripartite-collaboration/czech-republic. Retrieved February 19, 2024.

EU Citizen Science Platform. 2024. www.eu-citizen.science. Retrieved December 20, 2024.

European Commission. 2019. "European Commission – Open Science." https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/open-science_en (European Commission). Retrieved June 12, 2024.

European Commission. 2019a. Horizon 2020 AGA – Annotated Model Grant Agreement V5.2. www.h2020.md/en/horizon-2020-annotated-model-grant-greements. Retrieved December 20, 2024.

European Commission 2019b. Open Science Factsheet (13. 12. 2019).

European Comission. 2024. "European Open Science Cloud". https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/our-digital-future/open-science/european-open-science-cloud-eosc_en (European Commission). Retrieved December 20, 2024.

Estonian Research Council. 2024. Open science. Estonian Research Council. www.etag.ee/en/activities/open-science. Retrieved February 19, 2024.

Ministere de l'enseignement superieur et de la recherche. 2024. "Second French Plan for Open Science." *Ouvrir La Science*. www.ouvrirlascience.fr/second-national-plan-for-open-science-npos (Ministere de l'enseignement suprieur et de la recherche). Retreived June 23, 2024).

Ministrstvo za izobraževanje, znanost in šport. 2022. Resolucija o znanstvenoraziskovalni in inovacijski strategiji Slovenije 2030 (ReZrIS230). (Resolution on the Scientific Research and Innovation Strategy of Slovenia 2030 (ReZrIS30). Ur. l. RS. 49/22. www.pisrs.si/pregledPredpisa?id=RESO133. Retrieved December 20, 2024.

National Library of Sweden. 2023. "National Guidelines for Open Science. Proposal Open for Public Consultation 3 October–3 November 2023." National library of Sweden. www.kb.se/download/18.d8a384b18acfe2ed532cb5/1696936867649/Proposal-National-guidelines-for-open-science.pdf.

National Programma Open Science. 2022. "Open Science 2030 in the Netherlands: NPOS2030 Ambition Document and Rolling Agenda." National Programma Open Science. www.openscience.nl/sites/open_science/files/media-files/final_npos2030_ambition_document_and_rolling_agenda.pdf.

OECD. 2015. "Making Open Science a Reality." www.oecd-ilibrary.org/content/paper/5jrs2f963zs1-en. Retrieved December 1, 2024.

Open Aire. 2024. www.openaire.eu. Retrieved December 12, 2024.

"UNESCO Recommendation on Open Science." 2023. www.unesco.org/en/open-science/about?hub=686. Retrieved December 12, 2024.

Vlada Republike Slovenije. 2015. Nacionalna strategija odprtega dostopa do znanstvenih objav in raziskovalnih podatkov v Sloveniji 2015–2020. (National strategy for Open Access to Scientific Publications and Research Data in Slovenia 2015–2020). www.arrs.si/sl/dostop/strategija.asp. Retrieved December 20, 2024.

Vlada Republike Slovenije. 2023. Uredba o izvajanju znanstvenoraziskovalnega dela v skladu z načeli odprte znanosti (Regulation on the implementation of scientific research work in accordance with the principles of open science). Ur. l. RS. 59/23. www.uradni-list.si/glasilo-uradni-list-rs/vsebina/2023-01-1828/uredba-o-izvajanju-znanstvenoraziskovalnega-dela-v-skladu-z-naceli-odprte-znanosti/#I.%C2%A0SPLO%C5%A0NE%C2%A0DOLO%C4%8CBE. Retrieved December 20, 2024.