

Open Science and Open Access, a Scientific Practice for Sharing Knowledge

Simone Belli¹ ✉ , Ronald Cardenas², Martin Velez², Ariana Rivera², and Valeria Santoro³ 

¹ Universidad Complutense de Madrid, Facultad de Ciencias Politicas y Sociologia, Madrid, Spain sbelli@ucm.es

² Yachay Tech University, Urcuqui, Ecuador {ronadcardenas, martin.velez, ariana.riverah}@yachaytech.edu.ec

³ Barcelona Institute for Global Health Hospital Clinic Universitat de Barcelona. Carrer Rossell 132. 08036 Barcelona, Spain vsantorol@ub.edu

Abstract. Digital transformation is changing communication in the academic community, breaking geographic barriers with facilities of communication between collaborators. However, countries and institutions are not in the same context about resources to build an open path for research production. For this reason, Open Access and Science are strategies of relevance that enable collaboration among researchers around the world and institutional areas. We do a systematic review with the aim of exploring the potentials, and limitations of Open Science (OS) and Open Access (OA) to scientific collaboration and production. We did an initial screening of an abstract of 1664 publications in Scopus to select 144 documents related. Finally, a detailed review of the articles presents 17 documents that deal specifically with the functionalities and barriers of OS and OA. The given arguments highlight the efficiency, and abilities to democratize the production of knowledge and to generate ideas and innovative solutions to current problems. Likewise, this article addresses the barriers found in the academic level. The purpose of this paper is to analyze the arguments treated by scientists in the dispute over whether to use it or not. Specifically, our objectives are to: (a) analyze the role of open science and open access in scientific production, (b) identify the barriers that authors experience when opting for open access and open science. At last, we discuss the potential of OS to overcome the territorial, economic, and infrastructure barriers that certain researchers may experience in their production of scientific research collaboratively and equitably.

Keywords: Scientific Collaboration · Open Access (OA) · Open Science (OS) · Knowledge democratization · Literature Review

1 Introduction

The evolution of disciplinary scholarly practices has transformed knowledge production, with the introduction of technology in research being one of the major

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drivers of changes [18,41]. Digital transformation can change communication in the academic community, break geographic barriers and facilitate the communication between collaborators [21]. Works as [33,34] and Budapest Open Access Initiative, (2002) propose that these changes must be related to the transformation of scientific publications. These changes must consider some aspects. The first one is the transformation from physical to digital journals, and the second is the promotion of Open Access to breaking social barriers such as legal, economic, or technological.

Open Access has been redefined in many occasions. In Budapest (1993), Open Access was defined as the cost-less access to the Internet for the distribution and use of material for any legal purpose to break economic and technological barriers [3,24]. Another declaration of Open Access was in Berlin emphasizing the contributions of scientific investigation; it refers to data, photos, or graphics [7]. Moreover, the Salvador Declaration (2005) is focused on the development, access, and use of science information [31].

Open Access gives freedom to use scientific publications under some conditions [10]. This tool allows to use, publish, edit, and produce derivative research of the original work with the agreement of the original authors. In this sense, Open Access contributes to building knowledge society by promoting information and communication [39]. However, each region needs to create politics to promote, develop and limit Open Access [27]. For example, in Latin America, Copyright results in a barrier which obstructs the uses of data and limits the use of the publication. A lot of Open Access journals in Latin America keep restrictive copyright policies, which is inconsistent with the values of Open Access [37].

Open Access is an essential instrument by which Open Science is based on the new strategies to diffuse knowledge and cooperative work using digital technologies [25]. Open Science encompasses some instruments for openness as Open Data that focuses on fomenting the open publication of raw data and Open source that foments the openness of research prototypes and software [26].

Open Science development is showing the world that investigators are achieving attempts that otherwise would not be possible without collaborative networks and technological tools combined together. Some of the remarkable examples are significant in biology and medicine, such as drug development strategies getting better thanks to the addition of open strategies. These changes are reshaping the industry [36]. The relevant studies include drug development in malaria and tropical disease. Despite the risks that open science can have, this process is working better than traditional ways of co-working and at least, for now, it's a more efficient and fair way to make real science with global impacts.

Through time, a lot of advantages have been shown taking into account the powerful effects of Open Science and Open Access in the ways individuals tend to form collaborative teams, sharing profiles and creating a diversity of knowledge. This process changes local realities with the promotion of collaborations, including providing low-resource groups access to global resources and information. In consequence, it's important to learn about these wide strategies to deal with persistent challenges. As Hillyer et al (2017) suggest, its necessary to know

the local dynamics and strong structures that influence the collaborative teams formation [23].

Since Open Science and Open Access are seen as a strategy of knowledge production and dissemination that opposes the traditional closed strategies of knowledge production and dissemination, the purpose of this paper⁴ is to analyze the arguments treated by scientists in the dispute over whether to use it or not. Specifically, the objectives of the article are: (a) to analyze the role of open science and open access in scientific production, (b) to identify the barriers that authors experiment when opting for Open Access and Open Science.

2 Methodology

One of the most relevant arguments when defending Open Science and Open Access is the ability of these tools to favor scientific collaboration. Because of that, the paper aims to analyze the research publications that describe and analyze the capacities and limitations of Open Access and Open Science with regards to scientific collaboration.

We used Scopus as the source to collect the data. Two keyword searches were made. The first one used the terms open science and collaboration with 1 949 results. The second used the of open access and collaboration with 715.

We limited the results to only articles, reviews and conference papers. From this point, in order to filter the documents that were related to our research we analyzed their abstracts. Since we made keywords searches, most of the documents obtained did not address the problems we aimed to analyze. After a content analysis of their abstracts, we ended up with 94 documents for the terms open access and collaboration and 60 documents for the terms open science and collaboration. One hundred and fifty-four documents were included for the complete review. Duplicate articles and those that in spite of citing the use of open science, addressed other topics were excluded. After the complete review, we present 17 selected documents (Table 1) that analyze specifically the use of open science and open access in research, its advantages, and disadvantages.

The internal quality of the articles was not evaluated since the objective was to collect the diversity and multiplicity of arguments about the use of open science for scientific practice. However, the quality of the publications was guaranteed by the a description of publications to journals indexed in Scopus.

3 Results

We present the results of our review, where we could differentiate two main sections. 3.1 The role of Open Science and Open Access in scientific production and 3.2 Barriers that authors have when choosing Open Science and Open Access.

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Table 1. Authorship list presented in results

| Autorship | The role of Open Science and Open Access in scientific production | Barriers that authors have to choose Open Access and Open Science |
|---|--|--|
| Adams and Bullard, 2014 | X | |
| Arza, Fressoli, Sebastian, 2017 | X | |
| Bubnicki, Churski and Kuijper, 2016 | X | |
| Chataway J., Parks S. and Smith E. 2017 | X | |
| Choi and Tausczik, 2017 | X | X |
| Coro, Panichi, Scarponi and Pagano , 2017 | X | |
| Das, et al., 2017 | X | X |
| Ferpozzi, 2017 | | X |
| Laine, 2017 | | X |
| Lin, Wiebe and Zhou, 2017 | X | |
| Shaw, 2017 | X | X |
| Tsou and Hsu, 2016 | X | |
| Vesnic-Alujevic, 2014 | | X |
| Weitzel, et al., 2017 | X | |
| Wilbanks and Wilbanks, 2010 | X | |
| Wooldridge, Taylor and Sullivan, 2009 | X | |
| Zhitomirsky-Geffet, et al., 2016 | | X |

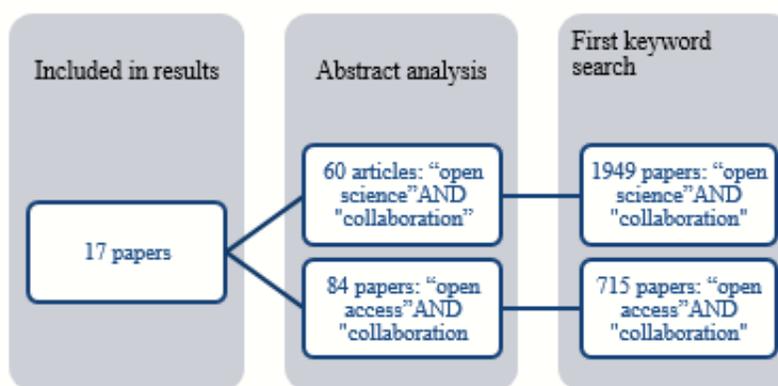


Fig. 1. Search and paper selection process (Papers from Scopus

3.1 The role of Open Science and Open Access in scientific production

The results of the review suggest that Open Science and Open Access are valuable tools to share information and collaborate in different social spheres. They allow to produce scientific knowledge involving science-related professionals and non-science related professionals by their collaborative work [4].

In this sense, open science is conceptualized as a strategy that allows, in the first place, to make the production of knowledge more efficient in the sense that it reduces the time and financial expense of the scientific output. Secondly, it is conceived as a strategy that allows to make more honest the production of knowledge, since it facilitates access to data by a wide range of people (researchers, policymakers, companies, and the general population) Third, given the ability to converge knowledge technologies widely and make them accessible to a higher number of people, open science becomes an essential element for innovation.

More efficient knowledge production Firstly, we have found arguments that refer to Open Science as a strategy that allows to reduce the costs of scientific production and favor the efficient construction of knowledge. In this sense, Shaw [36] discusses that traditional models of research are inefficient and expensive. For this reason, he argues that it's necessary to consider Open Science to produce scientific knowledge. From this point of view, Open Science is an indispensable tool that can increase the efficiency of researchers by including diverse strategies that search for public and external inputs. The benefits of openness can be seen in other areas such as firms. Openness allows firms to change strategies and increase their opportunities boosting their development [38].

Efficiency is a recurrently referenced theme, especially, in the area of data accumulation and management [29, 42]. On one hand, the openness of data from different sources such as scientific research, industrial experiments and the web has created a vast amount of data (big data). On the other hand, this diversity and quantity of data must be properly managed in order to obtain new knowledge to ensure its longevity, reuse and openness [14].

Das, et al. (2017) expose that Open Science is a potential solution to problems related to the limitation of doing science in institution based contexts where the amount of statistical power and resources are limited. On one hand, the Open Science initiative could prevent data loss, increasing sample sizes and statistical capacity. On the other, it would expand the reach and impact of research and reduce acquisition costs by reducing data [15].

Equitable knowledge access and production The most outstanding element of Open Science is its potential for an equitable production and access to knowledge. Open Science is conceptualized as an indispensable tool for the democratization of knowledge through the opening of resources, infrastructures, raw data and publications to a wide range of agents. The strength of Open Science lies in the fact that it supports the open publication and democratization of

methodologies, processes, results, and documents related to scientific research. The availability of this kind of data allows for the transparency, reproducibility, repeatability, and reusability of scientific results. In this perspective, authors such as Bubnicki, Churski, and Kuijper (2016) consider that the benefit from Open Science approaches can be seen in the community of users of this open data since using it can contribute with their own findings [9]. Professionals from the same and other areas can infer new knowledge from these data. In this sense, Choi and Tausczik (2017) consider that scientific progress can be accelerated, which allows to create new applications of these findings in other fields while promoting innovation [13].

In this framework, Open Access plays a prominent role, given that it is considered as the research dissemination strategy that allows to break the economic limits of access to knowledge of certain countries and institutions [1].

In consonance with this point of view, Arza, Fressoli, and Sebastian (2017) argue that the birth of OA breaks with a closed and split corporative statement about scientific knowledge diffusion [5]. They state that, opposed to closed publications [5], Open Access has become an essential element for the massive collaborative scientific teams and the information which they generate, avoiding unnecessary efforts and stimulating efficacy.

The ability to break with the elitist limits of closed publications is also evident in the growing presence and diffusion of Open Access around the world. In this line, Chataway J., Parks S. y Smith E. (2017) highlight a notorious increment of the relative presence of Open Access in the amount of the total world publications, which utter that in 10 years, the relative heaviness of Open Access has been rising about 6% (38% in 2004 and 44% in 2014) [12]. This fact benefits the supporters ascription and institutional commitments to promote Open Access as a standard mechanism in scientific publications. Similarly, Chataway J., Parks S. y Smith E. (2017) remark the effectiveness of Open Access in the efficient treatment of problems and the increase in collaborative teams that form looking for the same answers related to society complexity [12]. An example is the global Ebola crisis, in which different specialists were able to freely exchange information and discoveries about the virus, which in turn contributed to focus studies and generate team work around the world fighting to control the epidemic. Setting off the effective and efficient distribution of information to tackle emergent problems, Chataway, Parks & Smith (2017) argue that there is a limit imposed by the copyright because its influence often slows down the research process. For instance, the case of Saudi Arabia, where the quarrel about copyright and poor information has created big barriers to come against a respiratory syndrome Middle East respiratory syndrome (MERS) [12].

A key element for innovation Likewise, and as a result of the potential in the openness of knowledge and technologies that makes open science possible, it is conceptualized as a relevant tool for innovation, given that it allows for the convergence of disciplines, research groups and diverse agents in the construction of technologies and problem solving. Professionals from the same and other areas

can infer new knowledge from Open data, which could accelerate the processes of scientific production and promote innovative process in problem-solving [13].

In this term, Wilbanks Wilbanks (2010) compares how innovation was considered before and after the creation of the internet. The major change is related to the creation and management of products, data, processes and intellectual properties. They concluded that it is necessary to open the use of this information in order to find its complete potential in other fields. Among other benefits, the access to this knowledge, especially intellectual property, allows users to avoid repeating past failures and to receive feedback, advice and criticism [43].

In this sense, Wooldridge, Taylor, and Sullivan (2009) present a clear example of the potentialities of innovation of Open Sciences by showing the results obtained in Open Science Prize initiative, an initiative that aims to encourage open science in biomedical contexts and that has encouraged international collaboration by promoting open digital content and data [44].

3.2 Barriers that authors have when choosing Open Science and Open Access

Despite the benefits that Open Science can have to enhance science, some aspects can limit its implementation. Das, et al., (2017) discuss that Open Science at institutions has not reach completely the scientific community due to ethical, conceptual, and technical challenges involving researchers and the subjects of the research [15]. It suggests that the authorship and autonomy of the data they created can limit the openness of researchers to Open Science. This is due to the unknown potential of the data created. Another aspect that can limit Open Science is related to the ethical dimension considering privacy, consent, and security of the subject's information from which data is obtained.

Despite these two possible limitations, Das, et al., (2017) also highlight the possible benefits from Open Science initiatives, from the increase of the number of citations and recognition attributed to shared data to the increase of return of scientific funding and research investment [15]. The latter is thanks to the increase of sample sizes and variability that improves reproducibility and reliability of results, also increasing publication quality and impact. Another problem that Open Science must face is the quality of the data created. Due to the amount of information created from different sources, it is necessary to sort this data since misleading results can be obtained from noisy data. Choi and Tausczik (2017) highlight that professionals that want to use another data face the challenge of figuring out how relevant, understandable and reliable said data is since it usually lacks enough context and documentation to understand its relevance, format, and meaning [13]. For this reason, Choi and Tausczik (2017) show that collaboration with the data creators is necessary and suggest that as openness increases, norms for sharing data will become more homogenous, facilitating data created by different professionals [13].

Lastly, a fear that researchers can have related to Open Science is Scooping.

Laine (2017) works focuses on this problem [28]. Scooping is a term used when someone claims priority or claims to be the first one doing a research that

is also done by other researchers at the same time. In the same way, Shaw (2017) presents Open Science as a valid option improving the efficient development of technologies and pharmaceutical products, but he admits that this tool can be a potential risk because of the author's exposition to potential theft [36]. This fear to be stolen is a limitation for researchers to get involved in open science and open data sharing. Laine (2017) discusses that it is a major stress factor among researchers. Nonetheless, this work also discusses that openness can help to reduce scooping since the open publication of data online can be used as evidence to prove priority [28].

Finally, two concrete arguments emerge when establishing

Open Access Limitations: The fear of disseminating publications of questionable quality and the economic interests of publishers. In other words, on one hand, there is a debate about the fact that open access should consider the crowd-sourcing data which may contain defects either in redaction or in orthography. These aspects could generate concerns about the quality of articles [45]. However, Vesnic-Alujevic (2014) rebuts that although the quality and reliability of information can be jeopardized on the internet, Internet could be a good way to improve research control and improvement [40]. If a researcher publishes his or her work online, there is a broader community that can comment and criticize it. Thanks to this and the speed, efficiency, and flexibility of communication through the internet, researchers work quality and dissemination can be improved [40].

On the other hand, Ferpozzi (2017) exposes the existence of discussions about open access around the business competition of publishers, whose main goal is achieving economic resources. In this margin, the author expresses that knowledge production cannot be self-sponsored, by then, and organizations or companies will always be necessary to sponsor these researches [19].

4 Discussion

Open Science aims to democratize the access to knowledge, data, prototypes, and software for all the potential community [26, 35].

Although there is certain reluctance to use Open Science for the creation and communication of knowledge (mainly the fear of research data being "stolen" and the inadequate use of publications or doubts about the quality of the publications), Open Science strategies have multiple potential when it is thought of as a relevant tool to shortening barriers between researchers and institutions with limited resources and to respond to existing social problems from the complexity paradigm. The access to information related to science faces obstacles that limit the amount of people with access. Alperin et al. (2008) consider the dominance of English in science an obstacle to be part of international academic networks and to have articles published in prestigious international journals [3]. In the same way, Ahmed (2007), Grimshaw and Talyarkhan, (2005), Gaiza (2016) argue that the publications with more impact factor are from European or American Journals and not Open Access, making it difficult for low-income countries (such

as Latin America) to access the knowledge produced in their own territory or relevant for it [2, 20, 21]. It supposes a form of knowledge colonialism [22] and increases the divide between those who have resources and those who don't to access and produce knowledge. As consequence, knowledge becomes accessible to those well-off spheres (usually researchers and institutions of developed countries) and in turn, promotes the reproduction of social and research inequalities at a global scale [11]. These problems are approached by digital transformation, which represents a new strategy to share knowledge.

Open Access and Open Science can allow researchers to access, produce, and publish their findings for the society, replacing researchers from low income countries in the center of knowledge creation and dissemination, thus making access to research and knowledge more equitable concurring with De Jong, J.P.J., W. Vanhaverbeke, T. Kalvet H. Chesbrough (2008); who affirm that openness could enhance networking, collaboration, and knowledge exchange through different organizations (which allows innovation in knowledge production and problem-solving) [16], and with Melero and Hernandez San Miguel (2014), who point out that Openness is a key element to understand the distribution and production of scientific knowledge in a collaborative and coordinated way between academics and institutions, our findings show that Open Access and Open Science allow researchers to open the debate of their findings and analysis towards a more creative and holistic way and enhance the construction of effective solutions to social problems in a collaborative work [30]. In addition, it enables the promotion of the authors career to bring their results to a broader population range [35].

Nonetheless, we evidence some reluctance in the use of Open Science. This includes the fear of investigators of being victims of scooping and crowdsourcing as a factor that can affect the quality of the research productions. The use of open strategies (open science, and access) are key elements to enhance knowledge democratization if some key elements are taken into account. In OA there are two of special relevance: the tax payments to publish in open access that could limit the capacity of low resource researchers to publish in OA and the reluctance to publish in open access due to the doubt of quality in OA, fostered by the so-called "predatory journals" [17].

5 Conclusion

Open Science and Open Access have a special potential to be more efficient, innovative and to democratize knowledge, and its production, management and dissemination towards the community. In the case of science-related knowledge and data, there are some aspects that are limiting the acceptance of this idea among scientists. These problems include: (1) a lack of information that can help to use and understand the open data published, (2) the quality of the data available due to the easy access for anyone to publish it and (3) the fear of scooping or using ones data without addressing its original creator. Nonetheless, if these problems are solved, Open Science can benefit the scientific community. It can allow researchers to publish their research and get feedback from a wider

audience that can include professionals from areas not related to science. It can help to infer and obtain more knowledge from research results increasing the efficiency and the return of investment.

Finally, it can help to preserve data that would otherwise be forgotten. The paper analysis shows evidence of the notorious increase of Open Access at a global scale. The main elements that boost its development have been a positive experience at an international level in the solution of complex social problems and the breach of some barriers such as exclusive associations and author restrictions. These barriers turn out to be an impediment for the investigation because they place knowledge production towards privileged institutions and researchers. Nonetheless, a wide variety of policies that favor the implementation of Open Access have been implemented. Some relevant initiatives are: the Open Access Initiative in Budapest (2002) Bethesda (2003) and Berlin (2003) The UNESCO strategy to promote Open access to scientific production (2013) and The Latin American Federated Network of institutional repositories of scientific documentation in Latin America [6–8, 24, 32, 39].

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