Open Science and its Role in Global Scientific Collaboration

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Abstract

Open Science has transformed the generation and dissemination of scientific knowledge, promoting transparency and accessibility, the present study evaluates the impact of Open Science on the reproducibility and transparency of research through a mixed-methods approach, the methodology includes a bibliometric analysis using the Bibliometrix software, where 536 articles on Open Science extracted from Scopus were analyzed, Of these, 30 studies were selected with specific inclusion criteria such as: methodological rigor, empirical and theoretical relevance in the topics of transparency and scientific production. Likewise, a systematic review was carried out according to the PRISMA protocol to identify challenges and opportunities of Open Science in diverse areas, such as space exploration, health research and criminology.

Keywords: Open Access; Scientific Collaboration; Open Research; Data Analysis; Systematic Review.

Introduction

Open Science has changed the way scientific knowledge is produced and disseminated, promoting transparency and access, an example of this is the continuous scientific journals and publishers adhering to the open access model, wanting to provide knowledge to both authors and readers; This model aims to obtain democratic access to information and to bring about broader cooperation between researchers and society. But it is necessary to consider, as relevant, that Open Science has not been applied in a homogeneous way, there has been a commitment to seek a balance between the protection of intellectual property versus the openness of data, the lack of technological infrastructures that could manage large volumes of data.

However, the Open Science movement also has a considerable moral component (Desmond, 2024). In this way, we would be including school communities or communities without access to equitable educational systems and open to obtaining knowledge in an area of study of interest. In Colombia, for example, according to DANE, in 2023, the poverty line at the national level was $435,375, which is equivalent to a growth of 9.7% compared to the 2022 line of $396,864.

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This is talking about monetary poverty, but it is known that behind not having money for decent housing, for transportation, or food, they are only beginning to say that education is one of the few concerns when people have an empty stomach.

The objective of this research is to investigate various authors about their perspectives on Open Science and its virtues of open access in vulnerable communities, with the intention of continuing with the openness to this concept that in some way is as beneficial as it is generous for the global population. As mentioned by Thibault et al. (2023) in Smith's (2020) Health Psychology and Behavioral Medicine research, beyond journals, institutions and their leaders also play a role in developing a supportive culture where Open Science is rewarded in the criteria for funding, hiring, and promotions. Starting from here, with the following questions:

How does Open Science influence the reproducibility and transparency of scientific research?

What are the main challenges and opportunities of Open Science in different fields of science?

How does Open Science promote interdisciplinary collaboration and access to knowledge?

Materials and Methods

Assessing the impact of Open Science is essential for the understanding of its inhabitation in the scientific context, even if we analyze this concept in the approach of ML algorithms, as expressed by Da Poian et al. (2024) when describing that the formulation and implementation of Open Science ML challenges require a well-organized framework to address data preparation, benchmarking stages, choice of assessment metrics, and long-term sustainability challenges.

Eligibility Criteria

The inclusion of scientific references was based on the construction of a specialty search equation, to find relevant metadata; it begins with the reading of the abstracts, coherence with the topic to be researched, at the same time the keywords are considered, terms such as open access were established; scientific collaboration, open research, data analysis. In the exclusion phases, duplicate texts, without full access to information, documents outside the established age range, minutes, or other documents other than an article were not considered.

Sources of Information

The preferred academic database was Scopus, due to its recognition as one of the largest scientific databases. (AlRyalat et al., 2019), in their research *Comparing Bibliometric Analysis Using PubMed, Scopus, and Web of Science Databases* conceptually disposes Scopus together with Web of Science as databases that offer a wide range of scientific literature, in addition to providing breadth in topics, disciplines, and tools for searching and analyzing bibliometric information. Choosing Scopus guarantees us as researchers a relevant, representative sketch of scientific information in the field to be studied.

Sources of Information

To concrete the search for scientific references in Scopus, the following specialized equation was designed, adapted to criteria that were even structured to the context:

(TITLE ("open science") OR TITLE ("open science") OR TITLE ("open science") OR TITLE ("open science") AND (KEY ("open science") OR KEY ("open science") OR KEY ("open science") OR KEY ("open science")) AND (LIMIT-TO (DOCTYPE , "ar")).

Data Management

R Studio and its Bibliometrix library were used to store, analyze the information obtained from Scopus in a CSV file, in order to analyze the occurrence between concepts through the different graphs that the library makes available, this is key, as it facilitates the analysis and synthesis of the results.

Selection Process

The guide of the PRISMA 2020 declaration is used for the validation of the search, this allows us as researchers to reduce the risk of bias or of omitting information of relevance to the study; Microsoft Excel was implemented for the construction of a document analysis matrix or table, where the bibliometric information of each reference article was stored, this classification allows the ease of understanding the information, even categorizing it.

The search resulted in the location of 933 records published between the years 2019 and 2024. Of these, additional filters were applied to limit the search to peer-reviewed scientific articles in English, obtaining a total of 536 studies that addressed topics relevant to Open Science, aligned with the objectives of the research. Of these 536 referring documents, only 30 were chosen for their connection with the topic of study and their contextual relevance (Figure 1).
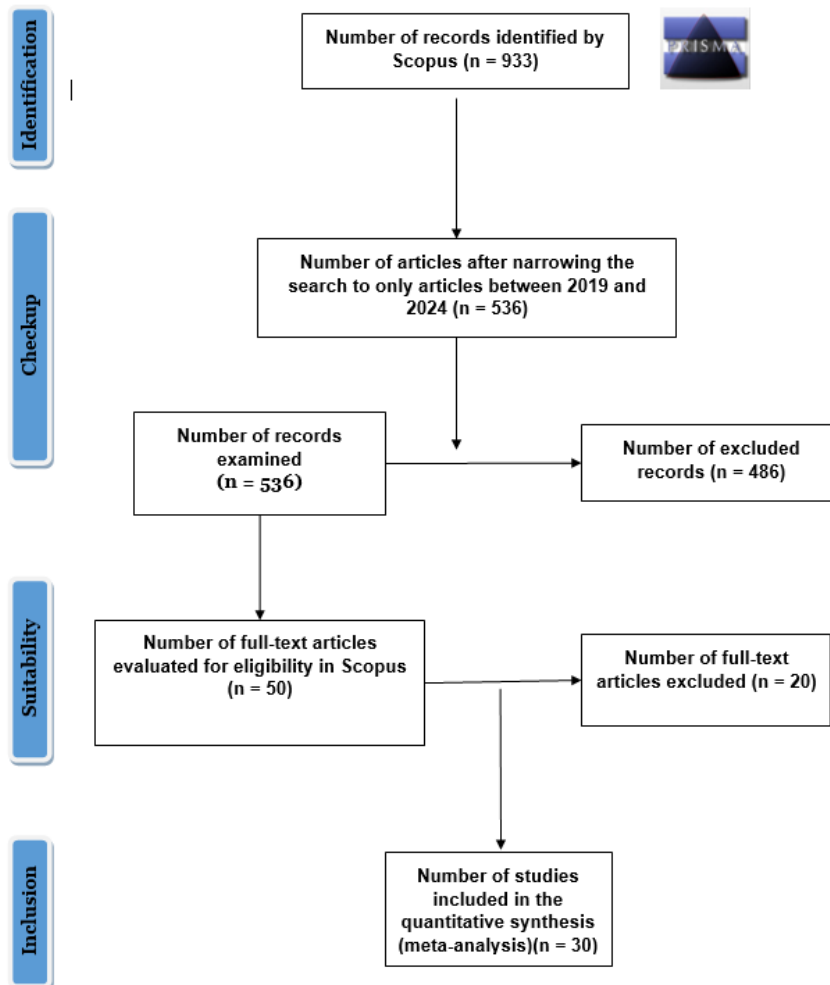
Figure 1. Flowchart, PRISMA. Own Elaboration

A document without full access to information or other types of documents other than an article were not considered, that is, neither book chapters nor books or conference papers were taken into account.

Results

Table 1 shows the 30 referents arranged in 5 categories, each of them with an analysis that resolves the conceptual findings found in the scientific referents. Categorizing or synthesizing the findings in this way simplifies the reader's task and understanding of the concepts connected to the research problem. As Lowndes et al. (2024) say in their research Shifting institutional culture to develop climate solutions with Open Science, Open Science is a reconfiguration that allows human beings to continue evolving as society itself and its culture change.

This collaborative approach not only facilitates the interpretation of data but also fosters a sense of global community around space research, increasing transparency and cooperation between various institutions and participants, as expressed by Sakamoto & Nakamichi (2024) in their

research Open Science Initiatives by Sakurajima Volcano Observatory. Journal Of Disaster Research.

Similarly, we have a reference in the health sector, Cheng et al. (2024) states that the combination of artificial intelligence and Open Science has demonstrated its potential in the development of treatments for neurodegenerative diseases, such as Alzheimer's; AI makes it possible to identify patterns in large open databases, accelerating the discovery of potential drugs and improving the reproducibility of studies. This AI-supported Open Science model represents a shift towards more accessible and collaborative research, which facilitates the advancement of precision medicine and fosters confidence in the results obtained.

Theme Key/ category	No. Articles	Analysis of each category
Open Science and Citizen Participation	6	Open Science invites citizen participation in scientific processes, thus allowing people to contribute to data analysis and data collection, especially in areas of environmental monitoring. For example: in the case of Yamori (2024) in collaborative seismic monitoring

		, citizen participation is essential, it is key to have citizens equipped with knowledge, who know about state-of-the-art devices. This means that when collecting seismic data in real time, valuable information is provided for scientists. This collaboration allows for expanded monitoring coverage in remote and hard-to-reach regions.

Intelligence Artificial in Health Sciences	6	In favor of AI in collaborations with Open Science, Kessel & Atkinson (2024) is a notable example is that AI serves to accelerate research in the development of treatments, highlighting the use of predictive models and open data where it could be useful for the treatment of Alzheimer's. Located in this corner of technological discovery for the cure or treatment of diseases like this, is

		where the implementation of Open Science takes on greater importance, with the human factor being a priority, or perhaps a guarantee to remain in life itself.
Open Science at the Space exploration	6	Study of Open Science challenges involving the analysis of spectrometry data from missions to Mars, fostering global collaboration through open platforms, this in relation to what Da Poian et al. (2024) express.

		The lack of open data structure in these contexts contributes to the selection of regions in terms of progress, it is necessary to take a holistic look at the contributions of discoveries in other universal spaces such as spatial recognitions, and to try to open the mind to the collaborative constitution in this type of research. simply for global benefits.

| Transparency and reproducibility practices | 6 | In the same direction as Schneider (2024) and his research Sorry were open, come in we're closed: different profiles in the perceived applicability of open science practices to completed research projects, the analysis of the implementation of Open Science practices in various disciplines to improve transparency in the publication of results and reduce irreproducibility is itself transparent, It allows us to make a reading of |

		its fractals in a generous, open way, as the universe in the rivers shows us in its transparency the algae that inhabit its bottoms bloom, today the sky in its immensity allows us to see clearly the movement of the clouds with the wind, so from this perspective, why can't the books of scientific documentation be opened?
Statistical models and Open Science	5	There is no more perfect way than that of Coro (2023) to express that Open Science has a place in

		all areas of knowledge, including the depth of statistical models. Nodes can depend on other nodes, which will be considered primary nodes. (Coro, 2023). This is not a paradox if the perspective of knowledge in general is made up of links connected to each other, where its meaning and purpose are one, the evolution of the human population, in areas such as its spirituality or scientific

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Table 1. Classification of Referents by Key Theme. Own Elaboration

Table 2 is a classification of the reference texts, exposed in three columns, in column number one there are key aspects for access to Open Science, followed by a column where authors who follow or maintain a similar position to the sense of aspect are related, in a third place there is a column called results, where this component of union between authors is exposed. Climate change is a global environmental problem that must be addressed on a global scale (Carayannis et al., 2024), global actions as relevant as thinking about climate change, need to remain in this figure of openness, since they are global effects centered on each of the human beings who inhabit the planet, in the same way the concept of Open Science is aligned with this perspective and we would also be answering the question How does the Open Science in the reproducibility and transparency of scientific research?

While there are various Open Science practices used among qualitative approaches, barriers still exist in some areas. For example, technology and knowledge lag behind the willingness of qualitative researchers to participate in Open Science (Huma & Joyce, 2022).

This last section is aligned with the thinking of Ewuoso et al. (2022) in the research entitled Addressing exploitation and inequities in open science: A relational perspective. For here it is manifested that Open Science is a path where some researchers, thinkers and people of different intellectual powers, as if only where they apply some quantitative methods, are not or do not feel the call to open their processes to the community in general; even being aware of the social shortcomings faced by large communities, in terms of inequality, hunger and monetary poverty.

Aspect	References	Results
Open Data and Participation **citizen**	(Chávez-Bustamante et al., 2024) (Yamori, 2024) (Da Poian et al., 2024) (Carayannis et al., 2024) (Tunç et al., 2022) (Adler et al., 2023) (Ng et al., 2024) (Smith, 2020)	Open Science facilitates collaboration between experts and citizens to improve literacy in various areas of study, such as earthquake observation and preparedness. From this perspective, the scientific community is invited to the liberation of knowledge to solve social problems, even from a global perspective, where the only objective of construction in research is territorial protection. Open Science allows improving the analysis of data such as mass spectrometry for missions to Mars, involving experts and participants from all over the world. This highlights how Open Science can improve transparency and collaboration in studies of various subject areas and complements traditional and cultural barriers.
Artificial Intelligence and Open Science	(Cheng et al., 2024) (Chorus, 2023) (Da Poian et al., 2024)	Artificial intelligence, applied in conjunction with Open Science, accelerates the identification of new advances, an example of this would be the creation of medicines for neurodegenerative diseases, such as Alzheimer's. On the other hand, the implementation of a Bayesian interpolation model oriented to Open Science to improve accuracy in the analysis of data on marine parameters, such as temperature, salinity and oxygen concentration. By incriminating himself for An open structure, the model facilitates access and collaboration between researchers from different institutions, promoting the reproducibility of findings.

Diversity in research	(Huma & Joyce, 2022) (Kessel & Atkinson, 2024) (Sanabria-Z et al., 2023) (Pantos et al., 2023) (Miljković & Medina- Franco, 2024) (Ahmed et al., 2024) (Ewuoso et al., 2022) (Hicks, 2021) (Chin et al., 2021) (Zarghani et al., 2023) (Leonard et al., 2023)	It is almost like a song, like a poem, to list several authors who are willing to write about the opening of knowledge in its different forms; From this point of view, a collective conscience is proposed, united by the collective and for egalitarian growth as a society. When an author opens his texts, his research results to the world, he makes a generous and loving call to the bonding of human beings. Even here, the philosophical nature of humanity in progress could be specified if it were to be even more so.
Open Science Storage	(Liu & Liu, 2023) (Elia et al., 2023) (Shmagun et al., 2022)	The generation of libraries with large numbers of texts for any being, thirsty for knowledge is one of the conservative but disruptive attributes that today's world needs most; Without a doubt, these types of spaces are already found in virtuality and in face-to-face spaces, but there is still an economic or social position layer that struggles between the potential reader and the encrypted document.

Table 2. Classification of Reference Articles. Own Elaboration.

Figure 3 was extracted from Bibliometrix, when processing the bibliometric export data of Scopus through a csv file, called a tree map; in this figure are the plus keywords identified by the software, it is notable how in this bibliometric analysis the term Open Science is at the top with a repetition value of 118 and a percentage of 11%, positioning it as the most relevant, this gives credible roots to the references used for research, since they are linked to the object of study.

The second term just below the values of Open Science is human, with a repetition value of 106 and a percentage of 10%, the difference between the two terms is quite small, but the relationship between the two has an energetic scope, from subjectivity could be seen as a human-knowledge relationship, to symbiotic, where each one needs the other to continue. In third and fourth place are the terms article with a repetition value of 101 and a percentage of 9, while humans have a repetition value of 64 and a percentage of 6%, the latter in the same relationship as the first concept and the second in its plurality; without a doubt the term article refers to the type of documents with a lot of openness to the concept of Open Science, it seems that the current trend

in open publication is through this figure, that of an academic article.

It is curious to see the term open access with a repetition value of 9 and a percentage of 1%, it seems to be questionable if semantic closeness to the main term of the study, it is almost like a utopia to yearn in the future to process a document with this term at the head, with the particularity of being connected to a number of libraries under the same figure.

Figure 2. Map of Trees, Obtained from Bibliometrix

On the other hand , Figure 3, called the network of co-occurrences, also obtained from the processing of Bibliometrix data, shows us the relationship between the key relevant concepts found, this would be the difference with Figure 2, since the networks of relationship between them can be evidenced, forming semantic and propositional groups, ready for the reader's interpretation. Mainly, there is a significant connection between open science and concepts such as citizen science, open data and open access, which highlights the interdependence between these elements to promote more accessible and collaborative research. But it is unmissable to leave aside the connection that exists with the term human, because it is the term with the greatest visibility and collaboration networks. Cheng et al. (2024) are thought of as important authors in the relationship with terms such as artificial intelligence and machine learning, suggesting the growing role of advanced technologies in the analysis of large volumes of data, as evidenced in studies on the use of artificial intelligence to optimize research in neurodegenerative diseases; the connections with reproducibility and software indicate the importance of transparency and the availability of tools to ensure the validity of scientific results, reflecting an effort to improve reproducibility in disciplines such as drug discovery, indicated by Edfeldt et al. (2024).
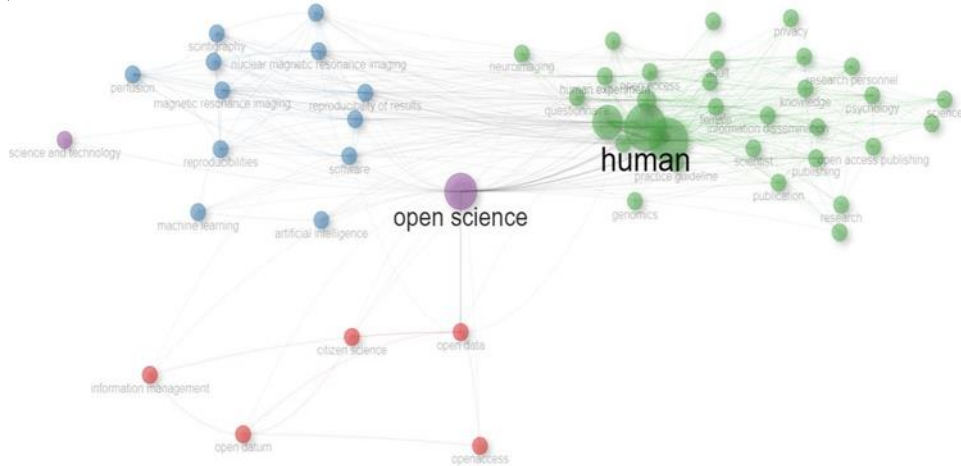
Figure 3. Network Of Co-Occurrences, Obtained from Bibliometrix

Weighted factors method: We wanted to assign the weighted factors method in Table 4, with the intention of unifying conceptual relevance to the different thematic areas of reference research.

Factors	Relative weight (%)
Social impact	30%
Scientific advances	25%
Reproducibility and transparency	25%
Practical application	20%

Table 3. Factors and Relative Weight. Own Elaboration

In this sense, it is possible to find how Open Science has been implemented in various scientific and technological fields, with an emphasis on collaboration and accessibility of data. As can be seen in Table 4.

References	Social Impact	Advances Scientists	Reproducibility and Transparency	Practical Application	Total Score
(Yamori, 2024)	9	7	8	8	8.05
(Da Poian et al., 2024)	7	9	8	9	8.15
(Cheng et al., 2024)	8	8	7	8	7.75
(Coro et al., 2024)	7	8	9	7	7.75

(Huma & Joyce, 2022)	9	7	7	7	7.7
(Ewuoso et al., 2022)	10	7	7	7	8.0
(Hicks, 2021)	7	8	9	7	7.85
(Nong et al., 2022)	6	8	9	8	7.7
(Chin et al., 2021)	7	7	8	8	7.55
(Zarghani et al., 2023)	7	6	8	6	6.85
(Leonard et al., 2023)	8	8	7	8	7.8
(Tunç et al., 2022)	7	6	7	6	6.75
(Liu & Liu, 2023)	8	7	7	8	7.7
(Adler et al., 2023)	6	8	8	7	7.2
(Schneider, 2024)	8	7	7	8	7.7
(Ng et al., 2024)	9	7	7	8	7.9
(Miljković & Medina- Franco, 2024)	7	9	8	9	8.15
(Elia et al., 2023)	8	7	9	8	8.0
(Shmagun et al., 2022)	8	7	8	7	7.8
(Smith, 2020)	8	7	8	8	7.9
(Alenkina, 2024)	9	7	7	8	7.9
(Lowndes et al., 2024)	8	8	9	8	8.1

Table 4. Weighted Factor Method. Own Elaboration

In the References column it is possible to see the texts used as a theoretical reference for this study, the highest weighted value is 8.15 and corresponds to the works Leveraging open science machine learning challenges for data constrained planetary mission instruments by (Da Poian et al., 2024) and the work entitled Artificial intelligence-open science symbiosis in chemoinformatics by (Miljković & Medina-Franco, 2024), both in disciplines different from each other, but with a common factor in the object of the study, Open Science, open access for knowledge, promoting the growth of each of the areas, without realizing that they are walking in the same direction, a link of openness to continue growing.

On the other hand, the lowest value is for the work of Tunç et al. (2022) entitled Is Open Science Neoliberal? With a total score of 6.75 followed by the work of (Zarghani et al., 2023) with a

total score of 6.85. Below the values of these works there are no other values, which stands out as a finding of a certain philosophical value, it means that the works have an acceptable level of link with factors of social impact, that is, in each of them there is a concern for the social and in this same line, scientific advances are promoted, regardless of the area of study of each research; All research promotes the transparency and reproducibility of knowledge, which answers the last two questions of the study:

What are the main challenges and opportunities of Open Science in different fields of science?

How does Open Science promote interdisciplinary collaboration and access to knowledge?

It should be noted that from the perspective of practical application, all the relevant research is established in this criterion.

Discussion

This section is designed to discuss the findings, create a connection between them and the referents, as well as discuss the practical implications and limitations of the study.

Analysis of the Results

The results reflect that Open Science is in a constant modification, through a search for globalization for the literary results of different areas of study, there are no limitations between collaborations and the current trends of intelligent technologies promote this academic movement. There are authors such as Hicks (2021) who, with their concern for the reduction of content reproduction in their area of study, promote it from a literary space, there are also authors such as Tunç et al. (2022) who assign political values to the open paths of knowledge; but it is shown among the results that the concepts of Open Science and humanity are increasingly closer and are quite related, we are constantly working on manifesting that an added value of generosity is to think of the third as someone included, who also needs knowledge and its benefits. Because writing, creating knowledge to open it to the world is an act of love for a society that struggles to break the bonds of inequality and inequity.

The implementation of the Open Science exercise faces limitations that affect its effectiveness and applicability in various scientific areas. Firstly, the lack of a uniform regulatory framework hinders the full adoption of Open Science in some contexts, particularly in those that require protection of sensitive or private data. In addition to this, the availability of technological infrastructure is uneven at the global level, which can accentuate gaps in access to and use of scientific data. Authors such as Tunç et al. (2022) highlight that Open Science, in certain contexts, can even reinforce neoliberal dynamics, promoting the commercialization of science instead of solving structural problems of access and equity, these factors show that institutional support is required to guarantee sustainability and equitable access to scientific and technological resources. He is one of the least mentioned authors in the study, but without a doubt his study has a destabilizing strength, is that the impact of science can also be seen as a commercial product and there are structures that fight to maintain an economic monopoly, a profit factor, a little removed from social and collective consciousness.

Limitations and Practical Implications

This study was based on the application of the PRISMA 2020 methodology, used Scopus as the main source of information, in addition to this, the Bibliometrix library of R Studio was used for the management of metadata, the rigor of these elements used is taken into account, but in the

same way limitations of possible omission of weighty scientific documentation are considered, Due to the non-use of other databases, we think that this could have affected the results obtained.

The resistance of different research actors to the free dissemination of knowledge has been evidenced as a practical implication, which leads to the omission of more scientific information that could have been of importance to the study, an example of this can be directed to the management of natural disasters or the discovery of stellar bodies, even to the discovery of new treatments for generative diseases. where the non-dissemination of information can delay research or deny citizen participation and affect their literacy in different areas of study.

Another implication also directed to the area of pedagogy would be the lack of universal policies that promote the free delivery of knowledge, guaranteeing equal and quality access to the general population, information that could be used by vulnerable communities, or independent researchers, focused on solving social problems.

Conclusions

As a society we should think of Open Science to bring knowledge to vulnerable communities, to students who strive to work and to study at night and it does not even count for a ticket on public transport, it is an opportunity to contribute to promoting others, to the academic community itself. The barriers of virtuality must be broken, since there are technological gaps, connectivity that must also be studied, to promote their reduction; there must be physical libraries, willing to reduce scientific literature with the sole purpose of keeping human beings educated.

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