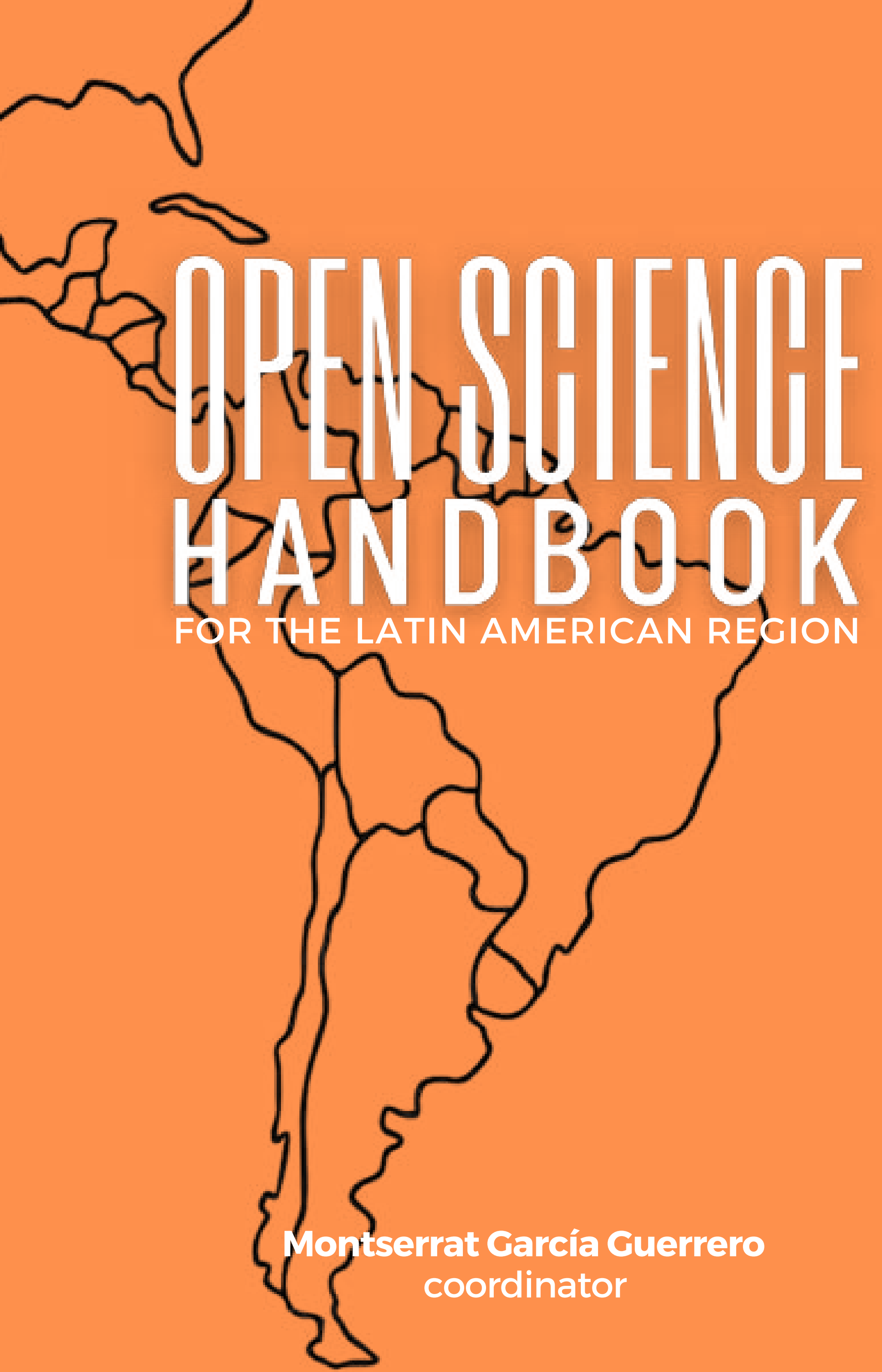

OPEN SCIENCE HANDBOOK

FOR THE LATIN AMERICAN REGION

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coordinator

Index

PROLOGE

Open Science (OS) has become a concept, a movement and a trend that seeks to defend transparency, equity and free access to knowledge arising as a result of a rich and historical debate on access to science worldwide. This should imply that scientific research should not remain in the hands of a few, but rather should be shared to solve global problems, reduce inequalities and build a fairer and more inclusive present and future. In theory, adopting these principles would mean committing to a science that is collaborative, accessible and at the service of society as it is based on the assumption that shared knowledge has a transformative power and that each scientific discovery can change lives, beyond the reach of researchers and their close colleagues.

Despite the fact that the initial ideals of OS were shown to be revolutionary, aiming to make knowledge widely accessible, over time, publishers, together with institutions and governments, have been shaping working models that once again are linked to payment barriers, such as Article Processing Charges (APCs) and transformative agreements, thus creating another access gap for countries with fewer resources for this type of payment. This reality calls into question the true openness of OS and invites other actors to promote and present other types of strategies, which requires the consideration of ethical aspects, human rights and alternative needs and work routes. Faced with these challenges, the use of technology has emerged as an ideal tool to promote a more accessible, inclusive and collaborative knowledge.

This Open Science Manual for the Latin American region is an invitation to explore the principles and practices of an open science, from a Southern perspective, recovering the experiences of experts in the field and project developers in the region. The objective of this document is to create awareness in as many academic institutions as possible, in order to transcend and integrate this awareness of OS into the daily lives of people interested in learning, to share and generate knowledge, and to have an impact on the quality of life and development of the region. To this end, documents with information and Latin American experiences have been compiled and are intended to serve as an example for the development of openness strategies in other centers and institutions, especially in the region, but without geographical restrictions.

OS is presented as a new concept, arising from the recommendations and work of international organizations, such as UNESCO, although there are also numerous efforts to share and promote open knowledge in a broad way; and Latin America is historically a clear example of how to work without economic barriers and thus, as part of a necessary discussion on the evolution in making science accessible, this region can play a leading role.

As explained in this manual, the search is for an approach that promotes transparency, accessibility and collaboration at all stages of the scientific process from a vision of knowledge as a common good; to democratize knowledge, making data, results and methodologies reusable and verifiable by anyone; thus, in the Latin American reality, the taxonomies and ideals of OS have been mixed with a natural tendency to share knowledge widely, having the budgets of universities and research centers as the main source of support.

This handbook is composed of documents that explore different pillars of OS, with chapters organized in an accessible and understandable manner; each text breaks down key elements, such as the history of OS and its taxonomies, open access to publications, data management, reproducible research and the technological infrastructures essential to sustain this ecosystem. These elements are especially important for the Latin American region, or take on another connotation, as it is a geographical space where access to knowledge is often limited by economic and technological barriers. Adopting these principles and having examples of action nearby not only has an impact on increasing the visibility of local research, but also promotes equity and regional collaboration.

The first chapters provide a conceptual overview that places the reader in the historical and philosophical context of OS, presenting the background and development of this movement, from its roots in open access proposals to its consolidation in global frameworks such as the Unesco Recommendation. Then, technical aspects such as the use of controlled languages, persistent identifiers, the use of repositories and scientific collaboration platforms are addressed; case studies are included to illustrate how these concepts are applied in Latin American institutions, to show that OS is a possible and necessary reality.

The second part contains documents related to the ideals of science in openness, recovering proposals for the public communication of science, citizen science and free software, success stories such as the Ceiba plan, the development of platforms in different universities and the principles for a more assertive science communication.

This book, more than a theoretical compendium, has always been intended as a practical guide: the authors invite you to participate in the transformation of knowledge, consult open access repositories, share research in collaborative platforms, contribute comments in citizen science projects or even learn to identify and use open educational resources, as concrete steps that anyone can take to support and benefit from OA.

Here we share strategies for implementing OS practices in personal or institutional projects, describe successful models, recommend tools and platforms, and detail public policies that support this cause.

Although a truly open science is still in process and difficulties and enormous challenges lay ahead, this book makes it clear that it is a collective effort that is worthwhile, because in order to make scientific knowledge available to all, it is important for governments, private initiative, universities, researchers and communities to collaborate. This book seeks to inspire in the reader the will to be an active part of this movement, to question, learn and collaborate, exploring open access platforms, sharing knowledge in their community or participating in citizen science projects.

Montserrat García Guerrero

FIRST STEPS TOWARD OPEN SCIENCE

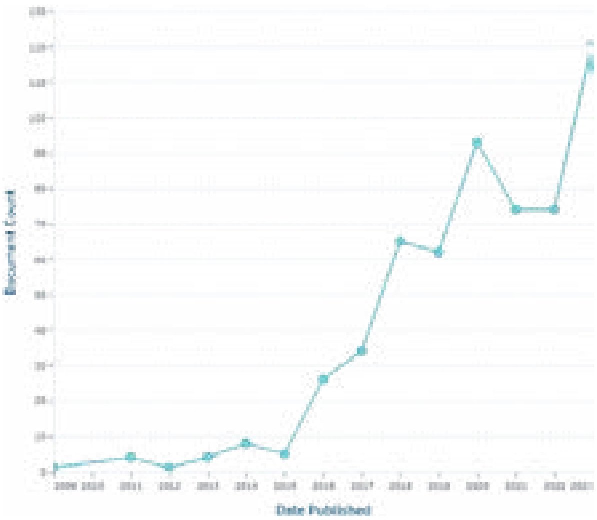
Alejandro Uribe-Tirado
Lúcia da Silveira

Introduction

Open Science (OS) has become an increasingly prominent topic in universities, research centers, and academic libraries. This is not surprising, considering Watson's statement (2015): "Open Science is not a different way of doing science; it is simply science, good science, science in the 21st century." Open Science is accessible, verifiable, and oriented toward the common good (Fecher, 2022). In other words, OS is about conducting quality science that is relevant and responsible in today's world.

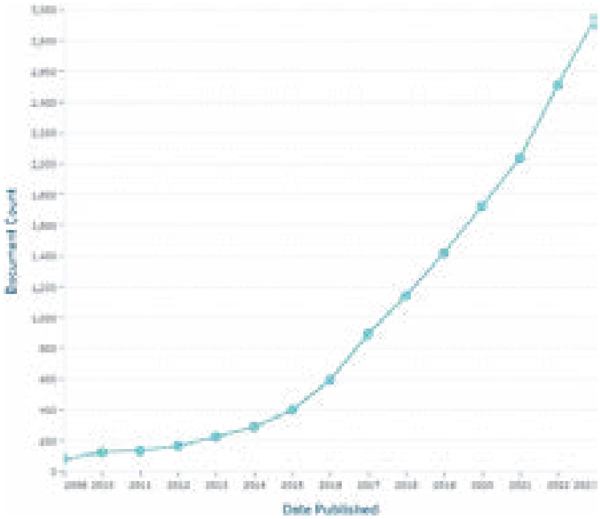
However, it is important to recognize that the frequently used concept formally referred to as "Open Science" has become more evident over the past 15 years, even though its values, principles, and epistemological and philosophical foundations extend beyond this last decade and a half. This assertion is supported by: a) a review of academic literature using the term "Open Science" (in Spanish-Figure 1-or in English-Figure 2); and b) a specific review of definitions of this concept (Uribe-Tirado and Ochoa, 2018; Vicente-Saez and Martinez-Fuentes, 2018, see Table 1). It has become more frequent since the beginning of the 2010s and its presence is steadily growing:

Figure 1. Scientific Production on Open Science



Source: Lens Database (2024a)

Figure 2. Scientific Production on Open Science



Source: Lens Database (2024a)

Although there has been a greater presence of the concept since 2010, this does not mean that its epistemology, philosophy, values, and principles were not present decades earlier (see UNESCO Recommendation, 2021), considering that:

> Among the pioneering authors, the philosophical origins of Open Science are evident in the works of Dasgupta and David (1994) and David (2002, 2004a, and 2004b), developed from an economic and administrative perspective influenced by Merton's (1973) contributions to the concept of the ethos of science. Following these are other authors who consider David as the leading reference on Open Science based on his works from the mid-1990s to the first decade of the 21st century. David is one of the most cited authors on this topic, having influenced later authors like Watson (2015) and Hey and Payne (2015), who represent some of the most current positions and discussions on the subject. Their works, such as *When Will "Open Science" Simply Become "Science"?* and *Open Science Decoded*, respectively, further the conversation. (Uribe-Tirado and Ochoa, 2018, p. 4).

Additionally, if we revisit some definitions-Table 1-they reflect how the concept is evolving toward a more collaborative, transparent, technological, accessible approach, concerned with reproducibility and aimed at greater participation in science by non-scientists.

Table 1. Definitions of Open Science

Author	Conceptualization
Peters (2010)	"Open Science is a term being used in the literature to designate a form of science based on open source models that uses principles of open access, open archiving, and open publication to promote scientific communication." (University of Antioquia, 2024).
Nielsen (2011)	"Open Science is a broad concept that includes closely related areas of open notebook science and open data. Open science advocates believe that there should be no privileged information, and that all protocols and results —including those of failed experiments— should be visible and open for reuse in laboratory notebooks and open data repositories." (University of Antioquia, 2024).
Albagli *et al.* (2014).	"Open Science is a general term that involves multiple levels and scopes of openness, referring to both a pragmatic sense, in the sense of allowing greater dynamism in Science, Technology and Innovation (STI) activities, and a democratic sense, in the sense of allowing greater openness and participation of society."
FOSTER (2015)	"Open Science is the practice of science in such a way that others can collaborate and contribute, where research data, lab notes, and other research processes are freely available, on terms that allow reuse, redistribution, and reproduction of the research and its underlying data and methods." (University of Antioquia, 2024).
Pitrelli and Delfanti (2015).	"Open science is a very broad concept, encompassing diverse practices and tools linked to the use of collaborative digital technologies and alternative intellectual property tools. Some inclusive definitions propose that open science encompasses practices as diverse as open access to scientific literature or digitally mediated forms of open collaboration; as well as the use of *copyleft* licenses to promote the reuse scientific research results and protocols."

Author	Conceptualization
Lopes *et al.* (2018).	"In 2014, open science was the term chosen by stakeholders during the public consultation to describe the constant changes occurring during the research process, the collaboration of researchers, knowledge sharing and the organization of science. Using digital technology, it represents a new approach to the scientific process based on collaborative work and new ways of disseminating knowledge. In practice, open science makes science more credible (scientific integrity), more reliable (transparency in data comparison), more efficient (avoids duplication of resources) and more effective in the face of societal challenges, helping to find answers to today's major problems (Boulton, 2013; European Commission, 2016a; Antunes, 2016)"
Fortaleza and Bertín (2019)	"The concept of open science is maturing and consolidating. This new paradigm of science envisions a collaborative science, in which research data are freely available for reuse, redistribution, reproducibility, traceability, accessibility and verifiability. These actions are moving research towards transparency, increasing scientific productivity, fostering innovation and social participation through citizen science, which is one of the pillars of open science".
Silva and Silveira (2019)	"Open science is a movement that promotes transparency in scientific research, from the conception of research to the use of open software. It also promotes clarification in the development of methodologies and management of scientific data, so that they can be distributed, reused and accessible to all levels of society, free of charge. It also proposes the collaboration of non-scientists in research, expanding social participation through a set of elements that provide new resources for the formalization of scientific communication".

Author	Conceptualization
Silveira *et al.* (2021, p. 12).	"Understand that the open science ecosystem can be classified according to its aspects: a) philosophical: ethics, integrity and transparency; b) scientific: innovation, use, reuse, reusability, reproducibility and replicability; c) social: collaborative network, science citizenship, exchange and democratization of information; d) technological: standardization, traceability and interoperability; e) political: related to development of legislation and public policies to promote open science; f) economic: referring to economic investments, scientific communication infrastructures and strategic negotiations of access to information among other countries."

Source: Authors' adaptation based on Silveira et al. (2021) and Universidad de Antioquia (2024).

OS today, as a concept and practice, is increasingly present; it has gradually come to be understood that this is the way to do science in the present and the future (together with Artificial Intelligence, as already indicated by different authors (Uzwyshyn, 2023; Méndez and Sánchez-Núñez, 2023). But it is clear that we would not have reached this point: from Merton (1973) to Dasgupta and David (1994), and onwards; if technology had not been present, since OS is the science where the Internet, with its collaborative, storage and networking possibilities, made it possible for the whole research cycle to be "open", sharing research ideas; project formulation; field, laboratory or documentary work (open data and open research); analysis and results; up to publication (open access), with its different metrics (open evaluation); and even enabling its reuse, its reproducibility (FAIR principles) and its permanence-availability over time (open digital preservation).

Open Science and responsible scientific research

Responsible scientific research is one of the aims of OS and the Unesco Recommendation (2021) is a key milestone, since in addition to the fact that 132 countries have adopted it, it has provided a worldwide reference for understanding everything that this movement and practice implies, based on its values[1] and principles,[2] which are the foundation of its fundamental pillars -components-, and thus, for understanding that:

> Open science is defined as an inclusive construct that combines diverse movements and practices in order to make multilingual scientific knowledge openly available and accessible to all and reusable by all, to increase scientific collaborations and information sharing for the benefit of science and society, and to open the processes of creation, evaluation and communication of scientific knowledge to social actors beyond the traditional scientific community. Open science encompasses all scientific disciplines and all aspects of scholarly practices, including basic and applied sciences, natural and social sciences and humanities, and is based on the following key pillars: open scientific knowledge, open science infrastructures, scientific communication, open participation of societal actors, and open dialogue with other knowledge systems. (Unesco, 2021, p. 7)

These changes highlight the limitations of traditional science, including restricted access to scientific publications, data and authors, lack of transparency in research processes and preservation of results, as well as the disconnect between financial investments and their respective products and actors. In this sense, OS not only seeks to solve these challenges, but also to

1 Quality and integrity; collective benefit; equity and fairness; diversity and inclusion.

2 Transparency, control, criticism and reproducibility; equal opportunities; responsibility, respect and accountability; collaboration, participation and inclusion; flexibility; sustainability.

improve scientific integrity and address problems associated with the three Rs: replicability, reproducibility and reuse of data.

It also highlights the complications arising from the confusion between moral and economic rights in academia, which have led to a loss of investment in science and knowledge. In the face of these problems, it is essential to recognize these challenges and address them through a more open, transparent, accessible, equitable, collaborative and inclusive science, to ensure greater benefit to society and the advancement of global knowledge.

OS promotes a democratic research ecosystem in order to expand collaboration, transparency and research infrastructure to seek solutions to common problems. Unesco (2021, p. 9) understands that:

> Open scientific knowledge refers to open access to scientific publications, research data, metadata, open educational resources, software and source codes, and hardware that are available in the public domain or protected by copyright and are openly licensed for access and reuse, reuse, repurposing, adaptation and distribution under specific conditions, and which have been made available to all actors immediately or as quickly as possible - regardless of their location, nationality, race, age, gender, income level, socioeconomic circumstances, career stage, discipline, language, religion, disability, ethnicity or migratory status or any other reason - and free of charge. Open scientific knowledge also refers to the possibility of opening up research methodologies and evaluation processes.

This implies that, in addition to focusing on making research accessible, connected and authenticated with those responsible for it (institutional, governmental, development agencies, and other associations), it is crucial to adopt practices that eliminate social and gender inequalities by providing solutions to that end.

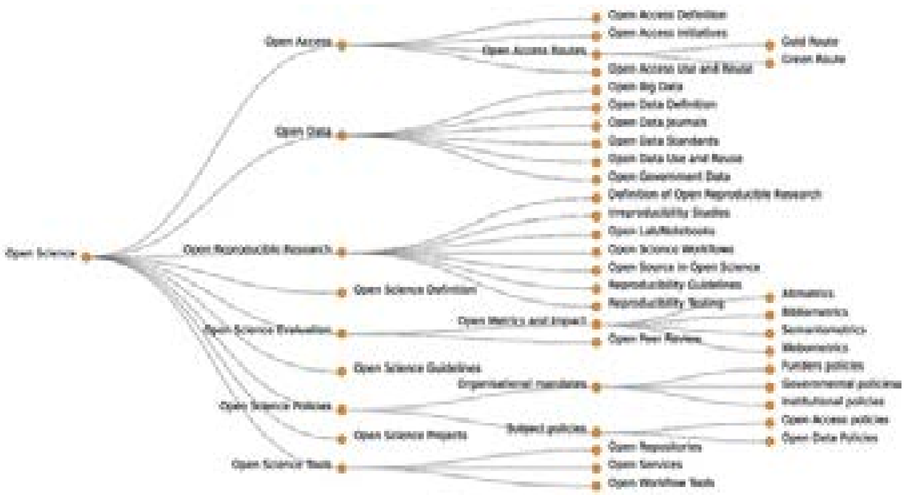
OS, therefore, represents much more than a fad or a passing movement; it is a transitional framework for the new science in the 21st century.

Pillars of Open Science: taxonomy

To explain the pillars of OS, a broader perspective that encompasses all the elements involved is necessary. For this reason, some authors use a map of this OS ecosystem to illustrate its complexity. Three taxonomies developed in different periods and contexts have been proposed to facilitate the understanding of OS.

The first taxonomy (Figure 3) was established as part of the Facilitate Open Science Training For European Research (FOSTER) project, to organize the FOSTER platform, with the aim of developing new skills in researchers, librarians or those interested in joining the OS ecosystem.

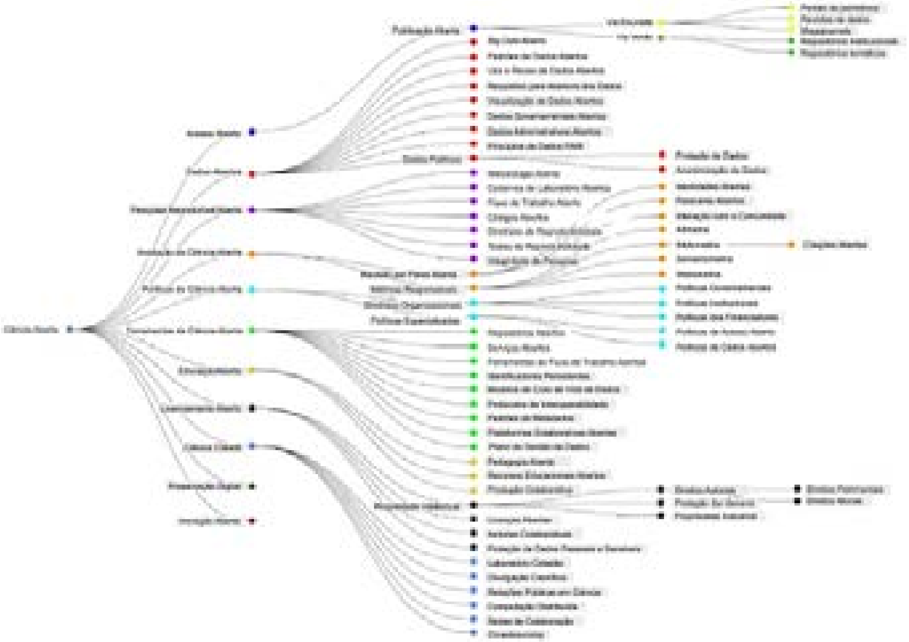
Figure 3. European Open Science Taxonomy



Source: Pontika and Knoth (2015).

The second taxonomy (Figure 4), a Brazilian version (Silveira et al., 2021), was developed to update the previous taxonomy, incorporating the perspectives of Brazilian literature and experts on each of the topics related to the OS ecosystem.

Figure 4. Brazilian Open Science Taxonomy



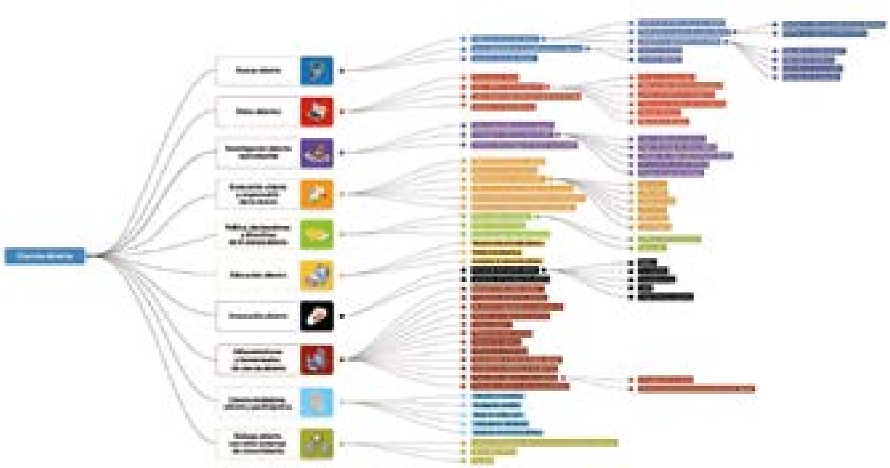
Source: Silveira et al. (2021).[3]

The universal taxonomy proposal (Figure 5), following a method similar to that of Brazil, considered previous taxonomy versions and compared them with the OS elements mentioned in the Unesco Recommendations (2021), elaborated globally with 68 experts from Colombia, El Salvador, Uruguay, Brazil, United States, Guatemala, Panama, Costa Rica, Mexico, Argentina, Peru and Chile. As a result, this recent taxonomy includes 10 first-level pillars (facets-components), subdivided into a total of 96 cate-

3 See at: https://doi.org/10.6084/m9.figshare.19122458.v1

gories (labels), 14 more than the Brazilian version and 51 more than the European version

Figure 5. Universal Open Science Taxonomy



Source: Silveira et al. (2023).4

This taxonomy covers the entire scientific process from various perspectives, including that of researchers, institutions and professionals such as teachers and librarians, all of whom are represented among those consulted. The objective of this universal OS taxonomy is to simplify the representation of existing knowledge, so that people who need to work with the subject matter understand the different systems - components - that interact throughout the scientific research cycle.

The specific context for each of these is presented below: (Szkuta and Osimo, 2012; Masuzzo and Martens, 2017; Foster, 2018; All European Academies, 2017; Silveira et al., 2021; Unesco, 2021):

4 See at: https://doi.org/10.5281/zenodo.7858978

1) Open Access implies the elimination of economic barriers to access or publish scientific articles, data and other resources, including primary and secondary sources, algorithms and software, guaranteeing the availability, interoperability between systems of these materials and identifying the authors' credits with transparent licenses, enabling the multiple use, reuse, replication and reproduction of research, as well as collaboration between nations;
2) Open Research Data (Open Research Data). This refers to the availability of scientific data, whether raw or processed, in digital or analog formats, considered as primary sources. These data may include analysis codes, texts, images, sounds, among others, accompanied by metadata that allow their proper identification and understanding.
3) Open reproducible research. This is the detailed documentation of all resources, tools and methods and processes used in the research to allow others to reproduce the results or replicate the method. In addition, the publication of research with negative results should be encouraged, ensuring transparency and integrity in research, as well as the evolution of science.
4) Open and responsible evaluation of science refers to two types of evaluation, one of scientific productivity with political implications and the distribution of resources, and the other tries to give transparency to the evaluation of scientific articles. There are more than 100 ways to open evaluation in a journal (Ross-Hellauer, 2017), the most common being to publish the opinion with or without the name of the referee.
5) OS policies, declarations and guidelines regulate, institutionalize and stimulate OS practice in different contexts, such as countries, states, institutions or journals. According to Silveira et al. (2021), these policies establish strategies and actions to promote OS, and can be formalized through laws, regulations or guidelines, as indicated by Foster (2018)

6) Open education is defined as an educational approach that promotes free and equitable access to educational resources, as well as collaboration and knowledge sharing among educators, students and the community at large. This concept is based on the idea that education should be accessible to all, regardless of geographical location, economic status or social context.
7) OS infrastructure and tools. These refer to the set of technological and human resources that allow the effective application of OS practices, covering both virtual and physical elements throughout the scientific research cycle.
8) Open innovation is the possibility for organizations to obtain greater benefits if they make appropriate and timely use of internal and external knowledge to create value; that is, if they creatively combine these sources of knowledge to generate new products or services (Chesbrough, 2003). This is consistent with the idea that OS seeks to increase collaboration and information exchange beyond the traditional scientific community; that is, an interaction of different actors (companies, governments/countries, scientists from the same fields or not) (Sena et al., 2023) with shared resources.
9) Open and participatory citizen science is the active collaboration of non-scientists in science, with the aim of involving people in science and making scientific results more inclusive and applicable to the needs of the community.
10) Open dialogue with other knowledge systems promotes the inclusion of knowledge from traditionally marginalized groups and enhances interrelationships between diverse forms of knowledge, such as scientific, indigenous and local communities. Discussed in this dimension are: values of equity, CARE principles (Collective benefit, supervisory Authority, Responsibility and Ethics)

Each of the dimensions presented highlights fundamental aspects of OS. Understanding them as a whole is essential to effectively apply its principles and practices, especially since many of the components are cross-cutting and interrelated. Next, we will show the uses of the taxonomy.

Uses of taxonomy

The expanded and updated, more universal OS taxonomy, as explained in the previous section, allows us to understand all that OS implies; that is, to understand that each of its components "is a world in itself", that they have their own development and dynamics, their history and milestones —timeline—,[5] and a great terminology. [6]

OS, as depicted, is "a large *umbrella*, "an inclusive construct that combines diverse movements and practices..." with the same goal: "to make multilingual scientific knowledge openly available and accessible to all...". This magnitude-complexity means that OS implies a large ecosystem (Figure 6) in which different strategies and processes, agents and contexts are involved and interrelated, so that it can function well, and this is one of its main challenges:

5 See Timeline at: https://www.preceden.com/timelines/288283

6 See Thesaurus at: https://skosmos.loterre.fr/TSO/es/

Figure 6. Open Science Ecosystem

Source: University of Antioquia (2024)

This implies especially, that each of its agents, with due adaptations to each context, must assume roles and responsibilities for which they must develop specific actions (considering the different components and subcomponents of the taxonomy), and thus, achieve impacts and benefits, not only for themselves, but as a contribution to the entire Ecosystem, and thus, achieve the advancement of science, of OS, as summarized by Ramirez and Samoilovich (2018) —table 2—:

Table 2. Agents of the Open Science Ecosystem

	Roles and responsibilities	Specific actions	Impacts and benefits
Governments, financing entities	Enact and promote open principles with public policies and harmonized plans for initiatives. Finance and monetize the development models of platforms and services.	Designing public policies and ensuring compliance with them; consolidating them with sustainability strategies. Creation and development of the necessary technological infrastructure. Study and propose sustainable business models for open initiatives.	Optimization of resource investment. Availability and access to quality inputs and evidence for decision making.

	Roles and responsibilities	Specific actions	Impacts and benefits
Universities, research and innovation centers and institutions	Adopt principles and define specific development models. Design and implement institutional policies in Open Science. Update the conditions for evaluation, recognition and incentives. Inform and train all members of the community. Provide, adopt and develop information services and technological communication platforms. Financing and sustainability of institutional platforms.	Design institutional strategies and plans based on the framework policies. Integrate incentives and recognition for the adoption of open practices. Regain control of their scientific publications and update their business models. Promote the training of researchers, the training of support professionals and new related professions.	Increased regional and international networking capacity. Cooperative development of information resources and technological platforms. Improved cooperative investment in technical and information services. Identification and visibility of own information resources. Provision, preservation and protection of scientific and documentary heritage.

	Roles and responsibilities	Specific actions	Impacts and benefits
Researchers, research and innovation groups and networks	Propose and participate in the design and execution of national policies and mandates of funding agencies. Adopt FAIR research integrity and data management principles. Test, implement and validate information communication platforms and protocols.	Design and appropriate research data management plans. Record, study and analyze the impact of actions in their research and career processes. Participate in the conformation and validation of standards and protocols. Communication of technological platforms.	Increased visibility of research results. Access, use and reuse of information and data from and for research. Increased participation in international networks with new possibilities for cooperation and financing.

	Roles and responsibilities	Specific actions	Impacts and benefits
Technical and information services (libraries, repositories and data centers)	Design, adopt and develop technical and information services, adapted to the entire research and innovation process. Conform and update technological platforms and communication protocols. Train its professionals and promote the training of trainers.	Develop, implement and validate scientific information communication protocols. Consolidate storage, organization and preservation platforms and methods. Participate in and strengthen international networks (repositories, standards, training, metrics, metadata, etc.).	Optimize procurement investment, increase the scope and coverage of information and data for research. Develop integrated services for the use, access, organization and analysis of information. Improve the identification, recovery and preservation of documentary scientific heritage.
Publishers and distributors of scientific information	Analyze, develop, adopt and propose sustainable business models that are compatible with the goal and principles of open access. Adopt transparent and reliable measurement and evaluation practices.	Design, appropriate and test sustainable business models for publications and data based on the effects of the open access policies (golden and green route).	Improve the impact of scientific communication based on reliable multifactorial metrics. Increase the use and visibility of open access scholarly publications.

	Roles and responsibilities	Specific actions	Impacts and benefits
Innovation and entrepreneurship centers	Participate, design and adopt plans to take advantage of open initiatives for innovation and economic development.	Innovation plans that take advantage of and monetize the benefits of open initiatives. Integration and development of economic sectors based on research results.	Identification and access to research results suitably disposed for innovation.

Source: Ramirez and Samoilovich (2018).

But these agents cannot understand all that this implies without adequate training, without a thorough understanding of OS and each of its components; therefore, the taxonomy becomes a "learning object" (classroom or virtual, depending on its use and didactic strategy) or a reference for "orientation to institutional or public policies", to achieve this understanding, and it is from there that different organizations and authors have been using it.[7]

The new taxonomy, therefore, has become a way of understanding "the umbrella", the "inclusive construct", that OS implies, and therefore, the multiple translations[8] are not surprising, nor are the references by au-

7 Examples of formative use-learning object of taxonomy: https://globaldiamantoa.org/posters/index.html?id=46 and
https://www.youtube.com/watch?v=_r_14ZCKG9Q
Examples of institutional or public policy use of taxonomy:
Panama: https://www.senacyt.gob.pa/publicaciones/wp-content/uploads/2024/05/EstadodelArte-PoliticasdeCienciaAbierta.pdf
Chile: https://acceso-abierto.anid.cl/wp-content/uploads/sites/4/2023/11/PRESENTACION-PAA-ENCUENTRO-MZN.pdf

8 Taxonomy translations: https://zenodo.org/records/7836884

thors from other contexts -not Latin American-,[9] who have noted that in order to understand OS, all the implications-interrelationships between the parts (components) and the whole (OS) should be easily understood — graphically (with this taxonomy).

Conclusions-recommendations

Many countries have already implemented some pillar-components of OS, especially open access through scientific journals in the diamond model and institutional repositories. However, it is necessary to evolve and work in an integrated manner with the other components for several reasons: 1) many components are cross-cutting and mutually reinforcing; 2) to have an effect on the entire scientific research cycle, actions are needed in infrastructure, both technological and human, as well as the training of all actors in the OS ecosystem.

In terms of global recommendations, Unesco (2021) provides fundamental guidelines for countries to move in a common direction in the implementation of OS. However, it is crucial that each country develops its own national, regional and institutional policies, norms and regulatory frameworks in order to support all dimensions of OS in an integrated manner. This allows strategies to be adapted to local realities, fostering effective and sustainable adoption in each context.

At the same time, it is necessary to become aware (to remove our own cognitive-scientific colonialism); that is, to believe in our own capabilities; to think that, in our realities and contexts, although often with limitations, we can indeed advance in OS, in its different components, since limitations can be a barrier, but also a possibility for creativity, collaborative-cooperative work, interoperability and collective visibility.

9 *Micro and Macro Open Science Perspective Taxonomy* (Rogers, 2024): https://zenodo.org/records/10835001

If Latin America managed in two decades to be the world's reference region in open access, with developments such as Latindex, SciELO, RedAlyc, LaReferencia, which are what other regions -even with more development- now want to achieve; why can we not be so in other pillar-components such as open data, open and responsible evaluation, citizen science, dialogue of knowledge and/or interaction with other agents beyond scientists. It is a matter of believing that we can make the right decisions in institutional policy and/or public policy that will enhance OS; but we must do so as soon as possible, and thus, in the next Recommendation Report our progress will be much greater. OS becoming a reality and not leaving us behind is in our hands...

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REPOSITORIES, INFORMATION MANAGERS AND PERSISTENT IDENTIFIERS TO SUPPORT LATIN AMERICAN OPEN SCIENCE

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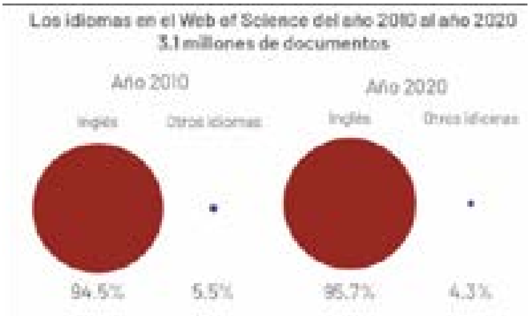
Introduction

At the international level, different elements that make up the work of Open Science (OS) have already been defined, with various taxonomies that add and exclude elements according to the progress of the debate, the history and the needs considered from the context in which these categories are built, as seen in the previous chapter. After many definitions, versions and the Open Science Recommendation of Unesco (2021), the debate has focused on the best ways to adapt or work under the ideals of OS, from common frameworks, which come from the debate of those countries considered "First World"; and although there is an attempt to take into account the reality and history of Latin American science communication, these visions of openness parallel to the proposals of the large publishers have not been incorporated into the current work routes.

Faced with an international reality that pressures researchers to follow the standards of scientific publication based on transformative/transformative agreements and Article Processing Charges (APC), the good practices of scientific work must be recovered to allow for working under the paradigm of OS without having to make large payments to publishing companies, since this is not an accessible reality in most of the Latin American region, where scientific production is mostly carried out in universites that do not have large funds for this type of service from world leading publishing companies, which thus gives some advantage to the private initiatives that are dedicated to education and research.

In Latin America we face a reality of exclusion, rivalry, inequity, under-representation, publishing monopoly, distortion of the concept of quality, submission, profitability by charging authors, which, in short, leads to a disappointing situation: it is almost impossible to compete with the realities of other countries, since most of the production recognized by the accepted scientific production rankings (Scimago Journal Ranking, SJR and Journal Citation Ranking, JCR) recover more than 90% of the documents in English, with a trend that continues to rise (Aguado, 2024) (See figure 1).

Figure 1. Language in which the papers included in JCR are published.



Source: Aguado (2024)

Eduardo Aguado, general director of REDALYC, has asserted in multiple events and conferences that there is an extraction of resources from South to North, derived from these practices of publication of scientific work, which has led to a structural dependence and a devaluation of the regional publishing ecosystem that, turn, has weakened the Latin American research system itself as well as those of other regions. It is therefore urgent to recover practices that lead to equitable, inclusive and multilingual work, to curb this structural dependence on other models that affect regional ecosystems.

It is necessary to invest economic and human resources in strengthening open infrastructures that offer independence from the economic models of large publishers. For this reason, this paper proposes the recovery of three routes or historical models that have worked for decades in the region to promote scientific work from Latin American universities and research centers. This reality of universities and research centers as the center of the scientific production process in Latin America makes it necessary to recognize other practices for the access and promotion of this type of resources, which have worked to share knowledge for decades, at least.

Universities in the region have historically worked with models of openness based on sharing knowledge, using as economic support the budgets of the institutions themselves, where university publishers and libraries have played a leading role, offering options for publishing books, journals and visibility of production in general. Three working models are discussed: the use of repositories, the use of information managers and the use of persistent identifiers.

Academic, institutional and thematic repositories

In the search for promoting access to knowledge, one of the tools that have been used as a common basis for making scientific production available are digital academic repositories, since the previous strategies of sharing in traditional websites in specialized events and with regional agreements for the exchange of collections always had a limited scope. When regulations concerning access to information were approved in the different countries, repositories emerged and positioned themselves as an appropriate and valuable option to widely display each country's research results (Adame et al., 2013; Galina, 2011); thus, some institutions and, later, countries in the region proposed the creation of repositories that could compile or promote the academic work of each institution and/or region, as is the case of Mexico, with the National Repository.

Recognizing the need of researchers to make their scientific production visible in the digital world, with wide access to consult, copy and cut, so that the works can be consulted in a simple way, following the FAIR (findable, accessible, interoperable, reproducible) principles; always with the idea of wider access, since the distribution channels for scientific literature that were historically used in the region did not reach many sectors of society; therefore, the use of the Internet to make the results of research work available is appropriate and efficient. It is under this premise that proposals for the use of repositories arise:

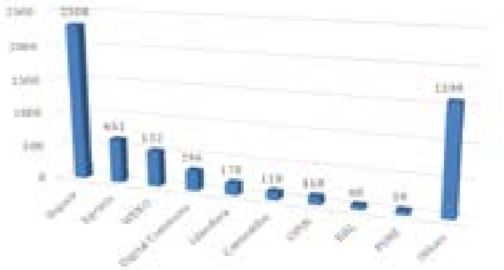
> Lynch (2003) defines a repository as a computer system that integrates a set of services that allow incorporating, gathering, preserving, consulting and supporting the management and dissemination of digital resources created by the university itself to the members of the community, through a web interface or portal, by means of an appropriate classification of its resources through metadata. (Adame et al., 2013, p. 150)

Repositories are web portals used broadly as platforms where the production of a work center, institution, country or region is presented openly and in full text, using common standards, such as controlled languages and specific information, in the quest to promote access to information, accountability and academic dialogue. The use of these systems is then one of the first steps that are recommended or worked on when thinking about open access and OS. Currently, the majority of the main institutions in the region have this type of resource that have been enriching and evolving, many of them becoming Current Research Information Systems (CRIS); ideally most research centers should have this type of visibility strategies.

Repositories can be classified according to their intended use: thematic, institutional, literature, data, and other categories that define the goal and intended use of the repository; although it is very common to find repositories that include varied collections and may include information that is not from a single institution, but may be regional aggregators, by working groups or by thematic affinity; under this system of work, possibilities such as data, OER, historical heritage, among other elements that have been considered valuable to safeguard and share have been added.

Due to the growing use of this resource, it is possible to find many models or developments for working with repositories. The first thing to consider is the software that will support the creation of the repository, since it is possible to work with a proprietary development or with already existing options that have been improved over decades. In 2014, Unesco published a comparison of software for the development of Institutional Repositories (IR) (Bankier and Gleason, 2014), where options such as Digital Commons, Dspace, Eprintis, Fedora and Islandora were included; these were chosen after an analysis of the most commonly used options at that time, with data from the Directory of Open Access Repositories (DOAR) and the Registry of Open Access Repositories (ROAR). This study was carried out with the intention of providing guidance for the need to compile, display and preserve digital collections of scientific output. The document was published at a time when the debate was at a peak, and from which the recommendations for working with this type of strategy emerged.

Figure 2. Most used software for institutional repositories by the year 2022



Source: Saikia et al. (2023).

In Latin America the most widely used software is Dspace, from the Lyrasis working group, which coincides with the international trend (Figure 2); it is an open source development useful for the management of digital collections, a free software proposal that has been developed by a large community for many years and for which there are manuals and guidelines on the web; in this tool it is possible to host academic papers, theses, photographs, videos, and even, in some cases, it is used for data collections and Open Educational Resources (OER). When using any of the software presented in Figure 2 or in the work of Unesco (2021), it is important to define the templates and data that must be requested to upload documents, as well as the rules or work routes defined by the institution or entity that created the system.

Almost ten years after the publication of Unesco (2021), Saikia et al. (2023) published a paper on the growth and development of repositories in the world, using data from the same systems (DOAR and ROAR), which resulted in valuable information for us. The country with the largest number of repositories is the United States, with 920 in 2023, followed by Japan, the United Kingdom and Germany. In Latin America, Peru stands out in first place with 185, and is ranked number 5 globally, followed by

Brazil with 159, Colombia with 109, Argentina with 91, and Mexico with 52; the study shows the first 30 places worldwide.

Table 1. Comparison of Institutional Repositories registered in ROAR for the Latin American Region 2023-2024

Country	Number of repositories 2023	Number of repositories 2024
Peru	185	197
Brazil	159	193
Colombia	109	154
Argentina	91	78
Mexico	52	55

Source: Own elaboration with data from ROAR and Saikia et al. (2023).

In addition to those presented in Table 1, which include the 5 Latin American countries that appear in the ROAR ranking 30 for 2023, it can be observed that by 2024 most of the countries in the region have repositories: Chile has 30, Ecuador has 32, Venezuela 24, Cuba 16, El Salvador 13, Panama 9, Nicaragua 8, Uruguay 8, Bolivia 3, Paraguay 1, and Honduras, 1. According to this record, the region has at least 822 repositories. It is true that this number does not necessarily reflect the reality of existing repositories, but only those registered; for example, for Mexico, there are 55 to date, while the National Repository of Science, Technology and Innovation reports 108 by the year 2024.

There is a lack of IR registrations in countries such as the Dominican Republic and Guatemala, but there is also a sustained growth of registrations in countries such as Colombia and Brazil, due to policies to support universities in the creation and maintenance of these platforms. What is clear is that the total number of Latin American repositories (822) is lower than the 912 found in the United States, and while the underrepresentation is recognized, it illustrates the need to work more with these tools, which do not involve payment barriers or large disbursements.

The recognition of the potential use of this type of record and the promotion of good practices in their use is needed, and for this, the creation and support routes for starting to work with IR must be shared, taking advantage of successful experiences in the region. The recommendation for those who are starting on this path is to carry out an analysis of the ways of working with IR in the region, taking into account their responses to different needs, such as choice of software, management of collections, definition of templates and ways of working; thus, by knowing the experience of institutions similar in number of collaborators, students and budgets, it will be possible to start working, since the references become more accessible in terms of practices.

Information managers

Latin America recognizes the creation, use and implementation of information managers that compile, catalog and present scientific production in the search to offer more equitable and accessible databases, efforts that begin by eliminating the payment barrier and are again supported by educational institutions, as is the case of Latindex, a system created in the 1990s by the National Autonomous University of Mexico (UNAM), to function as an information network on scientific production in the region, as well as in Spain and Portugal. The system went from being a directory to also offering a catalog of journals that comply with indicators of good editorial practices; to date, it presents information on almost 28,000 journals in its directory and close to 3,700 in its catalog. This system is operated by a network of 24 member institutions, including universities and 19 cooperating institutions, which include other aggregators and directories, initiatives such as the Public Knowledge Project and systems and initiatives related to journal publishing, such as the ISSN.

Another system that has functioned in a similar way is REDALYC (now identified as the Network of non-commercial Open Access scientific journals owned by academia), of the Autonomous University of the State of Mexico (UAEM), which compiles full text and with metadata tagging (JATS) the production firstly of the Latin American region and then of other regions, passing through quality filters that allow validation of the content of what is presented, being a catalog or indexer of journals with good practices, which allows access to the journals included.

The REDALYC project has been enriched and transitioned to another proposal called AmeliCA, which proposes the development of a OS model based on understanding knowledge as a common good, presenting a non-commercial work model of an academic nature, which allows giving visibility and support to those journal publishing efforts, using the Diamond Open Access concept, as opposed to the options of the oligopoly publishers that speak of Golden, Green, Hybrid access routes, among others.
Another project that began as a digital library and now also works as an index is SciELO, a proposal of the Foundation for Research Support of the State of São Paulo, Brazil, which to date has 15 collections from countries in the region plus Spain, Portugal and South Africa, with working models that are supported by the Science Councils and Secretariats and universities in the region. This platform allows the electronic publication of complete issues of journals that have undergone a quality validation process; it is based on good practices and access to the necessary information so that they can be connected in the digital world.

Figure 3. Latin American Knowledge Managers

Source: images taken from the websites themselves.

These four projects (Figure 3) serve as models, job paths, tools for institutions and information access options for society in general. The databases of these systems work against, or in spite of, the closed databases of companies such as Elsevier and Thomson Reuters (SJR-Scopus, JCR-Web of Science); therefore, they are models that support the vision of understanding knowledge as a common good and, at the same time, offer alternative work routes, demonstrating that the model of APC and transformative agreements is not the only model nor is it the best for access to information, which under these systems continues to be of restricted access. These experiences are a reflection of the fact that other forms of non-commercial work are possible and that, from the region, there are historical models of access to information that are adequate, useful and offer alternative quality models.

The way to think about OS with these tools is to promote their wide use, both as a source of information for the broad communities and as platforms for integrating the editorial efforts of the different institutions in the region. There is a need for training programs and for the valuation of these tools as efforts worthy of being considered of quality, so that their wide use becomes a value associated with good practices of knowledge openness, since there are visions of disdain for these strategies among decision-makers and private initiative options , shaped under a market vision, are privileged .

Persistent identifiers

Due to the enormous amount of academic production that can be found nowadays, persistent identifiers that allow the successful affiliation of persons, documents and institutions that may have the same or similar names are necessary. This need arises from the fact that it is essential to validate the quantity and quality of the production, so that the reports to be consulted can be segmented. Currently, the work of educational and research institutions is measured in large part by their scientific-academic production and its impact, represented by the citations of each work, author, institution or country. Under these parameters, the scientific development of a country or region is measured by metrics that take citations as the primary input; thus, digital presence and access are a primary issue.

When thinking about a broader and more significant access, it is not only about rankings or institutional, national or personal positioning, but also about the impact that the scientific effort can have on the life of the community or the population, from local to global visions. Thus, it is important to know some working tools that provide visibility, access and positioning to scientific work, as well as to the data resulting from this work. In view of this, persistent identifiers are an important tool for the location and definition of authorship, as well as the localization of a work.

In the first instance, institutional identifiers are necessary, such as the Research Organization Registry (ROR), an open initiative focused on providing institutions with persistent identifiers that allow the localization and accreditation of scientific production. This project is based on the work of non-profit organizations, such as Datacite and Crossref, which are in charge of doing the identification work, but in this case of virtual objects.

The use of author/person identifiers is recommended as a second tool, with ORCID (Open Researcher and Contributor ID) being accepted and extensively used internationally (following a process where entities and companies tried to promote their own identifiers, such as RsearcherID, Scopus ID, among others). ORCID is another non-profit organization that operates through institutional memberships, which support the financial cost of the work of the researcher identification system; according to its own information, it allows "all those involved in research, scholarship and innovation to be uniquely identified and connected with their contributions, across disciplines, boundaries and time" (ORCID, 2024).

As a third tool, it is important that the documents that are widely shared also have an identifier, the DOI (Digital Object Identifier). To obtain this type of identifier there are two organizations: Datacite and CROSSREF. These organizations, like the previous ones, operate on a non-profit basis and were born out of the need to identify and locate scientific production in a stable manner, due to the mobility that exists in the use of web pages and electronic support of documents. It is important to note that these organizations have a relationship and connection models with the other identifiers (ROR and ORCID).

In the case of Datacite, its work model has evolved towards offering a platform of usage indicators called Datacite Commons, where it is possible to find information on citations and downloads of documents with a

DOI and segment it according to the institution, person, organization or repository where the resource is hosted. This is an alternative strategy for measuring impact compared to the SJR indicator, which comes from a publishing company and is judge and jury; and JCR, which comes from a news company. Interestingly, this system not only compiles information from its own database, but also from CROSSREF, so it is possible to make use of this tool despite not being part of the Datacite consortium.

These identifiers of institution, author and documents are necessary for the location and preservation of the production of an institution, region and author at a broad level. They are global proposals that are recovered for the Latin American region, in order to have a broad presence in the OS ecosystem from a vision of knowledge as a common good. In summary, these identifiers (Figure 4) accompany the work of repositories, journal sites and information managers, so that they can comply with these international best practices, for a regional vision.

Figure 4. Identifiers used in the knowledge openness ecosystem

Source: Own elaboration

Access to all of them requires institutional membership fees and, in the case of the DOI, a minimum amount per document, so it is necessary to take into account within each institution on an annual basis to manage this disbursement, which is not very high, especially when compared to access to large databases, the APC and transforming agreements.

Conclusions

The presentation of these three initial and important strategies to start working with models of science openness aims to provide those who approach this type of strategies with a clear and defined guide on how to begin. But a pending issue is the promotion of norms and definitions of open knowledge in the different institutions, since frameworks are needed for the implementation of different strategies that promote access to science in the region. The following practical advice is also shared:

1. For institutions that do not have OS strategies in place, the creation of an IR is a good start.
2. For the creation of an IR, look for the most appropriate software for the institution and its needs.
3. The importance of registering IRs in specialized directories, such as ROAR and DOAR, should not be forgotten.
4. It is important to be aware of and encourage the use of information managers by journals, researchers and students. Here it is necessary to work from libraries and classrooms.
5. To push institutions towards other quality models, where information hosted in SJR and JCR is not privileged.
6. The need for the use of persistent identifiers at all levels should be clear, in order to guarantee the presence of the institutional work in the global academic digital ecosystem.
7. Good regional and local practices of preservation and dissemination of scientific work should be recovered and enhanced with international trends; that is, historical practices should nor be eliminated in order to change them for other, non-localized ones.

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METADATA AND STANDARDS FOR DIGITAL REPOSITORIES

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Introduction

In the fast-paced digital world in which we live, efficient information management is vital to make the most of its potential. In this context, metadata and controlled languages have emerged as fundamental tools in data organization and retrieval.

In this chapter, we will dive into the exciting universe of metadata and controlled languages; we will highlight the advances and specific challenges that have arisen in the Latin American region, where various initiatives and guidelines have emerged to promote the effective use of metadata and controlled languages; we will explore the impact of these tools on open access, academic research and information discovery in the region.

Development

According to the UNE-ISO 23081-1: 2008 standard (Spanish Association for Standardization, n.d.), "metadata is structured or semi-structured information that enables the creation, recording, classification, access, preservation and disposition of documents over time". Metadata includes a wide range of information that can be used to identify, authenticate and contextualize documents, people, business processes, regulation and their relationships.

In the context of librarianship, metadata provides information about information resources, such as books, articles, images, videos, and other materials. When we consult an online catalog, or a database, metadata provides us with essential information about the resources we are looking for. This data can include details such as title, author, publication date, abstract, keywords, format, file size and physical location. In addition, metadata may also contain more technical information, such as the file type, the resolution of an image, the compression format of a video, among others.

Metadata is useful for:

- Managing documents: search for them, find them, locate them, order them, organize them, classify them.
- Associating documents with other similar documents or related information.
- Establishing relationships between documents and other contexts, such as websites, other documents, videos, channels, social networks, etcetera.
- Making documents visible, contextualized, understandable, accurate, reusable, evaluable and retrievable locally or on the Internet.
- Maintaining traceability, protection, change control and information throughout the life cycle of data and documents.
- Facilitating migration, transformation, transfer and harvesting processes.

In order to manage metadata, international guidelines have been generated, such as the OpenAIRE guidelines (OpenAIRE, n.d.), which are international guidelines whose application, together with other tools, are aimed at improving the quality and standards of metadata, facilitating communication between different systems, ensuring interoperability and promoting good practices for the registration and retrieval of information.

In accordance with international standards, the science and technology agencies of Latin American nations are developing guidelines to adapt them to regional realities.

An example of this is the Guidelines for institutional research repositories (Ministry of Science, Technology and Innovation of Colombia, 2020), which aim to promote open access production and consolidate an offer of the country's scientific production in order to provide visibility and access to national scientific information. This guide is addressed to the technical managers of institutional research repositories for the construction and improvement of data quality.

Metadata management tools

- Metadata schemas: institutions define the minimum elements to be taken into account, i.e., the minimum metadata that meet their needs for describing documents. It is important that the schema defined be human-readable and machine-readable to ensure interoperability.
- Description standards: RDA alliance, Datacite.
- Validators: OAI-PMH https://validator.oaipmh.com/
- Search engine meta-search engines: Google Scholar

These are tools that capture metadata, which allows the documents in our repositories to be found through searches performed on these platforms.

Some of the most important collection services at present are:

- BASE: Bielefeld Academic Search Engine
- LaReferencia (Federated Repository Network of Latin American Repositories)
- Coar
- OpenAIRE Application Profile
- Redcol application profile
- Google Scholar

Standards are common agreements on what metadata to use, how it will be used, the order, quantity, characteristics and how it will facilitate interoperability. Some examples of standards are: OpenAIRE, Redcol and LaReference.

Metadata is classified into:

1. Descriptive metadata. This metadata is essential for identifying and searching information resources, because it provides details about the content and description of a resource. They include elements such as title, author, keywords, abstract, subject, genre, date of publication, publisher, among others.
2. Structural metadata. This metadata describes the internal structure of a resource; it is especially relevant in resources such as books, long documents or multimedia resources; it may include information about chapters, sections, pages, time of reproduction, indexes, among others.
3. Administrative metadata. This metadata provides information related to the management and administration of information resources and is essential for collection management and rights administration. It may include data on copyright, access permissions, date of acquisition, file format, file size, physical location, among others.
4. Technical metadata. This metadata is important for the management and preservation of digital resources. They contain technical information about the information resources, including details such as the file format, the resolution of an image, the codec[10] of a video, the type of compression, the duration, the file size, among others.
5. Rights metadata. This metadata describes the copyrights and restrictions associated with a resource, and is essential to ensure compliance with copyright laws and proper management of resources. They may

10 The computer language in which the video information is written, in which it can be encoded or decoded. https://platzi.

include information about licenses, permissions for use, reproduction restrictions, among others.

There is a great variety of metadata schemas, it is very important to know them in order to define which one is the most adequate to describe our resources. In addition, the selected schema must:

- Be compatible with the technological developments and systems used in resource management.
- Be prepared to ensure compliance with interoperability standards (OAI-PMH, ORE support) and compatibility with other schemes.
- Enable efficient recording of information through the correct use of tags and controlled vocabularies to ensure the reliability, authenticity, availability and integrity of the metadata associated with the documents.
- Enable the efficient use of uniform and persistent identifiers to encourage and simplify the correct and unambiguous attribution of scholarly output, eliminating ambiguity in author names and affiliations, and to uniquely identify a resource at a given location.
- Manage the use of de facto standards to indicate licenses of use (Creativecommons)

OpenAIRE recommends that metadata be encoded in the Dublin Core metadata format, as it allows information resources to be described and retrieved in a more effective and consistent manner, facilitating search and access to information.

This metadata schema provides a basic set of 15 elements to describe information resources.

1. Title: the name given to the information resource, which provides a descriptive name that identifies it.

2. Author (creator): person, organization or entity responsible for the creation of the resource.
3. Subject: the main content of the resource, generally expressed as keywords or phrases.
4. Description: a textual description of the content or purpose of the resource.
5. Publisher: person, organization or entity responsible for the publication, distribution or issuance of the resource.
6. Contributor: persons, organizations or entities that have made secondary contributions to the resource.
7. Date: date associated with the creation and availability of the resource.
8. Type: nature or genre of the resource, such as text, image, audio, video, etcetera.
9. Format: the physical digital format or medium of the resource, such as file format or media type.
10. Identifier: unique identifier of the resource, such as an ISBN number, URL or file identifier.
11. Source: reference to the source from which the resource was derived.
12. Language: main language of the resource content.
13. Relation: relation to other resources, e.g., a previous version of the resource, a part of a whole, etcetera.
14. Coverage: Temporal or spatial extent or scope of the resource.
15. Rights: declarations of intellectual property rights or legal restrictions associated with the resource.

These elements provide a solid foundation for describing and accessing information resources in different contexts. However, it is important to note that the Dublin Core allows for extensibility and the creation of more detailed and specific metadata profiles to address particular needs of different domains and user communities.

DataCite metadata schema. DataCite is an international organization dedicated to providing unique identifiers for datasets and promoting their accessibility and visibility online. DataCite uses a metadata schema called the DataCite Metadata Schema, which defines the information elements necessary to describe a dataset accurately and consistently. This schema is composed of the following key elements:

1. Title: name of the dataset
2. Authors: persons or entities responsible for the creation or compilation of the dataset.
3. Description: a brief description that provides details about the content and purpose of the dataset.
4. Keywords: terms or phrases that summarize the main themes addressed in the data set.
5. Persistent identifier: a unique and permanent identifier assigned to the dataset to facilitate citation and reference.
6. Date of publication: the date on which the dataset was made publicly available regardless of whether it is open or closed.
7. License: terms of use and restrictions applicable to the dataset.
8. Location of the dataset: the URL or location identifier where the dataset can be accessed online.

MODS (Metadata Object Description Schema) is used to describe digital resources such as images, audio and video files and electronic documents. It is based on XML and provides a flexible structure to describe different aspects of the resources. It is used in repositories and digital libraries for metadata management.

METS (Metadata Encoding and Transmission Standard) metadata schema is a standard system that combines descriptive, structural and administrative metadata to provide a complete framework for describing and managing complex digital objects. It uses XML to structure the information and allows the representation of relationships between different components of a digital object, such as the pages of a book or files in a collection.

Other metadata standards: there are many other metadata schemas and standards used in different contexts, among which we can find:

- EAD (Encoded Archival Description). Used to describe archival materials in the form of XML documents, it describes the structure and content of archives and archival collections.
- PREMIS (Preservation metadata). Used in the field of digital preservation to describe and maintain the information needed to ensure the authenticity, reliability, and long-term accessibility of digital objects. It includes technical, administrative, and copyright metadata related to digital preservation.
- FGDC (Federal Geographic Data Committee). Used to describe geospatial metadata, such as maps; geographic data, such as coordinates, projections, scales, and thematic metadata related to geography.

Conclusions

The metadata field faces different challenges and issues that must be taken into account for the near future. Interoperability of information between different standards and schemas continues to be a challenge. In addition, open access poses complexities in terms of the adoption of open standards and the implementation of licenses that encourage the reuse and transparency of information. Another aspect to consider is enriched metadata, which improves search and discovery of information in a more accurate way, but requires clear guidelines to achieve its full utilization. The use of linked or linked data allows for greater interconnection and linkage between resources and metadata. Finally, it is critical to consider emerging technologies, such as machine learning, Artificial Intelligence, and virtual and mixed reality, which can enhance the ability to search, organize, curate and retrieve information.

Practical recommendations based on our experience

- Use hidden local metadata.
- Use the fixed metadata template to avoid filling in data that may be the same for the collection. Example: the name of the university.
- File names. To name the files it is advisable to keep them in lower case and not to leave blank spaces. Do not use accents (á), nor virgulillas (ñ). Do not use special characters such as: (!@ # # $ % ^ & * ( ) / " : ; , ? +, among others).
- To avoid page break errors in the downloaded reports, no spaces should be left in the summary texts, for example.
- To improve indexer collection, it is recommended to deposit the files in PDF and not to assign passwords or locks to the documents, as these do not allow the robot to read the documents.
- Use the OAI-PMH validator to ensure the quality of the metadata recorded.

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AI+UX IN SCIENTIFIC JOURNALS

Joel Torres Hernandez
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On universal access to information

The social function of Open Science

In an era of hyper-connectivity, where we face an overwhelming volume of information on a daily basis, it is paradoxical that much scientific knowledge is still accessible only to a certain sector of the population. Initiatives such as Open Science (OS) are changing this panorama by advocating universal and unrestricted access to knowledge. This international movement not only facilitates the dissemination of information, but also fosters collaboration and transparency in research. As Ramírez-Montoya and García-Peñalvo (2018) state, OS is crucial for innovation and social advancement, as it "promotes collaboration and transparency in scientific research."

Open access scientific journals as vectors for the democratization of knowledge

Scientific journals play an essential role in the democratization of scientific knowledge. By adopting open access models, these publications eliminate economic barriers, allowing research to reach a greater number of people at no cost. This model not only improves interaction between scientists from different disciplines and regions, but also drives innovation and scientific progress. In Latin America, the impact of these journals has expanded thanks to initiatives such as SciELO, a decentralized cooperative model that improves the international visibility of regional research (Canales, 2017).

With the development of technology, scientific journals have evolved from printed formats to digital platforms, adapting to social needs. Systems such as Open Journal Systems (OJS) have revolutionized the management and publication of scientific articles, facilitating the transition from print to digital publishing, promoting a more open and equitable access to knowledge. This transformation not only optimizes the operational efficiency of journals, but also expands their reach and accessibility. These collective efforts, while raising the quality of published research, also ensure that scientific findings are widely shared, bringing benefits to researchers, academics and society in general. In this way, scientific journals continue to ensure their relevance and accessibility, facilitating a more open and democratic knowledge, an essential element to face global challenges and foster a more informed society.

About Artificial Intelligence in Journals

Generative artificial intelligence has started an unprecedented revolution in this century, transforming content creation and expanding the frontiers of knowledge. This technology not only changes the production and distribution of data, but also redefines the methods and development of the research cycle. However, despite its multiple benefits, the ethical challenges in its application within editorial processes and in the creation of scientific content is one of the most urgent points to address.

The current use of Artificial Intelligence (AI) in the field of scientific publications is mainly focused on plagiarism detection and optimizing the efficiency of the editorial process. However, knowledge gaps were found in the current literature to improve the user experience. The implementation of personalized AI systems could radically transform user interaction with scientific journals through AI-guided interfaces that enable more intuitive navigation. These technologies could leverage long language models to streamline the query process in a precise and contextual manner, thus enriching the user experience by interacting more dynamically with the content.

In addition, AI tools have the potential to play an important role in the editorial management of journals. According to Diaz and Vega-Escobar (2019), the implementation of strategies to improve editorial quality and ensure the relevance of published articles is essential for scientific and technological advancement. This includes declaring and complying with editorial policies, improving the frequency of publication, and expanding accessibility and international visibility

These AI advances not only enhance scientific research and interaction, but also promote a wider consumption of science, reaching a more general audience and generating a greater social impact. The exploration and development of these applications of AI to maximize the academic and social impact of scientific knowledge should be a hotbed of opportunities for future research.

User experience (UX) in scientific journals

User experience (UX) is defined as the interaction between a person and a product or service and how this interaction influences their perceptions, emotions and behaviors. In the field of scientific journals, UX is necessary to facilitate access and understanding of science, ensuring that articles are accessible and understandable, not only for the specialist user, but also for the general public. This user-centered approach becomes essential to ensure that scientific advances fulfill the social function of science, i.e., that they have an impact on people's daily lives.

In parallel to the growing development of emerging technologies, the UX in scientific journals demands an equal advancement to facilitate the transfer of knowledge. According to Hassan-Montero et al. (2014), technology has enabled the implementation of interactive graphical interfaces in open access journals, thus facilitating intuitive navigation and efficient access to bibliometric information.

dPyx, an open source tool to evaluate the usability of a scientific journal

The relevance of user-centered design to promote the consumption of scientific output is indisputable; it requires that systems, in addition to being functional, must be efficient, intuitive and generate a pleasant user experience. This approach allows journal designers and publishers to better understand the needs and expectations of different types of users, ensuring that interfaces and content are accessible to increase the frequency of visits to the platform, which is vital for scientific journals, digital libraries, academic databases and other knowledge repositories.

Given this scenario, it becomes a priority to explore methodologies, processes and tools for the objective evaluation of UX indicators. The dPyx software, developed by eScire, is an open source tool that was designed to meet the need to evaluate the performance of programs and policies, including editorial products and information systems. This tool is configured to adapt to different contexts and needs, providing an assessment based on international standards, norms and recommendations to facilitate informed decision making. One version of dPyx has been designed and configured to evaluate the usability of digital platforms, based on principles established by UX experts such as Don Norman, Eric Reiss and Jacob Nielsen, among others, ensuring that it promotes more meaningful social consumption of science for broader and more diverse impact.

Table 1 lists the most important advantages of the dPyx usability evaluation system:

Table 1. Most important advantages of the dPyx usability evaluation system

Community adoption	dPyx allows you to identify and track user behavior within the platform, integrating gamification strategies to increase user participation and engagement. For example, dPyx uses tools to identify active and inactive users, which is crucial to develop targeted interventions and improve interaction.
Standardization	The platform ensures that the interface and internal processes comply with international accessibility and usability standards. This is vital to ensure that the journal is accessible to a wide audience, including those with disabilities. The standardization of metadata and adoption of controlled vocabularies facilitate search and retrieval of information, which significantly improves the UX.
Interaction with the system	The tool evaluates how users interact with the system, focusing on ease of use and interface efficiency. dPyx helps identify areas where navigation could be more intuitive or where processes could be faster and less error-prone, reducing user frustration and improving overall satisfaction.
Technological infrastructure	dPyx evaluates the underlying technology infrastructure to ensure that the platform is secure, reliable and up to date with the latest software updates. This includes security measures, such as anti-bot protection and interoperability with external systems, which ensures that the scientific journal can operate continuously and securely, preserving the integrity of the data and published research.

Source: Author's elaboration

A look at the opportunities for generative artificial intelligence in scientific journals to improve user experience

In the last decade, we have witnessed remarkable advances in AI technology, particularly in Machine Learning algorithms. These advances have enabled the development of generative artificial intelligence models capable of creating textual content, images and other multimedia formats, boosting automation and efficiency in the production of article-derived content, which represents considerable savings in time and resources.

Integrating these emerging technologies into academic resources, such as scientific journals, enhances the user experience by offering content in different multimedia formats that facilitate the understanding of scientific information.

The adoption of generative artificial intelligence to create derivative products, such as podcasts, videos, infographics, chat-bots and abstracts, has contributed significantly to the dissemination of scientific knowledge. These tools aid the translation of technical terms into more accessible narratives, broadening the academic dialogue and fostering scientific and technical progress (Rodríguez and Muñoz, 2020). Science popularization has also evolved to adapt to emerging trends, developing discursive strategies that reach wider and more varied audiences (Alonso and Ortiz, 2022). However, it is critical that the use of generative artificial intelligence in the creation of these derivative products focused on public communication of science be handled responsibly and ethically. Ensuring that the generated products do not alter or distort the original content of scientific articles, while maintaining the integrity and accuracy of the data and results presented, should be a priority when designing policies, processes and tools for this purpose. In addition, adhering to transparency practices in the declaration of the tools used is essential for an ethical and responsible use of generative artificial intelligence. This will create a trustworthy environment for the authors and for the scientific community in general, facilitating their informed and conscious consent on the transformation of their work into AI-generated derivative products.

Challenges and opportunities

Scientific journals are currently at a turning point in their evolution, facing important challenges, such as the need to continuously improve the management of editorial processes and ensuring the quality of publications. However, the adoption of frontier technology that offers innovative alternatives for their integration into digital environments represents a range of significant opportunities to modernize the dissemination of scientific knowledge, according to Vázquez-Cano (2013).

On the other hand, as Chirinos and Villoria (2017) point out, open access scientific journals face additional challenges in terms of periodicity and motivation to maintain quality and consistency in publication. This is where generative artificial intelligence can play a transformative role, contributing significantly to improving a journal's quality indicators. Personalization of content according to the specific interests of each audience, intuitive navigation across platforms and the support of virtual assistants, which enable real-time interactions with users, are just a few examples of how AI can enrich the UX.

In addition, the use of AI tools and applications has the potential to increase the visibility and accessibility of scientific articles through the generation of derivative products, such as infographics, visual summaries and explanatory videos, which expand the horizons of a publication's scope. These formats, in addition to providing an attractive first approach to the content, can also awaken a greater interest in science in an audience not currently contemplated by scientific journals. On the other hand, tools that convert text into audio offer the possibility of accessing the content in an alternative way, allowing users to listen to articles while performing other activities.

However, as Abad-Garcia (2019) points out, high ethical standards must be maintained in scholarly publishing, therefore, this statement extends to the use of generative artificial intelligence in this field. By doing so, copyright protection and correct attribution of authorship of content generated by AI-based generative tools is guaranteed. Another important challenge is to ensure the quality and veracity of derived products, requiring the implementation of rigorous regulatory structures and validation mechanisms that are aligned with international standards, but adapted locally for the global South .

Finally, it is suggested that the tools to evaluate and improve these processes should be analyzed in depth and shared collaboratively in the open science ecosystem, especially in developing regions, where access and application of advanced technology may face additional barriers due to their context. These collective initiatives not only improve the quality and accessibility of science, but also strengthen the integrity and relevance of scientific publications in a changing global context.

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METADATA QUALITY AND VALIDATION FOR OPEN ACCESS SCHOLARLY REVIEWS

Dagoberto Salas
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Introduction

The quality of metadata in scientific journals is essential to ensure the visibility, accessibility and effective retrieval of scholarly information. Metadata are structured descriptions that allow the identification and organization of digital content -such as scientific articles-, facilitating their search and retrieval in databases and indexing systems.

Proper metadata management improves visibility and access; it also ensures that articles are easily found by researchers and academics. Metadata is essential for organizing and retrieving information, which increases the visibility of journals in platforms such as Open Journal Systems (OJS) (CAICYT-CONICET, 2023). This is crucial in an academic environment, where quick access to relevant information can influence the impact and citations of a publication.

For regulatory and standards compliance, the use of standards such as Dublin Core is vital to ensure that metadata is consistent and accurate. Journals should ensure that their metadata complies with these standards to facilitate their integration into indexing systems such as Dialnet and OpenAIRE (Pantaleo, 2024). This not only improves the quality of the information presented, but also ensures that it is interoperable with other systems, thus increasing its scope.

Tools such as MetaMetrics allow publishers to continuously validate and correct by evaluating the quality of post-publication metadata, identifying errors and areas for improvement (Flores Chávez, 2023b). This continuous evaluation is essential to maintain the integrity of the records, avoiding problems that may result in rejections by indexing systems. The ability to correct errors quickly contributes to greater efficiency in the editorial process.

The quality of metadata also influences the impact of academic research, in bibliometric analysis and bibliographic description. A correct application of standards allows for more precise analyses of the impact of publications (Flores Chávez, 2023b). In addition, greater precision in metadata can translate into an increase in the number of citations, which is a key indicator of academic impact.

Methodology

In this work, the descriptive methodology is used to define the operation of three metadata validators that will improve the quality of records in open access journals, mainly those that use OJS (Open Journal System). The systems to be described are:

- MetaMetrics, by Biblat
- Proof of quality, from Dialnet
- Validator service, from OpenAIRE|provide (OpenAIRE Validator)

The validators are selected to work with Dublin Core metadata, provided by the OAI-PMH protocol, which normally all journals implemented in OJS are enabled by default.

Development

Biblat MetaMetrics

Biblat is a specialized platform that generates bibliometric indicators and frequencies from the CLASE (Latin American Citations in Social Sciences and Humanities) and PERIÓDICA (Index of Latin American Journals in

Science) databases. This portal is designed to provide information on the characteristics of scientific production in Latin America and the Caribbean, published in academic journals of the region (Flores Chávez, 2023b). To meet this objective, Biblat gathers and organizes data from CLASE and PERIÓDICA, bibliographic databases that contain an extensive and diverse representation of academic journals from Latin America and the Caribbean (more than 3,000 journals and more than 700,000 bibliographic records in total). Both databases have a multidisciplinary approach, covering all areas of knowledge

Biblat offers the following services:

1. Bibliographic references of articles and documents published in more than 3,000 titles indexed in CLASE and PERIÓDICA, through basic and advanced search options.
2. Access to the full text of articles published in open access journals. Biblat offers two types of access to the full text: through hypertext links to the journals' websites (external resources) and through the digital collection of the Latin American Virtual Newspaper Library of the General Directorate of Libraries and Digital Information Services (DGBSDI), belonging to the National Autonomous University of Mexico (UNAM).
3. Frequencies and bibliometric indicators extracted from journals indexed in CLASE and PERIÓDICA, in SciELO collections, as well as from other sources of information.
4. The criteria for selecting journals for indexing in CLASE and PERIÓDICA, Biblat's main sources of information, are described.

MetaMetrics is an interactive data visualization system that generates analytical reports on the quality of metadata in scientific publications. Its evaluation methodology is based on three fundamental characteristics identified through previous research: sufficiency, precision and consistency (Flores Chávez, 2023b). The tool executes an article-level metadata validation process in journals that use the OJS platform. Its methodological framework is based on the Manual de indización en OJS: Buenas prácticas para la región latinoamericana (Flores Chávez, 2023a), a document that establishes standardized guidelines for the management of scientific publications in Latin America and the Caribbean.

The validation implemented by MetaMetrics encompasses three fundamental dimensions of analysis (see Figure 1):

1. Sufficiency. Evaluates the integrity of the bibliographic records, contemplating both the metadata of the journal and of each individual document. This criterion includes the verification of the authors' institutional information, ensuring the completeness of essential data.
2. Consistency. It examines the conformity of the metadata with the regulations established in the OJS Indexing Manual: Best Practices for the Latin American Region. This evaluation comprises three aspects:
   - Spelling rules
   - Syntax (data structure, type and format)
   - Semantics (adherence to predefined values in specific fields)
3. Accuracy. Verify the accuracy and functionality of the data by:
   - Correspondence between journal data and ISSN portal records.
   - Appropriate specification of publication languages.
   - Verification of the correct resolution of persistent identifiers.
   - Testing the functionality of full-text links.

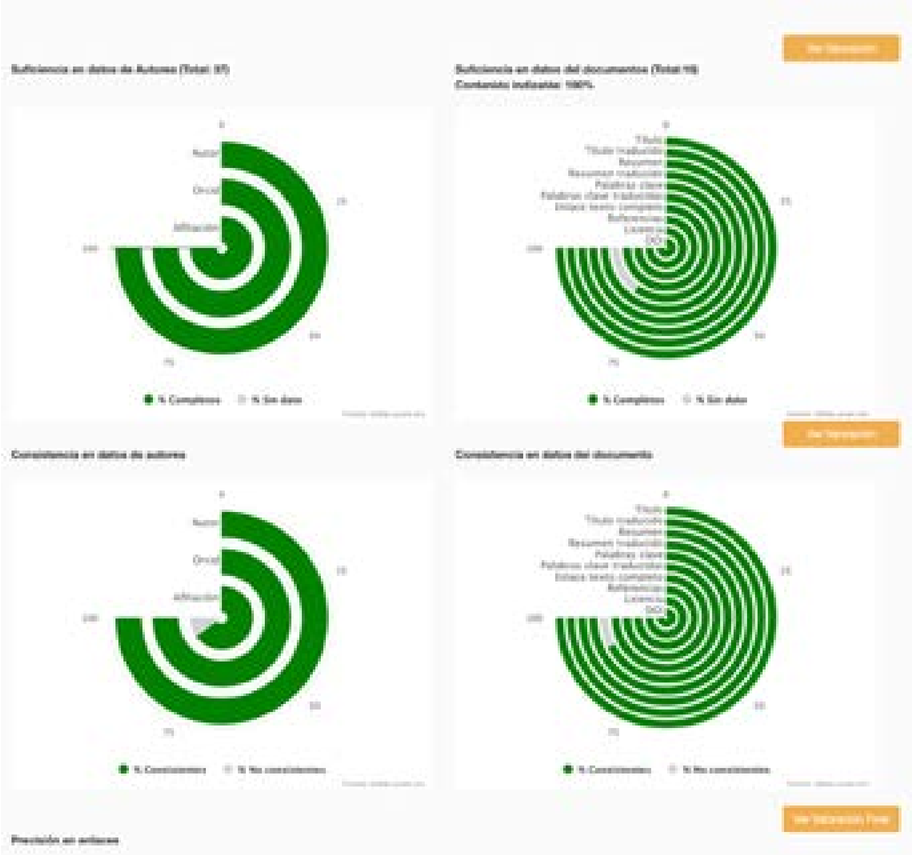
Figure1 . Elements that are considered in the validation of metadata.

Source:https://biblat.unam.mx/en/sobre–metametrics

MetaMetrics is a specialized tool that identifies and analyzes cataloging and indexing errors in OJS records. To perform the evaluation of your publication, you can access through the following institutional link: https://biblat.unam.mx/en/metametrics

The validation process is performed by analyzing the URL of the Open Archival Identifier (OAI) of the periodical. The evaluation considers two temporal dimensions: the three most recent issues and a historical sample covering up to eleven retrospective years. The results are graphically represented by visualizing the three fundamental evaluation criteria: sufficiency, consistency and accuracy. These parameters provide a comprehensive assessment of the quality and thoroughness of the publication (see Figures 2 and 3).

Figure2 . Graphs resulting from the sufficiency and consistency assessment.



Source: MetaMetrics

Figure 3 . Plots resulting from the accuracy evaluation.

Source: MetaMetrics

The results derived from the validation of the metadata quality of your publication constitute a valuable tool for continuous improvement, regardless of your intention to be indexed in Biblat. MetaMetrics is positioned as an evaluation tool that identifies specific areas of opportunity related to metadata quality. Its usefulness transcends the single evaluation, since it can be implemented as a systematic verification tool for each new issue published, allowing the quality standards of the journal to be maintained and raised in a consistent manner.

Dialnet

Dialnet emerged in 1999 as a joint initiative of the Library and the Computer Service of the University of La Rioja (Dialnet, 2020). Although its initial purpose was focused on issuing information alerts on the contents of scientific journals, it has now become consolidated as one of the most relevant bibliographic portals worldwide, with special emphasis on the dissemination and visibility of Hispanic scientific literature.

This system has positioned itself as a fundamental tool for the retrieval of quality academic information, with particular strength in the areas of human, legal and social sciences. As a collaborative project, Dialnet integrates various documentary resources and services including:

- Hispanic scientific content database
- Bibliographic alert system
- Virtual Newspaper Library
- Repository for full-text access to Hispanic scientific literature

Adhering to the principles of the Open Access movement, Dialnet maintains a firm commitment to free and open access to scientific knowledge, facilitating the democratization of academic information in the Spanish-speaking world. Its fundamental mission focuses on promoting the dissemination, visibility and accessibility of Hispanic scientific production, prioritizing the paradigm of free access to academic knowledge. As an inclusive collaborative library project, Dialnet maintains an open-door policy for the participation of library institutions that share its vision. This collaborative initiative has as its fundamental purpose the optimization of resources and high quality services, benefiting multiple actors of the academic ecosystem:

- End users
- Participating libraries

- Academic Authors
- Editors of scientific publications

In its current phase of development, Dialnet has established specific technical priorities:

- Preferential incorporation of journals managed by OJS.
- The implementation of the OAI-PMH protocol (Open Archives Initiative-Protocol for Metadata Harvesting) for the efficient transmission of metadata in digital environments.

Dialnet Quality Check

The Quality Checker is a tool developed by Dialnet to verify the completeness and accuracy of the exposed metadata, through the OAI protocol. This validation tool thoroughly examines the completeness of the metadata entered in OJS. The implementation of this tool arose in response to the significant increase in electronic publications and the systematic detection of inconsistencies in the metadata record, which frequently presented deficiencies or were incomplete. As a preventive measure, Dialnet makes this verification resource available to publishers, allowing them to validate the quality of their metadata before starting the indexing process on its platform.

The validation procedure comprises the following steps:

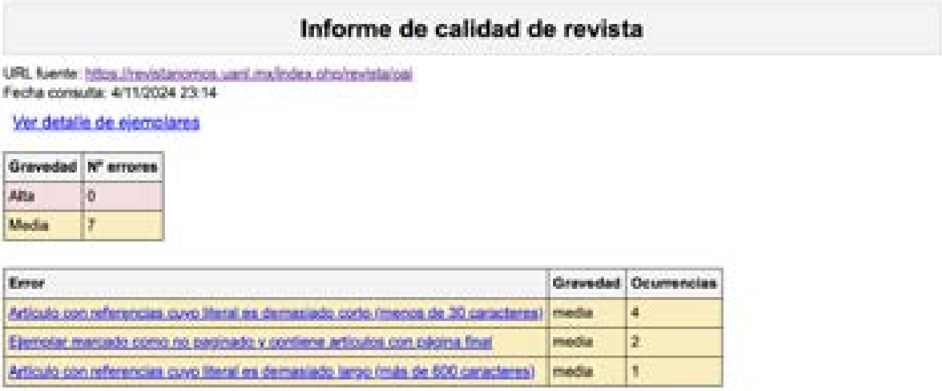
1. Pre-registration of an account in Dialnet
2. Access to the report request form through the link: (Dialnet, 2020)
3. Insertion of the journal's OAI URL
4. Automatic information processing
5. Receipt of the validation report via email

This automated process generates, in a matter of seconds, a detailed analysis that is sent directly to the requesting user's email. Unlike MetaMetrics, this validator focuses specifically on verifying the presence of information in the metadata fields, without evaluating the quality or accuracy of the data entered. Nevertheless, it is an effective tool for ensuring the completeness of bibliographic records.

The validation report categorizes the detected incidents into three levels of severity (see figures 4 and 5):

1. High severity errors (marked in red):
   - They require mandatory correction for indexing in Dialnet.
   - Its resolution is essential, even for journals with no intention of indexing.
   - They represent critical omissions or errors in the metadata.
2. Errors of medium severity (marked in light yellow):
   - Require review for possible inconsistencies.
   - They include cases such as:
     - Unusually short surnames.
     - Bibliographic references of atypical length.
   - They may constitute false positives that require manual verification.
3. Errors of low severity:
   - Subject to editorial consideration.
   - They may reflect legitimate particularities of the publication.
   - Their omission is at the editor's discretion, depending on the specific characteristics of the magazine.

Figure 4 . General Dianet Quality Proofing Report



Informe de calidad de revista

URL fuente: https://revistanomos.uanl.mx/index.php/revista/oai
Fecha consulta: 4/11/2024 23:14

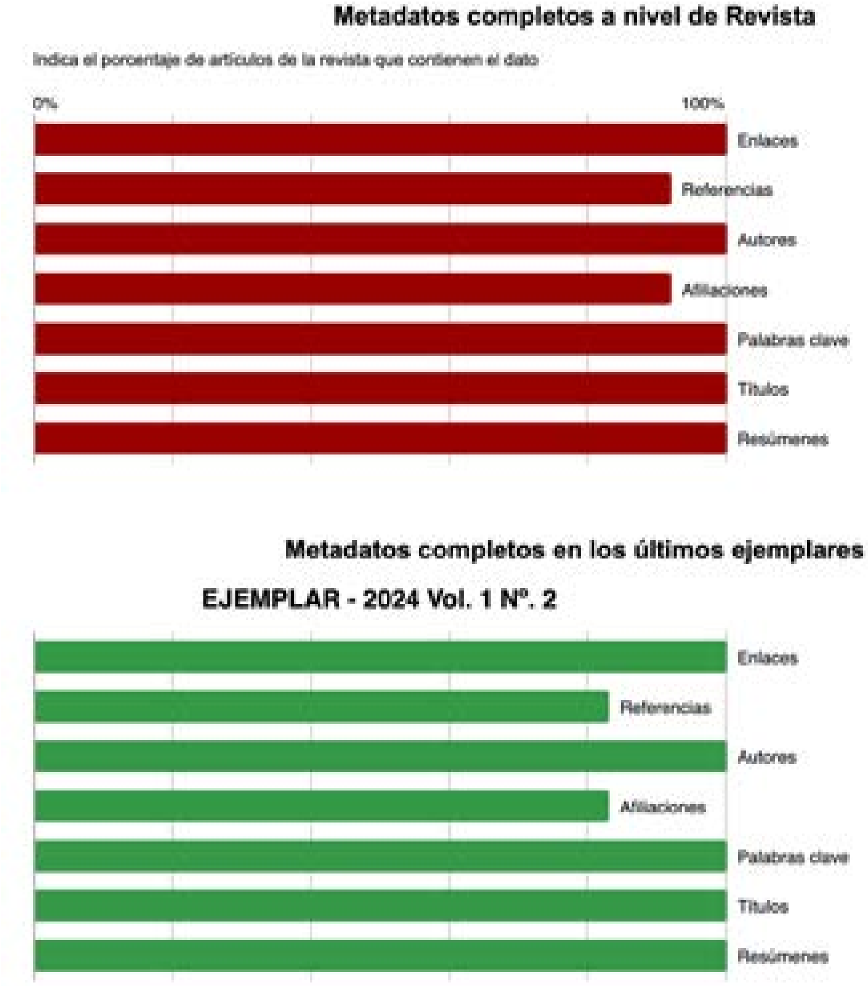
Ver detalle de ejemplares

Gravedad	Nº errores
Alta	0
Media	7

Error	Gravedad	Ocurrencias
Artículo con referencias cuyo literal es demasiado corto (menos de 30 caracteres)	media	4
Ejemplar marcado como no paginado y contiene artículos con página final	media	2
Artículo con referencias cuyo literal es demasiado largo (más de 600 caracteres)	media	1

Source: Dialnet

Figure5 . Example of Dialnet Quality Proof Report



Source: Dialnet

OpenAIRE PROVIDE Validator Service

OpenAIRE PROVIDE is the OpenAIRE content access service, a platform that facilitates the integration of academic content with the OpenAIRE ecosystem and the European Open Science Cloud (EOSC). This service makes diverse scholarly resources - including repositories, data archives, scientific journals, aggregators and CRIS systems - accessible to a wide range of users, from researchers and research centers, to funding agencies, policy makers and citizens (OpenAIRE, n.d.). The platform distinguishes itself by minimizing technological barriers through multiple integration options, providing a visual interface to access OpenAIRE data collection services. The integration process is developed in four fundamental phases:

1. Validation. Evaluation of data sources using the OpenAIRE Validator to ensure compliance with established guidelines.
2. Registration. Incorporation of data sources into OpenAIRE and associated global networks, facilitating:
   a. Text and data mining links
   b. Viewing validation history
   c. Collection status monitoring
3. Enrichment. Optimization of descriptive metadata of data sources using the OpenAIRE Broker, including:
   d. Notification subscription system
   e. Metadata update and enhancement
   f. Content refinement
4. Statistical analysis. Implementation of the OpenAIRE Usage Counts service for:
   g. Generate aggregated usage statistics
   h. Provide COUNTER-compliant metrics
   i. Monitor metadata views and full-text downloads
   j. Evaluating the impact of open research

This comprehensive system facilitates the democratization of scientific knowledge and strengthens the European open science infrastructure.

OpenAIREValidator

The OpenAIREValidator tool performs systematic checks on two fundamental levels: the implementation of the OAI-PMH protocol and the conformity of metadata with specific established schemes. This tool is based on a rule-based system that incorporates an administration panel, allowing users to configure both individual validation rules and sets of rules that implement the established guidelines

The OpenAIRE validation service facilitates the assessment of compatibility between data sources and OpenAIRE guidelines. Once validation is successful, the data source can be registered for aggregation and periodic indexing in the OpenAIRE system, ensuring effective integration of resources into the open science infrastructure. This reformulation maintains technical accuracy while improving the clarity and flow of the text, using more formal and structured language that is appropriate for an academic context (OpenAIRE, n.d.) .

To validate the metadata of a journal, the first step is to have an OpenAire account (https://www.openaire.eu/) and then log in to the OpenAIRE PROVIDE dashboard, which basically has two services: register (journal, repository, etc.) and validate (see Figure 6).

Figure 6 . OpenAIRE|PROVIDE menu

Source: OpenAIRE

Metadata validation process in OpenAIRE

Metadata validation of a scientific journal requires, as an initial step, the creation of an account on the OpenAIRE platform (https://www.openaire.eu/). Subsequently, the OpenAIRE PROVIDE control panel, which offers two main functionalities, must be accessed.

For the registration process, it is strongly recommended to begin with the journal registration before proceeding to validation. This procedure not only allows the incorporation of metadata into the OpenAIRE database, but also provides access to a control panel with detailed statistical information on the publication. The registration process is characterized by its simplicity: simply select the "JOURNAL" category and complete the information requested in the corresponding form

To initiate validation, these specific steps must be followed:

1. Select the "Literature repository" option, which is the most appropriate category for periodicals.
2. Identify the journal in the directory of registered publications. Although there is the possibility of registering a new publication during this process, prior registration is recommended to optimize the use of the statistical functionalities and to guarantee the availability of the metadata in the OpenAIRE database.
3. Select the OpenAIRE version. The system presents multiple version options (see figure 7). It is recommended to opt for:
   - The most recent version available
   - The specific version of the OpenAIRE plug-in implemented in the journal's OJS system.

Figure 7 . OpenAIRE version selection

Source: OpenAIRE

Once the identification of the journal in the system has been completed, the platform will request the specification of the sets that will be submitted to the validation process. The sets correspond basically to the sections configured in the journal's OJS system (see Figure 8)

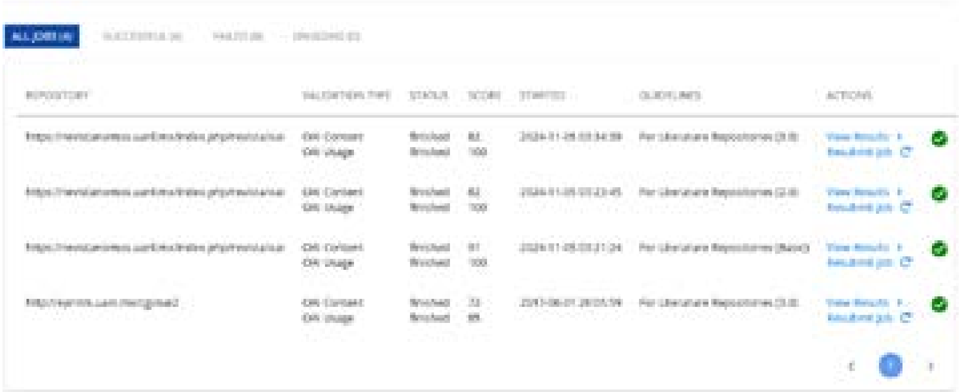
For a comprehensive validation, it is recommended to select the "All sets" option, which guarantees a comprehensive evaluation of all sections of the publication. This comprehensive approach ensures the correct implementation of the metadata standards in the entire journal structure.

Figure 8 . Journal OAI set selection.

Source: OpenAIRE

At the conclusion of the validation process, the system offers two complementary mechanisms for accessing the results. First, it generates an automatic e-mail notification containing the detailed report. Additionally, it provides immediate access through the "Validation History" section, where a chronological record of all validations performed is maintained (see Figure 9).

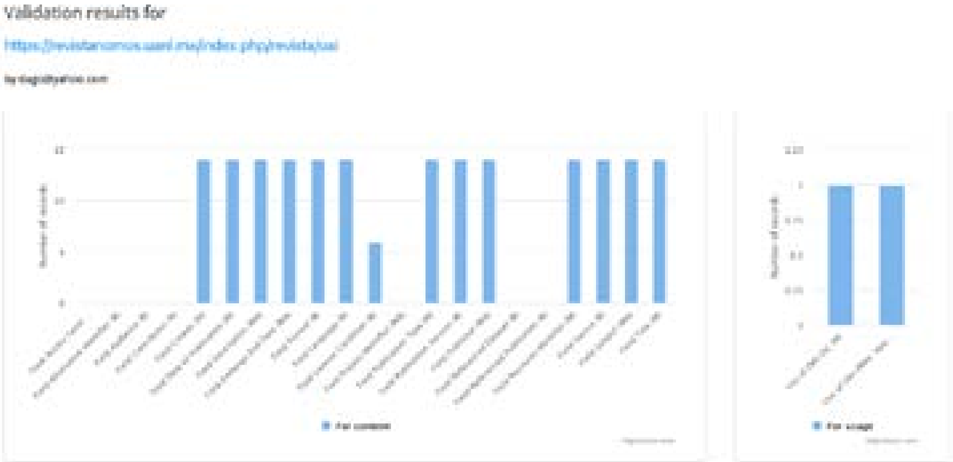
Figure 9 . Results of validations in ValidatorOpenAIRE



Source: OpenAIRE

To examine the specific results, the user must select the "View Results" option. This action displays a preliminary analysis that covers the fundamental elements of the OpenAIRE guide for content, the implementation of the OAI protocol and compliance with the Dublin Core standard (see figure 10).

Figure10 . General summary of ValidatorOpenAIRE results.



Source: OpenAIRE

Interpretation of the assessment. The system presents a detailed breakdown comprising various evaluation elements. Each aspect analyzed includes the validation rules applied, accompanied by a specific description of the criterion evaluated. A numerical score is also assigned and the number of records affected by each rule is counted. To facilitate the interpretation of compliance status, the system implements an intuitive color code. Elements marked in green indicate rules that have been satisfactorily complied with. Those marked in yellow represent warnings that require attention, while those marked in red identify errors that require immediate correction (see figure 11).

Figure 11 . Detailed results of the ValidatorOpenAIRE

RULE NAME	RULE DESCRIPTION	RULE WEIGHT	# OF RECORDS	STATUS
Field Access Level (M)	Use terms from the info:eu-repo-Access-Terms vocabulary. View guideline	5	0/14	View Errors
Field Alternative Identifier (R)	List alternative identifiers for this publication that are not the primary identifier (repository splash page), e.g. the DOI of publisher's version, the PubMed/arXiv ID. View guideline	5	0/14	View Warnings
Field Audience (R)	A class of entity may be determined by the creator or the publisher or by a third party. View guideline	2	0/14	View Warnings
Field Contributor (R)	Examples of contributors are: a supervisor, editor, technician or data collector. The DC element "contributor" describes the scientist(s) that has/have made contributions to the given scientific output, not as a primary creator or (commercial) publisher.) View guideline	2	0/14	View Warnings
Field Creator (M)	Use inverted name, so the syntax will be the following: "surname", "initials" ("first name") "prefix". View guideline	4	14/14	

Source: OpenAIRE

The system presents each evaluation criterion in separate rows, where each row includes a detailed description of the rule applied and a link to the complete guide documentation. In cases where errors or warnings are detected, the system provides additional links to examine the specific details. When accessing these links, a specific list of records that do not comply with the evaluated criterion is displayed (see Figure 12).

Figure 12 . Elements that present an error in ValidatorOpenAIRE.

Source: OpenAIRE

The implementation of this validation tool represents a fundamental instrument to guarantee the conformity of metadata with European standards for scholarly publishing. The use of the OpenAIRE plugin for OJS, which facilitates the automated conversion of metadata to the format required by OpenAIRE, is strongly recommended.

The adoption of these standards offers significant benefits for scholarly journals. Primarily, it ensures the journal's international visibility through the OpenAIRE infrastructure; while simultaneously strengthening its academic standing through compliance with recognized international standards. This adherence to rigorous standards not only improves the accessibility of the journal, but also contributes to its credibility and relevance in the global academic arena.

Conclusions

The rigorous management of metadata has become critically important in the current ecosystem of scientific publications, since these informative elements are fundamental for the interoperability of various digital identifiers. Metadata forms the structural basis of identifiers such as DOI (Digital Object Identifier) and ORCID (Open Researcher and Contributor ID), facilitating the accurate identification and retrieval of scholarly content and authorship.

The implementation of specialized tools such as MetaMetrics, Dialnet's Quality Checker and OpenAIRE's Validator Service provides a systematic framework to ensure:

- Completeness of bibliographic records.
- Accuracy in data entry.
- Optimal visibility in academic information systems.

These validation tools represent a significant advance in metadata quality control, facilitating the systematic supervision of bibliographic information, compliance with international standards, optimization of indexing processes and efficient integration with academic content aggregator systems.

In conclusion, the implementation of a robust metadata control system is a fundamental practice that strengthens both the quality and transparency of scientific publications. This meticulous management not only improves the visibility of academic production, but also contributes significantly to the integrity and accessibility of scientific knowledge in the digital environment.

Metadata quality is a critical component for the success and sustainability of scientific journals. Ensuring that this data is complete, accurate and compliant with established standards not only improves the visibility and accessibility of content, but also enhances scholarly credibility and facilitates better knowledge management. The tools available to evaluate and improve the quality of metadata, such as MetaMetrics, Dialnet's quality validator, or OpenAIRE's Validator, are valuable resources for publishers in academia to ensure the quality of their journals.

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PARTICIPATORY SCIENCE OUTREACH: BUILDING LEARNING COMMUNITIES

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Introduction

We live in a network society. When any relevant event occurs, be it political, artistic, sporting or scientific, memes start circulating in a matter of minutes on platforms such as Instagram, Facebook and WhatsApp. Their humor amuses us and motivates us to share, flooding much of our lives. But memes go beyond funny images or videos that are endlessly reproduced on the Internet, they are an example of the power of ideas. The concept was born with the biologist Richard Dawkins, in his book The Selfish Gene, as a parallel with the biological world.

Genes carry the characteristics of an organism, provide it with conditions to compete with other living beings and try to prevail and reproduce. For Dawkins, competition in evolution does not take place between living beings, but between the genes that shape them. Similarly, a meme is an idea that gets into someone's head and, if it is successful, the person shares it with others who, in turn, reproduce it again. This behavior is as old as humanity itself, but it has accelerated with the advent of the Internet and social networks.

Thus, someone can share an image that is loved by many people who, in turn, replicate it and multiply its reach. This is similar to what happens with a virus that infects someone: it hijacks the "machinery" of their cells and begins to create copies of itself that can infect more individuals. That is why we talk about viralization and the danger of this multiplication is that the information carried by a meme does not have to be true: it is enough that it seduces enough people for it to go around the world.

Disinfodemia and the challenge of lifelong education in the face of constant change

During the COVID-19 pandemic, misleading information circulated globally that put the health of the population at risk and even cost thousands of lives. False information circulated on the Internet with the deliberate purpose of misleading people is called "disinfodemia". To combat it, some international organizations have undertaken actions, such as campaigns focused on developing counter-narratives that lead people to question the content of such news.

Critical reflection on what we see and hear is a key point to take a position on issues that involve decision making. This not only occurs in crisis contexts, the dynamics of the world in which we live means that we face constant changes for which we must be prepared. Every day we must make decisions in which knowledge plays a fundamental role: it is not that science is going to choose for us, but that it provides us with elements to exercise informed judgment.

Education contributes to the formation of critical citizens, through the promotion of spaces for conversation and reflection on topics such as health, wellbeing, technological progress, among others. These spaces can be promoted in different areas of education (formal, non-formal and informal), making information reach more people. Museums and interactive science and technology centers are examples of such spaces; there, visitors can participate in activities in a variety of formats (thematic exhibitions, workshops, demonstrations, etcetera) where they are invited to exercise critical and reflective thinking through the slogans proposed.

These spaces are wonderful to bring the public closer to science, as a way to understand the world, but, unfortunately, not everyone has access to them. On the other hand, the pandemic made it evident that many people are more exposed to sources of distorted or false information, especially on social networks, than to spaces that offer them a verifiable overview of the topic being addressed.

Equity in scientific training

Reducing existing gaps (opportunity, gender, digital, among others) is a key point in all projects aimed at improving people's education. Achieving equity should be the first goal of educational policies, promoting spaces for the most disadvantaged communities to feel part of the knowledge society. The latter encompasses all areas of human activity, particularly science and technology, where information is advancing by leaps and bounds. Many people do not have the necessary tools to understand its scope. An example of the latter is the exponential advance in the area of Artificial Intelligence.

Inequality means that not all people have the necessary means to receive a quality science education. Some limitations are due to the shortcomings of the educational institutions themselves (lack of infrastructure, teaching resources and human capital, among others). Other people do not even have the possibility of attending a formal educational institution throughout their lives. Nor do they have the opportunity to visit non-formal educational spaces where scientific and technological knowledge is disseminated.

We understand that an equitable scientific training is one in which all people enjoy access to the resources for the educational act to take place. It is accessible and adapted to their contexts. It is co-constructed as part of the culture and takes into account people's interests and needs. Therefore, any effort made to promote the approach of people to museums and science education centers will surely benefit the reduction of existing gaps.

People in vulnerable situations

According to Pizarro (2001), the concept of social vulnerability has two explanatory components. On the one hand, there is the insecurity and defenselessness experienced by communities, families and individuals in their living conditions as a result of the impact caused by some type of traumatic economic-social event. The other is the management of resources and strategies used by communities, families and individuals to cope with the effects of this event.

Among the groups in vulnerable situations is a segment that has gained special importance in recent decades: migrants. These people are generally displaced by political, economic and social crises in their countries of origin. They are often motivated to migrate in search of better job opportunities in other countries.

Latin America is the region that currently registers the largest migratory flows in the world, and the movements will continue. According to World Bank specialists, openness to the changes this entails is necessary. The perception of migrants must change in order for them to be able to integrate into the host population. A positive interaction between a migrant and a local will help to change the idea that one has of the other. Involving the migrant population in scientific outreach initiatives could be a way to make them feel welcome. Sharing information about scientists from different countries, their areas of research, their developments, among others, would be a way to bring cultures closer. This, at the same time, would enable people to come into contact with the scientific advances of the countries.

Modalities of education: formal, non-formal and random (informal)

In this paper we approach the concept of education from a broad perspective: the set of processes that allow us to build knowledge about our reality and develop skills to face the challenges in our environment. It is not something that begins and ends with school, although it represents a very relevant part, but permeates all aspects of life.

Pastor Homs (2001) details the historical path that led to the distinction between three educational modalities: informal, non-formal and formal. It should be noted that, although in linguistic terms the first two terms are equivalent, in education there is a clear difference between these concepts. In the following, we will seek to clearly establish the conceptual framework of the modalities of education.

To begin with, we must recognize that, even without any preparation or planning, our daily experiences provide us with learning: from burning ourselves by touching a hot object on the stove, to getting used to handling a new application on our cell phone, apparently trivial experiences help us become familiar with reality. Informal education is the modality that includes the endless amount of learning that occurs by chance, by accident, by imitating the behavior of the people around us or by "trial and error". It can be said that it is an educational modality that occurs from the beginning to the end of our lives, providing elements that give meaning to everything we can learn in the other two.

Secondly, the set of efforts planned to try to make us learn something comes into play: it can be our parents, teaching us to go to the bathroom; the road authorities, trying to make us respect speed limits when driving, or Coca-Cola, convincing us that it sells the spark of life (I mean, not everything is for the forces of good). Ah, but you can't miss the work of museums, magazines or even social media channels, which seek to help people get interested and learn about different topics. It is precisely here where the work of science popularization comes into play, as an effort to bring the non-specialized public closer to science and technology. Non-formal education contemplates organized and systematic activities that are carried out with the objective of facilitating learning among specific groups of the population (Unesco cited by Pastor Homs, 2001). The key here is that someone must have planned a educational process that seeks to involve people, with no prerequisites for accessing a particular process. No channel asks you to prove that you watched a previous YouTube video in order to access the newest one.

Finally, we find the most visible of the three modalities: formal education. This is what we find in schools: an institutionalized system, with a chronological sequence and hierarchical structure. There is background support from government agencies that certify school work, with grades that must be taken in a specific order and that lead to access to different levels (preschool, primary, secondary, high school, college, university).

Educational analysis gives enormous relevance to formal processes, but this neglects the fact that we spend most of our lives outside of school and that the things we see there make little sense without the support of everyday experiences linked to informal education. Ideally, there should be a strong complement between the three modalities of education, to give strength to what is learned in each and to prepare people for lifelong learning. For clarity, here is an example:

We get out of the bath and, while we are still wet, the sensation of cold on our skin is noticeable. As soon as we pass the towel over our body, removing the water, the heat loss phenomenon disappears and we no longer feel "cold". We have all experienced this, it is something we know empirically, but few people investigate to find out what happens. Water molecules, like those of all substances, are in constant motion: the more they move, the higher their temperature. But not all of them have the same energy; there are small variations from one to another. The air around them is also in constant motion and collides with the surface of the water. When an air molecule hits a water molecule, it transfers energy to it, which makes it move faster; in some cases this is enough for it to detach from the water and jump into the air (evaporate). The key here is that the molecules that leave are the ones with the most energy: the hottest water evaporates, leaving the one with the lowest temperature. This is why we feel cold when our skin is wet.

Here we can find a simple example of the crossover that people need to understand situations in their lives. There is an experience that no one planned, but that can stimulate our curiosity or demand some understanding to solve a problem. School gives us the basis for understanding concepts such as temperature, energy, molecules and evaporation, but does not necessarily articulate them for such specific things. There are situations, such as a museum exhibit, a recreational workshop, a YouTube video, or the chapter in your hands, where someone plans a strategy to help us understand the topic at hand. In order for people to gain an understanding of their reality, on different topics and levels, it is important to articulate the three modalities of education.

And in the field of science and technology, with the need to prepare people for a world in which the only constant is change, the relevance of public communication of science as an agent of non-formal education is growing.

Public communication of science and technology

The progress of modern science achieves ever deeper knowledge about the phenomena around us and, therefore, in order to establish efficient communication between experts in a field, very specialized codes that are incomprehensible to most people have been established. What is gained to facilitate dissemination (communication between colleagues in a discipline) is lost to the rest of the people.

Here appears the need for public communication of science and technology (PCST), which includes what is also known as outreach, to recontextualize different aspects of science and technology so that they are relevant to specific social sectors. This implies selecting, redirecting and adapting knowledge produced in the specialized field to fulfill different functions for a particular community (Alcíbar, 2004).

Disseminating science requires a communication process in which the main focus is on the sector of the public to which we are going to address. This is the first thing we must take into account. There is no such thing as the general public (Burns et al., 2003); wanting to be suitable for everyone means not being suitable for anyone. Once we are clear about who we are targeting, we can establish objectives to outline strategies that contemplate the issues we wish to address, the form of participation and the narratives we will try to build with the public.

Over the last forty years, PCST has become a truly dual field: with a practical dimension dedicated to bringing science closer to the non-specialized public and an analytical component that studies the processes of the former. The ideal is to achieve a balance between both parts (Tonda, 2008), in which they feed back on each other to advance in tandem. It makes no sense to address one without the other.

As a basis for our approach to outreach, we present a brief description of the main models that characterize its practice. It should be noted that this is not a sharp distinction , but rather general schemes in the face of a reality that often presents different degrees of amalgamation among them (Lewenstein, 2011).

The deficit model characterizes initiatives that have the premise that the problems surrounding science arise from ignorance, so if we manage to correct that, there will be a better acceptance that will benefit everyone (Bubela et al., 2009). It assumes a cognitive gap between the experts who dominate the subject and the public, as a passive recipient of information; thus, the process ends up being linear and unidirectional, with the scientific side defining what is said and how it is approached. In the face of criticism of this first vision, a new perspective emerged, much more horizontal for PCST: the contextual, dialogue or interactive model. Here, the importance of the public's contribution to the process is recognized, providing feedback to the disseminator with their experiences, interests and needs (Lock, 2011). It is no longer only a question of what is to be discussed from the scientific side; now the participants are taken into account to achieve a much more relevant and meaningful experience.

Finally, with a much more ambitious and complex vision, we find the democratic model (Durant, 1999), which does not focus on people learning about scientific issues, but rather on collectively making decisions to shape their progress. The basic idea is to foster spaces for communication between the different social sectors -including government, researchers, private initiative and civil society- to build a path that responds to social needs.

All this sounds very good, nothing better in a society dominated by advances in science and technology than an active citizenry in the field, with the ability to make informed decisions. The key question is how to achieve this and, although there is no definitive answer, in this document we seek to offer useful references and experiences for those who want to promote valuable outreach initiatives.

Development

It is time to get down to work. However, it is not easy to make the transition from motivation to successful action in science and technology public communication. Once we know the audience we are targeting, the next step is to be clear about the medium we will use for the outreach process and to prepare ourselves to manage it effectively. As in any profession and trade, we must clarify that practice makes perfect: it is necessary to know the theory of what is being done, but only with hundreds or thousands of hours of work is it possible to master the strategies to be developed.

If we assume that we have an adequate command of the chosen medium, we can concentrate on the dissemination process that we are going to promote. Burns et al. (2003) constructed the AEIOU model, as a reference of the reactions we can look for with the activities we carry out. We share with you a tropicalized version in order to preserve the acronym of this proposal:

- Awareness. People learn about the existence of a particular scientific topic that they can learn more about, if they choose to do so. This goes with the view that outreach activities should be voluntary for the public.
- Enjoy. Enjoyment is used as the main axis that motivates audience participation: if they enjoy what they do, they are more likely to stay involved and try to repeat the experience. This promotes a stimulating process, with the production of hormones, such as dopamine and oxytocin, which reinforces the learning of the topics addressed.
- Interest. This consists of motivating participants to find out more information about the subject being discussed. This can be channeled to the same outreach initiative being promoted or left as an incentive to encourage curiosity as a driver of further learning.
- Opinion. A dissemination process should not aim to transmit a specific position to the public, but rather to offer elements so that, with their own criteria, people can define their opinion on the matter. For disseminators this can be especially complicated in life and death situations, such as a pandemic, but we must consider that it is counterproductive to try to impose our vision on people.
- Understand. The last reaction we can look for in the audience is to achieve understanding of the topic being discussed. This implies that it has real meaning for people, i.e., that it is placed in a way that is consistent with their previous experiences and knowledge.

Although the AEIOU model is not explicitly designed to be analyzed as a sequence, in practice we can see that each of the points implies a greater depth in the approach and link with the participants. Thus, the proposal works as a guide to plan the activities we want to carry out: either as a sequence of processes that trigger the different reactions, or as a reference to define the objectives of our outreach initiatives.

Now, this works in the context of independent activities. If we enter into recurrent outreach settings, such as museums, festivals, clubs and other periodic programs, we can consider the six strands that Bell et al. (2009) point out as characteristics of learners in non-formal settings:

1. Experience excitement, interest and motivation to learn about phenomena of the physical and natural world.
2. Generate, understand, remember and use concepts, explanations, arguments, models and facts related to science.
3. They manipulate, test, explore, predict, question, observe and understand the physical and natural world.
4. They reflect on science as a form of knowledge; on scientific processes, concepts and institutions; as well as on their own learning processes about the phenomena around them.
5. Engage in science activities and hands-on learning with others, using scientific language and tools.
6. They think of themselves as science learners and develop an identity as someone who knows science, uses science, and can contribute to science.

Now, together with the already discussed importance of articulating the different educational modalities, it is time to articulate this vision from the non-formal scope of dissemination with strategies that have gained strength in the school environment.

STEAM education and recreational science workshops

STEAM education is a didactic approach that has gained momentum in recent decades in the Latin American region. The origin of STEAM dates back to the 1990s in the United States. It was coined by The National Science Foundation (NSF) and emerged as a movement to promote interest in science, technology, engineering and mathematics careers. At that time, already foresaw that, in the short term, there would not be enough human resources to face the challenges of the future in science and technology.

In the beginning it was called STEM, an acronym for science, technology, engineering and mathematics. Later, in 2006, Georgette Yakman added the arts to this educational approach. The inclusion of the arts is based on the understanding that this area of knowledge imparts sensitivity to problem solving. Today there are new approaches, such as STEAM + H (humanities), which have emerged with the aim of continuing to add areas of knowledge.

Beyond acronyms, this approach promotes the implementation of didactic strategies based on active methodologies, such as problem-based learning, project-based learning and inquiry-based learning (among others). It is constructivist and, therefore, assumes that students construct knowledge accompanied by the teacher, who acts as a guide in the process. It promotes disciplinary integration, teamwork and the development of 21st century skills (scientific thinking, critical thinking, communication, etcetera).

Along with the boom in the implementation of the STEAM approach, the literature reports a growing interest in investigating the benefits of putting it into practice. The benefits of this educational trend focus on the promotion of scientific vocations and the development of certain skills to meet the challenges of a globalized society (Pineda, 2023).

The strategies promoted by the STEAM approach offer certain parallels with the methodology of recreational science workshops developed in Mexico in the 1980s, but has had independent developments in other Latin American countries. The similarities lie in the integration of theory and practice in the activities, so that the experiences of the participants give meaning to the scientific concepts being addressed (García-Guerrero et al., 2020), putting the participants who assume the role of scientists at the centre of the process.

The contrast in approaches arises in their origin and scope of implementation. While STEAM education was born at the NSF level, the workshops emerged as a bottom-up movement, out of the interest of people passionate about engaging the public in science in an accessible and engaging way. Versatile small-scale but high-impact actions, with inexpensive and easily available materials, have led to characterize them as a guerrilla science communication (Garcia-Guerrero and Lewenstein, 2022). The vision was expanded in Mexico with the work of Recreación en cadena, the Mexican Recreational Science Network (García-Guerrero et al., 2022), which developed a manifesto that characterizes recreational science activities based on two major aspects:

1. Three levels of interaction (physical, emotional and intellectual) that develop directly and immediately between the people involved.
2. Discursive recontextualization, relevant to the audience, to build new interpretations of phenomena, concepts, controversies and scientific challenges.

Along with this general vision, the work integrated a range of activities that transcended the workshops to incorporate demonstrations, talks, games and staging. All these dynamics appear as ways of building communities of action, reflection and discussion about science. This involves groups that are built together with the public, but also sets the tone for organizations that promote educational initiatives through recreational science.

The concept of community of practice (Wenger, 1999) appears here, as the collective of people who meet on a constant basis to promote activities around a topic they are passionate about. Communities have three distinctive elements: the domain, which is the topic that attracts their participants and gives meaning to the community (in this case, science and its dissemination); the community, the collective of people with different profiles and degrees of knowledge who enrich each other as they promote their work; and the practice, as a dynamic to develop an aptitude in the field in which they are working. The key here is that the practical work gives meaning and significance to the theoretical elements, while the reflective part guides the action of the participants.

It is the action-reflection duality that gives strength to the work of students in STEAM processes and to participants in recreational science dynamics; and, at the same time, it is the basis for growing communities of educators (formal and non-formal). Thus, great opportunities arise to promote collaborations that help individuals and organizations to take their work much further.

Collaboration networks

According to Sebastián (2000), networks can be understood as incubators of cooperation, where interactions, collaborations and transfers between partners contribute to generating a multitude of products and results, both tangible and intangible. Networks imply the existence of partners (actors or nodes) whose objective is to join efforts to achieve objectives that are common to all. They have the potential to connect people and complement capabilities, among others.

There are specialized networks in the region, such as RedPOP and the EducaSTEAM Network of the Organization of American States (OAS). Both networks have been in existence for many years and involve institutions that seek to collaborate in order to facilitate the achievement of their objectives.

The Network for the Popularization of Science and Technology in Latin America and the Caribbean, known as RedPOP, is an interactive network that brings together groups, programs and centers for the popularization of science and technology (S&T). It operates through regional cooperation mechanisms that favor the exchange, training and use of resources among its members. RedPOP was created in November 1990, in Rio de Janeiro, at the request of UNESCO's Science, Technology and Society Program.

The EducaSTEAM Network of the OAS is a teaching network specialized in sharing knowledge and practices on this educational approach. It provides the teaching community with a space for exchange and different Moocs to deepen their knowledge on specific topics. It was created in 2015 and brings together 400 educational agents in the region.

Both networks generate spaces of connection between knowledge from which society could benefit in order to approach science and technology. In addition, they promote spaces for the exchange of experiences that are open -in different modalities- so that even non-members can take advantage of the discussion.

Conclusions

Those of us who decide to embark on the adventure of science education, both in formal and non-formal ways, always start with a flame of passion to give society the elements needed to navigate a world dominated by science and technology. We do not always know exactly where to start, which leads us to trials and errors that teach us a lot, but are not ideal for promoting our work.

The challenge becomes even greater if we consider that it is a matter of making the road as we go along: with few institutional spaces, and even less support, to try to build bridges between science and society. It is easy to feel alone when promoting science outreach initiatives, especially when it is an area that is just beginning to be valued as much as it deserves. This is why it is key to connect with other people who have faced similar challenges, to take advantage of existing experiences and theoretical references that serve as a basis for a better prepared work. We have shown you the cases of RedPOP, Recreación en cadena and Educa STEAM, but there are many other options that you can join.

In this chapter we have tried to share basic references to understand what we do from science outreach and education, as well as some ways to launch ourselves to detonate processes that bring the public closer to relevant discussions on science and technology. They are a useful starting point, but only practice gives them meaning to build a feedback that helps to develop the necessary talent to communicate science in an adequate way with the different sectors of society.

We must not forget that it is not only about having knowledge about the science we are going to address and how to discuss it with the audience (as if these two things were not enough); we must also master the skills to develop the activities with the audience, read their reactions, modulate the voice, have a good body management, make an active listening, adapt the language to different specific contexts and many more elements. No matter how much we read, watch tutorials or attend courses, the only way to master these arts is through practice.

So, disseminators of all countries, join the action. Join the path of participatory science and communities of practice, to come back with your experiences, which will help us all continue to grow. It's a long but fun road, it moves us all forward and, hopefully, will help us to be better prepared for the next global emergency.

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FREE SOFTWARE SEEKS OPEN SCIENCE

Daniel Viñar Ulriksen

We primates have a cognitive bias (which is why scientists must distrust ourselves) and, perhaps for this reason, in many fields, such as politics or economics, notoriety and trust are particularly important. And this, at least, influences scientific activity on a daily basis. We rigorously apply scientific methodology to our actual research, but we constantly consider that we live "on the shoulders of giants". We trust that the laboratory reagents we buy are what they claim to be, that the information we collect is what it claims to be and corresponds to our research; we rarely study and verify the scientific theories and technological achievements that support the benefits provided by sophisticated experimental equipment. We often act as if the whole world were the shoulders of these giants, conforming to the standards of science and, with them, the countless scientific-technological products and services available. Among them is software.

We consider software as a product, often even as a commodity, and not as an integral part of our methodology, techniques and research tools. We evaluate and select it, not by scientific methodology, but with the usual criteria of a consumer: notoriety, trust in the brand, quality, usability or simply availability. I believe that this is the point of conceptual articulation that should be (re)established. We must place software under the magisterium of science, not consider it as an innocuous element, because it conforms to the hegemonic imaginary order. From the initial reference to scientific methodology, I could well have deduced that science is, by essence, Open Science (OS). By construction, science is the opposite of obscurantism, be it witchcraft, alchemy, or any discipline that does not proceed by that methodology of establishing its concepts on the basis of evidence debated and agreed upon in a broad and open community.

Then, to make the link with free software, I would have quoted (like most of the literature on the subject in its introduction) its definition by the four freedoms it must fulfill:

1. the freedom to run the software for any purpose,
2. the freedom to study how the software works, which requires access to the source code,[11]
3. the freedom to make modifications to the software to suit other needs,
4. the freedom to re-distribute the software and its modifications to help others,

and verify that only these allow the application of the scientific methodology stated, thus validating, scientifically, the result of the information processing performed by the software in question. And that proprietary software (that which does not comply with any of these freedoms), on the contrary, hinders or prevents this peer validation, as well as the consensus on the evidence required by a scientific object. In the article Free Software, Free Science (Viñar Ulriksen, 2022) I tried to discuss why science should use and produce free software, and how the experience of free software can inspire practices in OS. But here the objective is different. It is to contribute to a manual that seeks to help researchers in the global South to do OS and for that, in this chapter, why and how to adopt and produce free software.

If what we have just stated - that only free software suits science - is true, and that we consider scientists to be particularly committed to its

11 The source code of a software is its version as elaborated by the developer. It is usually not included in the distribution of proprietary software, delivering only the binary or executable file, which is sufficient for the computer, but insufficient for human understanding. Beyond the legal and juridical scope of its license, the availability of the source code is the main practical characteristic of a free software.

methodological principles, we should use, if not exclusively, then essentially free software in academia. So this article will discuss how to do it better, how to link scientific teams and FOSS development and maintenance communities, how to integrate computer developers into projects in other disciplines and get them to fulfill their roles in the project, while contributing to the global pool of FOSS available to humanity.

Undoubtedly, the panorama has become more complex in the last two decades, articulated with the generalization of the problem of access and rights over all intangible production (scientific literature and databases, in particular for research), as well as cloud computing, in which software as a service (SaaS) is accessed remotely, and today, rapidly, Artificial Intelligence (AI). But that complexity can make sense of things, as it is put to the service of the emerging concept of OS. Twenty years ago, for a non-specialist, adopting free software was undoubtedly an act of faith, an arduous path, probably with more unforeseen difficulties than fulfilled promises. Today, with understanding and care, it can be a powerful way to do better science, to ensure that each step and component can be concretely validated, following a scientific peer-review methodology.

In trying to think about freedom, Miguel Benasayag (1996) argues that freedom does not lie in sacrificing oneself for a grand and free future, but in holding on to the threads of freedom that we come across in the present. And perhaps this is today the best possible attitude for a scientist who adheres to what we argue here about OS and free software: not to stop pursuing their own objectives, nor to take the mandate of software freedom as a dogma, but to seek the understanding and perseverance that will allow them to never give up the freedom of software (and of knowledge in general) where it is crucial to their scientific work, nor to hide the eventual black boxes that still "support" their work (that is, the elements of methods, processes, software, techniques, equipment, materials or other that have not been subjected to an exercise of peer review, allowing the reproducibility or refutability of its function).

Therefore, sorry, reader, this text is not a manual as such, but a mere essay, thought from these shores -the Copyleft and the Global South-, which tries to move forward in recent and under construction territories, trying to understand where we come from, rescuing the good ideas and trying to understand why they were achieved or not, and seeing how we can continue. I hope you will find, at least, some eclectic curiosities and, hopefully, some clues to do OS, to do better science, according to its foundations.

Free software, the Internet and Latin America

H'Obbes' (1993) Internet timeline, which until 2001 was that of the Internet Society, begins in 1957, with the launch by the Union of Soviet Socialist Republics (USSR) of the first Sputnik. In 1969, Arpanet, the forerunner of the Internet, was born. In 1995, the World Wide Web was created at CERN, with which the Internet quickly became global and ubiquitous. By an intertwined path, free software and Open Source were born (A Brief History of FOSS Practices, 2019). The early software of the 1950s was usually shared, the enclosure of access to source code began in the 1960s and 1970s. In 1983, Richard Stallman initiated the GNU project and, in 1984, founded the Free Software Foundation. In 1991, Linus Torvald sent the first message to a news group about the operating system he was developing, Linux (Torvalds, 1991), which today runs on the vast majority of Internet servers and on all existing supercomputers. The Internet runs on free software and the crucible in which it is forged. At the turn of the millennium, the Internet and free software, two intertwined, liberal and community-inspired initiatives, are revolutionizing the telecommunications and computing industry. Their philosophy and precepts become central to the new information and communication technologies (NICTs, then ICTs, more commonly IT today). In the first two decades of the 21st century, the Internet and free software are the subject of political, societal and even civilizational debate.

In 2005, Nicholas Negroponte and Kofi Annan announced the One Laptop per Child (OLPC) initiative, which proposed to design and mass-produce a laptop computer, costing US$100, and distribute it to the world's children, as a particularly efficient action to bridge the education gap and the digital divide. The XO, as the distinctive little green and white laptop was called, which was ready in 2007, ran a GNU/Linux Fedora operating system, with Sugar as the human-access graphical environment: a highly innovative system, which abandons the desktop metaphor, with its folders and documents, for one that encompasses the neighborhood, in which "migrupo" stands out, in which the child is at home doing a certain activity, to which he/she can invite members of his/her group. Free software was key in OLPC, not only in this concrete realization of the XO software, but also in the whole philosophy of the initiative. It is one of the five key principles of the initiative (OLPC: Five principles-OLPC, 2007).

Why science requires free software

All the recommendations for the structure of a scientific article include a chapter on methods, or methodology, which includes the set of materials, procedures, techniques and instruments with which it is developed (Castillo, n.d.; Hassan, 2024). The raison d'être of this part of the research is an exhaustive description of the development of the research, so that another person, or another totally independent team can reproduce the results, or refute them. What is this reproducibility or refutability if software intervenes in the course of the research? Whether it is the on-board software of a measuring device or other scientific equipment, a modeling software, or simply the operating system and office suite used by the researchers.

With free software, by construction, we have access to the source code that details with total precision, and without misunderstanding, the data processing it performs. With proprietary or closed software we have to trust whoever gives it to us, in an executable form, but with inner workings we cannot analyze. There is no true reproducibility or refutability. Evidently here, “reproducing [the] research” is not a mere “copy and paste” of data and software to see, after running it, that “Oh! by chance”, I arrive at the same results.

The code is science

Since software is an integral part of scientific instrumentation, the principle is the same as for peer-reviewed publication: establish the authorship of the software to be reviewed, make available what is necessary to study it (i.e., its source code) and ensure an effective review, for critical evaluation, based on a minimum understanding of the software itself and of the scientific domain it covers. It is worth emphasizing the approach of the Codeis Science Manifesto, which, ideally, is to make scientific software available to all under a free license, so as to allow anyone to download, review, reuse and expand it, and which is based on five statements: Open overclosed, Incorrect code results in incorrect science, Code deserves credit, Code for the future and Availability over perfection Kent Beck et al., 2001). This is the type of practices that modern agile development methodologies recommend and that allow the deployment of the software forges cited above.

The Internet and free software manage to survive and grow technologically and in the market because they base their development on scientific principles. In today’s software forges, such as Gitlab or Github,[12]

12. Gitlab and Github are two front ends of the git code versioning system, which com-

where the essentials of free software are developed and distributed, code contributions are subject to review, can be commented line by line, give rise to exchanges, to new formulations of the proposal, until a consensus allows them to be integrated into the software they improve or extend. Any scientific software should be developed in this ecosystem, subjecting it to collaboration/peer review from the beginning of its design and throughout its life cycle. Some examples of this for the OS are the use of Public Knowledge Project (PKP) initiatives, such as the Open Journal System (OJS) and Open Monograph Press, for the editorial management of journals and books; and the use of Dspace, for institutional repositories for different types of resources such as literature, data, theses and open educational resources.

Software in contemporary society

It is essential not to confuse free and free (we have already seen: free as freedom of expression, not free software), it would be denying the evidence that an advantage and part of the success of free software is that it is legally available at no cost. With software as a service, not only is the software free, but they lend you the computer and store your data. GAFAMN built their empire on the commons of software source code, but they operate platforms on the algorithms and software of which absolute secrecy reigns. Moreover, not only do they have full control of the software they run, in their cloud or on your device, be it the browser, an app, or the operating system itself, they also have access to all of your data.

But the free nature of free software and that of SaaS are very different. The free software corpus is available by the will of its authors, because working

plete with the apparel for software development cycle management. Github, which became the leading global code repository, is a service of a company, which was acquired by Microsoft in 2018. Gitlab is first and foremost an open source software, which anyone can install on their servers (e.g. git.interior.edu.uy, framagit.org).

together in community they make free, ethical and better software. When SaaS is free, it is for a very different reason: it is because the provider is interested in your data. "If it's free, the product is you," warn the empowered collectives. The business model of the Internet giants is not one of service provision, it is one of data monetization. Value emerges from big data. A hacker manifesto (Wark, 2009) states that, as the possession of land is an abstraction of nature, capital is an abstraction of land, information is an abstraction of capital. On the edge, the GAFAMNs now occupy the first places in the ranking of stock market capitalization, already far ahead of the oil multinationals, which used to occupy that place.

Web and social networks

We build our digital identity through the accounts we create in different Internet services, through a browser or from applications installed on any of our devices, and we give life to it with the use and data we provide or that the system collects. This identity can be of a physical person, or of a collective, be it a community or an institution. They always have, in interaction, public and private parts.

The hegemonic GAFAMN services are of a quality, versatility and ease of use that is hard to match. They manage to recruit the best designers and developers, and have gigantic global infrastructures. It is for objective reasons that they capture the vast majority of the market. Almost everything that happens in this world happens primarily there. It is very difficult to do without them. Even if you want to extract yourself, many of the people we interact with are still there.

Because, as we already mentioned, if the service is free, the product is you (and even if there is a cost for use, you are most likely still a product). Unless we step out of the world, today it is difficult not to be monetized, as a product or as a consumer. But we can still build a strategy to protect at least some of our privacy. Use GAFAMNs as a sounding board, but play your own instrument, in the orchestra to which you belong.[13]

Let's start with a collective. As a first communication channel, it is usually considered to create and nurture accounts in hegemonic social networks: Twitter, Facebook, Instagram, TikTok. This is not public broadcasting, it is communicating in the bubble in which each of these accounts will be deployed, composed of accounts with similar profiles and interests. That is why it is a particularly efficient communication, but it is not a public communication, which should be universally accessible, without access control, identification or any other requirement.

Why not start with a website, even a simple one? The web is public and has universal accessibility, neutrality upon which lies the innovation and strong growth that the Internet has always had. Without prejudice to the use of social networks, but in these, except for specific purposes, you can publish, manually or automatically, the same content as in a public section of the site called, for example, News, and always with a public link to the corresponding page.

Latin American experiences with free software

In the last two decades there have been several initiatives, particularly in Latin America, to promote free software in education and the public sector. They were not a failure, in the sense that there is no doubt that they left their mark in terms of awareness and concrete practices in Information Technology (IT), but they were not a resounding success either, if we consider today the extent of use and production of proprietary or specific software. We can apprehend some concrete, particular, eventually isolated or partial cases, look for lessons in these, we can take a critical look at the road already travelled -which is not minor, but in the area of the emerging

13 Credit to Tom Bouillut for this metaphor.

OS, in other sectors, such as education or public administration, where free software has been a patent reality for more than two decades-, we can practice interdiscipline to achieve an accurate approach to that articulation that OS and free software demand.

Uruguay was the first country to deploy OLPC, with its Plan Ceibal and, although there were many OLPC experiences in the region and in the world, it was the only one to date that did so by systematically adopting two of these five principles: ownership and saturation. The computer is attributed to the individual child, and to each and every child in the country. Plan Ceibal did not embrace all of OLPC's principles, particularly the one we cited, free and open. It was developed completely independently from Law 19.179, on Free Software and Open Formats in the State and Education (Uruguayan Parliament, 2013); on the other hand, Ceibal's relationship with the Uruguayan and regional free software community was never very good.

In early 2008, Bolivia was on the verge of deploying a plan similar to Ceibal (Viñar Ulriksen, 2008), an attempt that failed. However, shortly after, it adopted an IT policy with clear guidelines of sovereignty and freedom, as well as considerable resources, which was deployed by the Agency of Electronic Government and Information and Communication Technologies (AGETIC), created for this purpose. Here, too, there are paradigm shifts. Until today, for example, the page through which citizens can report incidents and vulnerabilities in public information systems is: hackers.bo, with a "wall of fame" of these ethical hackers and citizens. Since 2018, the AGETIC organized an International Congress on Information Security, where they met to address these issues, not only public officials, but also professionals and hundreds of students, for whom a capture the flag (CTF) contest was organized, a competition in which teams solve logic and computer puzzles referring to computer security.

Brazil was undoubtedly the country in the region that deployed the most ambitious policy, with many resources and strong implications in society, culture and industry, as evidenced in the film RiP!: A Remix Manifesto (Gaylor, 2008, sc. 1:09:00). It developed new concepts, such as public software or public trademark registration (Public Software, n.d.), thus seeking to build the incentives and balances of a new economy of the immaterial.

The network of Computer Units

At the UdelaR I am neither a teacher nor a researcher, but a technical officer. I coordinate the Computing Units Network, in which the IT Departments and units of several independent and autonomous services pool certain resources and activities. First of all, we maintain a cloud computing platform, from which we provide a range of services of different kinds. We usually organize an annual meeting, where we compare experiences, set goals, learn about something new that seems to be of use to us.

The will to perform information services of which we have full control, deploying them in our own infrastructure and using free software, leads us to develop our own team culture, which has a hacker attitude, of permanent deconstruction of the established; so much more of a research profile than a classic technical-administrative service.

In the first generation of our platform, which was operational from 2012 to 2021, we learned to virtualize. Today Ceibal has agreements with Samsung for the provision of devices, whose operating system is based on Android or MSWindows, with Google, for email and other services, and with Schoolology for its platform of virtual learning spaces.

Free science forges

Increasingly, science is computation. We need more programmers who are scientists, and more scientists who are programmers. OS requires more interdisciplinary links, particularly with information technologies, which underpin a growing part of scientific activity. Doing OS is not merely research as usual. In today's globally interconnected world, to do OS is to open up as much as possible each and every step of research, to interact permanently with the whole world.

Perhaps this is one of the most interesting edges of the encounter between free software and OS: making software is to digitize the work, not acting directly on our object of study, but modeling or analyzing it, in a discrete space that represents it, managed by a computer, with which we can investigate, explore hypotheses, study behaviors, simulating time, changing parameters and conditions, which eventually we can only generate in this virtual projection, but that can be of great importance to apprehend reality. Designing and building that software is itself a creative work, it is research (Wilkinson, 2018).

Software forges not only allow the organization of design and development, but also allow to implement, in an automated way, the deployment of each software version on platforms, first the test and then operational, with the appropriate resources, eventually replicated in as many instances as necessary. Large groups can interact with this software as a service, but tailored and community-based. An online platform will also be able to collect data and information, from open sources, or from robotic devices with sensors and sensors, process data, generate results, make decisions and transmit commands to actuators (Internet of Things, IoT).

Used for OS, it is possible to imagine scientific, research or educational projects that can be replicated and developed by multiple teams, in different places, contexts or disciplines, whose results are consolidated and analyzed globally, thus multiplying the scope of the initiative and of the team that originates it. The cyclical and progressive development of the systems may eventually allow, from research and testing, the emergence of services with economic value, thus interconnecting with applied science and the productive sector. In the same way, it will be possible to interact with education and the rest of the public sector, or with society in general.

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