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Article

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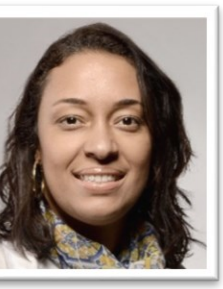

Communicating science: the use of public social networks by Brazilian scientific journals in the Area "Communication and Information"

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ABSTRACT

Introduction: In 2002, with the Budapest Open Access Initiative (BOAI), the scientific community in many countries began to support actions in favor of Open Access to scientific knowledge. Since then, other attitudes have emerged, such as the definition of guidelines for the reproducibility of studies and the opening of research data, based on conducting more collaborative scientific research and democratizing access to its results, culminating in Open Science practices. As for this democratization, scientific journals are the most used channels for communicating the results of studies, therefore they have the potential to also inform such results to the non-specialized public, giving evidence to scientists and their institutions. Objective: To analyze the engagement of posts made on Instagram, Facebook and Twitter by scientific journals evaluated with Qualis A1 and A2, by the Coordination for the Improvement of Higher Education Personnel (2017-2020), in the "Communication and Information" area and whether the posts have content intelligible to the non-specialized public. Methodology: Informational survey, content analysis and calculation of engagement of journal pages and posts on the aforementioned social networks. Seven journals were identified, and 341 posts made between August 2022 and January 2023 were analyzed, of which 173 were categorized as "Promotion of scientific manuscript, number or volume", of interest to the study. Results: The social network Facebook has a greater number of followers in the profiles of all the journals surveyed, but when calculating engagement versus number of followers, Instagram and Twitter appear with a higher percentage of interactions. In all public social networks polls, the "comment" tool is little used. Most posts like "Promotion of a scientific manuscript, number or volume" are an image with the title of the article and the names of the authors, with parts of the abstract of the work in the description, with the exception of a journal that publishes the manuscripts with videos of the authors themselves, which explain the content of the research. Conclusion: With the calculation of the engagement of the posts and its relationship with the number of followers of the pages, it is concluded that journals have the potential to use public social networks to reach the lay public, as long as they consider the main question of scientific dissemination: who is it intended for?

KEYWORDS

Scientific communication. Scientific dissemination. Scientific journals. Open Science.

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Comunicando ciência: o uso das redes sociais públicas pelos periódicos científicos brasileiros da Área "Comunicação e Informação"

RESUMO

Introdução: Em 2002, com a Iniciativa de Acesso Aberto de Budapeste (BOAI), as comunidades científicas de muitos países começavam a apoiar ações em prol do Acesso Aberto ao conhecimento científico. Desde então, outras atitudes surgiram,

como a definição de diretrizes para reprodutibilidade dos estudos e abertura de dados de pesquisa, baseadas na realização de pesquisas científicas mais colaborativas e democratização do acesso aos seus resultados, culminando em práticas de Ciência Aberta. Quanto a esta democratização, os periódicos científicos são os canais mais utilizados para a comunicação dos resultados dos estudos, portanto possuem a potencialidade de, também, informar tais resultados ao público não especializado, dando evidência aos cientistas e suas instituições. Objetivo: Analisar o engajamento das postagens realizadas no *Instagram, Facebook* e *Twitter* pelos periódicos científicos avaliados com Qualis A1 e A2, pela Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (2017-2020), na área "Comunicação e Informação" e se as postagens possuem conteúdo considerado inteligível ao público não especializado. Metodologia: Levantamento informacional, análise de conteúdo e cálculo de engajamento das páginas e postagens dos periódicos nas referidas redes sociais. Identificaram-se sete periódicos, sendo analisadas 341 postagens realizadas entre agosto de 2022 a janeiro de 2023, das quais 173 foram categorizadas como "Promoção de manuscrito científico, número ou volume", de interesse do estudo. Resultados: A rede social *Facebook* tem maior número de seguidores nos perfis de todos os periódicos pesquisados, mas quando se verifica o cálculo de engajamento versus número de seguidores, *Instagram* e *Twitter* aparecem com percentual maior de interações. Em todas as redes sociais públicas pesquisas, a ferramenta "comentário" é pouco utilizada. A maioria das postagens do tipo "Promoção de manuscrito científico, número ou volume" são uma imagem com título do artigo e nomes dos autores, com partes do resumo da obra na descrição, com exceção de um periódico que divulga os manuscritos com vídeos dos próprios autores, que explicam o teor da pesquisa. Conclusão: Com o cálculo de engajamento das postagens e sua relação com o número de seguidores das páginas, conclui-se que os periódicos possuem potencial para utilizar as redes sociais públicas para alcançar o público leigo, desde que considerem a principal pergunta da divulgação científica: a quem se destina?

PALAVRAS-CHAVE

Comunicação científica. Divulgação científica. Periódicos científicos. Ciência Aberta.

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1 INTRODUCTION

Since the crisis of scientific journals in the 1980s, characterized by high subscription prices charged by publishers, scientific communities in different parts of the world have taken steps to develop more open, transparent, and collaborative scientific practices (Oliveira, 2020). These practices were strengthened by the Budapest Open Access Initiative (BOAI), an event held in Budapest in 2002, the fruits of which became known worldwide as the Open Access movement.

In the context of OA, other declarations have emerged from different countries, such as the Bethesda Statement on Open Access Publishing (2003) and the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (2003). In Brazil, the Scientific Electronic Library (SciELO) has been at the forefront of actions in line with the objectives of OA, even before the BOAI, since it began opening its scientific publications in 1998 (Packer, 2021). Another Brazilian organization that stands out is the Brazilian Institute of Information in Science and Technology (IBICT) with the adoption, adaptation and translation of the Open Journal System (OJS), an open source software developed by the Public Knowledge Project (PKP) with the aim of managing and publishing journals, mainly associated with higher education institutions. IBICT was also responsible for the creation of the Bank of Theses and Dissertations (BDTD).

In the last twenty years, "several other movements have taken shape in line with the original proposals of the open access and open software movements, [...] forming a broader movement for open science" (Appel, 2019).

In this sense, initiatives such as Horizon Europe (2020) in the European Union, the 5th U.S. National Action Plan for Open Government (2022-2024) in the United States, and the Australian National Data Service (2008) in Australia can be mentioned, but their description is beyond the scope of this study. The point of interest here is that these guiding documents include actions ranging from the production of scientific research using open, accessible, and verifiable methods and resources to the dissemination of the results of such research.

One concern that emerges from discussions of open science is that these results should be understandable and available to the general public, not just the scientific community itself, leading to discussions of scientific dissemination.

Interested in following the Open Science movement, Brazilian research funding agencies have already included in their funding notices the need for researchers to inform the general community about how their results are disseminated, such as the National Council for Scientific and Technological Development (CNPQ, 2022). Similarly, studies in the field of altmetrics, as indicated in Fachin (2022), have considered alternative social metrics to measure the visibility and reach of the results of scientific studies. Still in the context of visibility and reach, it is necessary to point out the great importance that editors give to the impact of scientific publications in journals, which is generally measured by factors that are globally or regionally established and widespread. These impact factors now consider alternative metrics, such as presence on social media platforms, both academic and non-academic.

"Academic social networks are digital platforms that promote communication networks between individuals directly or indirectly involved in the academic universe" (UNIFESP, 2020). Some of these social networks are Academia.edu[1], Mendeley[2], Research Gate[3], and others. Non-academic or public social networks, on the other hand, bring together a multitude of people with countless interests, including but not limited to academic ones, such as

[1] https://www.academia.edu/

[2] https://www.mendeley.com/

[3] www.researchgate.net

Instagram, Facebook, Twitter, YouTube, among others.

The following questions arise Is it possible to establish a relationship between the alternative metrics of journal impact factors and scientific dissemination? Does the content of scientific research results published by scientific journals on public social networks demonstrate the interest of these agents in approaching the lay public, with accessible language and different types of formats, in order to facilitate understanding?

In an attempt to clarify these questions, this study aims to analyze the profiles and publications on the social networks Instagram, Facebook and Twitter of Brazilian scientific journals evaluated with Qualis A1 and A2 in the "Communication and Information" (C&I) area of the Coordination for the Improvement of Higher Education Personnel (CAPES), in the last evaluation made available (2017-2020).

Qualis is a method of analysis in which committees composed of consultants from each evaluation area evaluate the scientific production of Brazilian stricto sensu postgraduate courses (Master's and Ph.D.) by measuring the quality of scientific journals in which faculty and students publish scientific manuscripts (articles, reviews, etc.). Qualis 2017-2020 has levels: A1, highest; A2; A3; A4; B1; B2; B3; B4; C, decreasing, based on the respect of good editorial practices, exogeny, presence in indexers, among others (CAPES, 2023).

Scientific journals are known to be channels of formal communication between peers, but public social networks reach both specialized and non-specialized audiences. So, while it is known that elements of the current digital context are driving journals to create profiles on non-academic social networks, has the practice of scientific dissemination produced up-to-date content in accessible language that actually reaches the lay public? Motivated by this question, the next section discusses the theoretical issues surrounding the proposed problem.

2 LITERATURE REVIEW

Scientific journals emerged in the second half of the 17th century with the aim of making scientific communication more efficient, formalizing it, and registering it so that it could be accessed over long periods of time and by a wide audience (Meadows, 1999). They are characterized by being a collection of articles written by different authors and distributed at intervals determined by the team in charge, the editorial board (Meadows, 1999).

Since their inception, journals have been the main channel for communicating research results within the same scientific field, and the impact of productions used to be measured by traditional metrics such as the number of citations (impact factor). With the popularization of the Internet, the growing use of social media and, in particular, discussions about open science, the need to communicate the results of scientific research to non-specialist audiences has emerged.

While the results of scientific research are still mostly published in scientific journals, there is a potential for them to also be the protagonists in the popularization of science, highlighting scientists and their institutions (Barata, 2010).

In this way, the impact of scientific productions can be measured, in addition to traditional metrics, by alternative indicators specific to digital environments, such as visibility and engagement. Beyond this aspect, we turn our attention to the lay public in an attempt to ensure that public social networks are indeed used to communicate science in a way that is understandable to everyone. The following subsections present the theoretical constructs that support the needs of both impact measurement and science communication practices.

2.1 Scientific communication through the lens of dissemination

Scientific communication is a broad term that, according to Bufrem (2019), encompasses the activities of producing, disseminating, and using scientific information.

However, there is a clear distinction between its practices: those that are usually directed to peers, that is, scientists within the same scientific field, formally defined as scientific communication or dissemination, and those that are directed to the lay (or non-specialist) public, known as scientific dissemination or popularization (Caribé, 2015).

With regard to the former, the channels used are mainly scientific journals. Publications published through these channels fulfill one of the intended functions of scientific communication, which is to transmit acquired knowledge after rigorous peer review (Bernal, 1946), a characteristic that has remained unchanged since the exclusive use of printed journals.

However, most of the time, this type of publication uses a language specific to members of research institutions, with technical terms and far-fetched expressions that make it difficult for non-specialist audiences to understand. Scientific dissemination or popularization aims to bridge this gap and make science and its results accessible and understandable to the lay public.

It is therefore important for research institutions and researchers to engage in the democratization of scientific knowledge from the earliest stages of research production. Such democratization, combined with collaborative processes for the development of scientific research, is one of the objectives of the Open Science movement (Packer; Santos, 2019), which envisages actions such as government initiatives, the gradual opening of peer review, the publication of scientific manuscripts that communicate research results, preferably in open access, the sharing of scientific data (as long as they are not protected by law, as is the case with personal data), among other initiatives.

Pereira (2022, p. 75) warns that "[...] possible and expected effects of this movement are the social engagement of science and the greater visibility and recognition of researchers", adding that science communication can "[...] arouse the interest of the general public in science [...]" (Brandão, 2006, p. 3).

In Brazil, motivated by the desire to improve and create actions and public policies to popularize science, the Ministry of Science, Technology, Innovation and Communication (MCTIC) and the Center for Management and Strategic Studies (CGEE) carry out from time to time the "Public Perception of Science and Technology (S&T)" survey. The first one was conducted in 1987 and the others in 2006, 2010, 2015 and 2019. The results of the latter show that 61% of respondents said they were "interested" or "very interested" in S&T, especially in the areas of health, environment and technology (Brasil, 2019).

The above-mentioned study (Brasil, 2019) also points out that, although the consumption of information on S&T through the different media is always below 22%, there has been a significant change between 2015 and 2019 in those who use the media to learn about these topics, highlighting that the Internet has overtaken television as the main source of information on S&T among all age groups and social classes surveyed.

It is therefore necessary to reflect on how the results of scientific research reach the non-specialist public. Furthermore, a simple and plausible justification for the importance of scientific dissemination is the fact that everything around us is the result of acquired knowledge, as Bernal (1946) quotes, in other words, the result of science, from the chair or the structure of the building in which we are now reading this text, to the countless processes, analyses and tests that culminate in vaccines that make it possible to protect against diseases and extend the life expectancy of the population.

In this context, the Covid-19 pandemic, which killed more than 6 million people around the world, has increased people's interest in science, in a mixture of curiosity about how the studies are carried out and the hope that solutions will be found before their own lives or those of their loved ones are taken.

Considering that in Brazil the last survey on public perception of science was conducted in 2019, in a period before the pandemic, it is believed that the next study in this series to be conducted will bring a profile of individuals even more interested in the subject of S&T. However, this interest is accompanied by concerns about misinformation and manipulation of

content. This understanding is in line with the results of a national study conducted by the National Institute of Science and Technology in Public Communication of Science and Technology (INCT-CPCT) in 2022, which found that trust in science in Brazil was negatively affected by disinformation campaigns during the Covid-19 pandemic, so "[...] the role of more solid, continuous and well-structured science communication and science education policies is evident [...]" (INCT-CPCT, 2022).

Thus, it is argued that disinformation can be combated by sharing truthful information and properly disseminating scientific knowledge in an understandable way (INCT-CPCT, 2022). However, it is important to note that the path is not so simple, it is not enough to transfer the content of a scientific journal to a digital social network, which has its own language and content aesthetics. The next section reflects on the use of social media in science communication.

2.2 Social media and science

We will begin our reflections on social media by placing them in an earlier context, that of the Internet, which can be seen both in terms of its technological infrastructure and in terms of the ideas that have emerged and changed with it over the years (Spyer, 2011). This article focuses on the latter, more specifically on the revolution caused by social media.

From its inception in the 1960s to the present day, the Internet has been improved and appropriated by different nations and individuals for a variety of purposes. Many of these advances were possible thanks to the restructuring of capitalism in the 1970s (Caltells, 1999) and the promotion of many countries, such as the US, China and Japan, which had economic and political interests in the rapid development of information and communication technologies (ICTs).

ICTs, both from a tool point of view and from a logical point of view, referring to information systems, are mainly responsible for the exponential growth of circulating information, for example, mobile phones, which now have multiple functions and are responsible for the rapid and almost instantaneous dissemination of content in different formats. As a result, the communication mediated by these technological devices, computers, mobile phones, tablets, etc., has the power to create virtual communities, the so-called social web (Valerio, 2012).

Valerio (2012) adds that in these communities, users and content creators become confused and there is a very close relationship between the social processes established, where, for example, one person produces an audiovisual material, but it is manipulated, shared and assimilated by a countless number of people. In this way, although there are times when we feel that technology exists as an end in itself, it is individuals who represent the current Internet revolution, in which social media, especially social networks, have provided different types of interaction, almost always instantaneous, whose reach and the types of manipulation derived from it are something unimaginable.

Clementi et al (2017, p.459-460), when analyzing the different definitions of the term social media in the literature, consider that there is a consensus among them that "[...] a user communicates certain content (information, knowledge, ideas...) in an environment that promotes interaction". In the same vein, Recuero (2011, p.14) states that social media comprise a "[...] set of new, more participatory, faster and more popular communication technologies and the social appropriations that have been and are being generated around these tools".

When we talk about social appropriations, we are referring to the interactions of individuals themselves, because as social beings they are constantly forming bonds and exchanges with others, which can be called social networks, and they occur in both physical and virtual environments. Digital environments enhance these networks and increase the number of people with whom relationships can be formed, giving rise to an underlying concept,

that of digital social networking platforms (Recuero, 2011).

On these platforms, social networks are permanently connected and allow both synchronous and asynchronous communication, where "[...] information circulates, is filtered and shared; it is connected to conversation, where it is debated, discussed, and thus generates the possibility of new forms of social organization based on collective interests" (Recuero, 2011, p.15).

There are many studies that analyze profiles on digital social media platforms based on an infinite multiplicity of interests, such as the study of posts about the Zika virus on Twitter and Facebook (Barata; Shores; Alperin, 2018) or the use of social media to teach astronomy (Silva Filho; Galluzzi, 2021). The article presented here focuses specifically on the Instagram, Facebook, and Twitter profiles of Brazilian science journals with Qualis A1 and A2 in the CAPES Communication and Information (C&I) assessment area. The question seeks to understand whether the content they publish for the dissemination of scientific research results is aimed at the lay public, or just a translation of scientific communication into these media. It also asks about the impact of scientific productions in the face of such contributions.

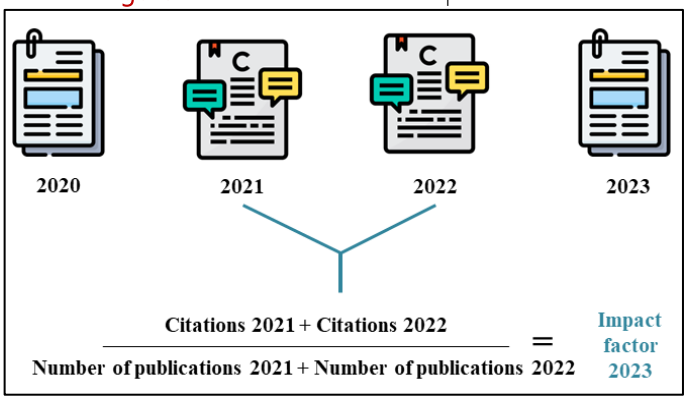
The next subsection presents the reasons why Brazilian scientific journals create profiles in public social networks, while trying to resolve the questions raised above regarding scientific dissemination.

2.3 Altmetrics and Scientific Dissemination

The emergence of the printing press and later the computer represented a revolution in the way scientific research results were disseminated. If, in the early days, letters or academic events were basically used, with the mechanisms of printing and then the internet, it was possible to disseminate scientific discoveries to a greater number of peers, inevitably leading to exponentially multiplying quantities of scientific publications (Gomes; Santos; Reis, 2020).

As a result, concerns have arisen in the scientific community about the quality and impact of what has been published. With regard to the problem of quality, one of the ways forward has been peer review, whereby the results of a piece of research become more reliable and credible when evaluated by other researchers within the same scientific field (Miranda; Carvalho; Costa, 2018). For the second concern, researchers Eugene Garfield and Irving H. Sher, in the 1960s, created the impact factor (IF), a simple calculation which establishes the ratio between the number of citations of items published in a journal in the last two years and the number of articles published in this same period, by this same journal (Fachin, 2022). The IF can be better understood in Figure 1.

Figure 1. Calculation of the Impact Factor.



Source: the authors.

A "good impact factor" can vary depending on the area or scope of the journal, since it only serves to create a ranking and compare the journals that have the best rating in relation to another. In this way, IF has also come to be used as a quality indicator (alongside peer review) for scientific journals.

The popularization of the internet and social media, coupled with the emergence of Open Science practices, i.e. "[...] access, sharing, cooperation, transparency, ethics and other evolutionary aspects of scientific communication" (Fachin, 2022, p. 16) meant that measures such as IF, although useful, became insufficient.

Altmetrics then emerged in an attempt to meet the need for alternative metrics to assess the impact of publications in the online environment, and therefore on social media (Priem et al., 2010).

Fachin (2022) presents a compilation of alternative impact indicators from the perspectives of various theorists (Chart 1).

Chart 1. Alternative indicators of the impact of scientific production in an online environment.

Author(s)	Nature of indicators	Key metrics
Vanti e Sanz-Casado (2016)	Quantitative - evaluating the impact of publications on networks	Number of online mentions or citations;
Martín-Martín, Orduña-Malea e Delgado-López-Cózar (2018)	Quantitative - evaluate the impact of publications on networks	Number of downloads of scientific materials from the web or number of users who have included data from scientific works in their personal reference lists;
Araújo (2015, 2018)	Qualitative - evaluate research interactions on the networks	Number of citations on peer review sites.
Orduña-Malea, Martín-Martín e Delgado-López-Cózar (2016)	Qualitative - evaluate research performance	Views; Downloads; Profile views; Following; Followers; Readers; Publications; Reposts.

Source: the authors based on Fachin (2022).

Based on Chart 1, it can be inferred that each indicator can be used to measure a specific behavior of scientific communication (Fachin, 2022), and there is no one metric to be used exclusively, or that can be considered better than the others. Each indicator can be used according to the analysis you want to make, even in conjunction with traditional metrics.

It should also be noted that, in general, when it comes to public social networks, these indicators do not specifically analyze the content published. This means that posts with good engagement (a high number of likes, comments or shares) are not checked for content and language that is understandable to non-specialized audiences.

This brings us back to the dilemma of the exponential increase in the number of scientific productions and the need for the results of such research to be intelligible not only to the scientific community itself. In this regard, Valério (2012, p. 154) ponders that "since its beginnings, the science communication system has been faced with the relationship between the growth of information and distribution, with some type of technology already helping to solve the new flows of information, whether demanded by society or not".

It can be said that Open Access, the forerunner of the Open Science Movement, makes it possible for anyone, specialized or not, to have access to the results of scientific research in the form of articles or other manuscripts. When we return to Open Science's concern with more collaborative, transparent and accessible scientific practices, we must not lose sight of the fact that, by accessible, "it is necessary for erudite knowledge to be passed on and understood by a greater part of the population, in a dialectical relationship between science and the public" (Valerio, 2012, p. 154).

Democratizing scientific knowledge to the lay public would be a good justification for the results of scientific research to also be disseminated on public social networks, but it is unquestionable that scientific journals make up a universe, most of which are academic, whose concerns go beyond scientific dissemination and are based on institutional requirements, funding bodies and concerns about the quality and impact of the content published. Therefore, the determinations of the academic world can drive the presence of scientific journals on public social networks, as will be elucidated below.

Since mid-2010, with the Priem et al. Manifesto (2010), the impact of scientific publications has also been measured by alternative metrics, such as presence on social media platforms. Indexing databases, such as the Scientific Electronic Library Online (SciELO), Brazil version, already evaluate the individual performance of scientific journals for admission and permanence in the SciELO Brazil Collection, with criteria that include indicators of presence on social networks, both academic and public (SciELO Brazil, 2020).

In the same vein, Brazilian research funding agencies, such as the National Council for Scientific and Technological Development (CNPq), have included in their calls for funding the need to draw up a Scientific Dissemination Plan, with a view to "[...] contributing to the popularization of science and including all activities aimed at disseminating scientific knowledge to non-specialized audiences" (CNPq, 2022).

In addition, based on the guidelines of the Open Government Partnership (OGP), joined by more than 78 countries, Brazil, in its 5th Action Plan, established in Commitment 8 - Transparency in Science: new evaluation mechanisms for the advancement of Open Science, Milestone 4 - Proposal of Alternative Metrics Indicators (altmetrics) for measuring the Impact of Scientific Research (Brazil, 2021). These initiatives demonstrate that Brazilian bodies involved in scientific research are committed to scientific practices that are more open and accessible to all audiences. However, this article is based on the hypothesis that the content published on public social networks, on the profiles of scientific journals, continues to be aimed at the scientific community and not at the non-specialized public.

It is argued, in line with Cosmo, Sena and Muriel-Torrado (2021), that in the context of science communication, the use of social media by scientific journals requires a clear definition of the metrics to be achieved, the production of content based on the target audience and constant evaluation, monitoring and possible actions to improve this content. Therefore, this study seeks to establish a relationship between alternative impact metrics and scientific dissemination, using a selection of metrics listed in Chart 1 and content analysis of the pages of Brazilian scientific journals, rated A1 and A2 in the CAPES C&I assessment area, on Instagram, Facebook and Twitter.

3 METHODOLOGICAL PROCEDURES

From the point of view of the approach, this is a mixed study that brings an informational survey with quantitative and qualitative characteristics. In terms of procedures and objectives, the study uses the methodology and technique of content analysis, the scope of which will be outlined below, according to Bardin (2011).

Regarding the content analysis approach, Bardin (2011) points out the quantitative and qualitative nature of this type of study, with the quantitative approach being more objective because the quantification of descriptive data is better controlled. The qualitative approach is adaptable to the phenomenon being studied. In addition, Bardin (2011) advocates the creation of hypotheses.

Bardin (2011, p. 145) states that it is important to consider the context of the message, i.e. "who is speaking, to whom, and under what circumstances". Therefore, "who is being spoken to" is a crucial point in this study. In this case, the Brazilian scientific journals rated A1

and A2 in the CAPES C&I assessment area "speak" only to their peers or also to the non-specialist public.

Also according to Bardin (2011), studies that set out to carry out a content analysis do so on the basis of a series of stages that are characterized according to the study carried out.

1 - Pre-analysis: first, the C&I evaluation area of CAPES was chosen, since it is the research area in which the authors are inserted and also the area where a large number of studies related to scientific communication and dissemination on social media are concentrated. Next, we selected Brazilian scientific journals that were rated A1 and A2 in the most recent evaluation published on the CAPES website until the time of the survey in February 2023, that is, the Qualis CAPES 2017-2020 evaluation.

We then reviewed the websites of these journals, selecting those that provide links to their public social networks and whose focus and scope correlate with the basic areas of C&I: archivology, library science, information science, communication, journalism, and museology, according to the CAPES Area Document (2019).

In this pre-analysis, the hypothesis was formed that the content published in public social networks continues to be aimed at the scientific community and not at the non-specialist public, and in order to prove or disprove it, we moved to the next stage of content analysis, described below.

2 - Exploration of the material: the posts of the sample journals on the social networks Instagram, Facebook and Twitter were analyzed in the last six months before the study (August 2022 to January 2023). To collect the data, the template shown in Chart 2 was used, with general information about the page analyzed and each post.

At this point, it was possible to establish relationships with the alternative indicators of the impact of scholarly production in an online environment presented in Chart 1. In addition, each post was categorized into one of seven options: A - Promotion of a scholarly manuscript, issue, or volume; B - About; C - Calls for papers; D - External links; E - Events; F - Commemorative events; G - Other. This categorization process groups the posts into "analytical units that materialize the issues to be verified" (Sampaio; Lycarião, 2021, p. 58), which allows for a qualitative and quantitative analysis of the content published on the social media pages of the journals.

Chart 2. Spreadsheet for data collection.

Magazine Name - Social Network (Instagram, Facebook or Twitter) Profile URL: Number of posts in the period: Number of followers: Average frequency of posts:			
Post	Format (text, image, video or combination of formats)	Categorization	Impact indicators (variable, depending on the social network analyzed) Views: Likes: Comments: Shares: Reposts:

Source: the authors.

Based on the research objective, we turned to the posts categorized as "Promotion of a scientific manuscript, issue or volume". The results were then processed, the last stage of content analysis, according to Bardin (2011), which will be presented in the next section.

4 RESULTS AND DISCUSSION

The CAPES assessment area called "Communication and Information" (C&I) "is made up of the basic areas of Communication, Information Science and Museology and covers postgraduate programs in Archivology, Library Science, Information Science, Communication, Journalism and Museology" (CAPES, 2019, p. 3).

> Communication and information are considered to be elements of individual empowerment and open up possibilities for social emancipation. However, these elements are generally not accessible to certain social strata, making it difficult to reflect and criticize facts and situations experienced in reality (CAPES, 2019, p. 3).

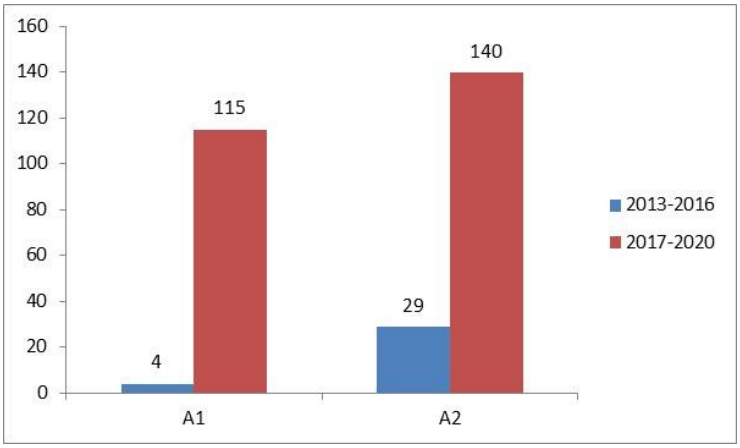
From this perspective, it is recognized that researchers and journals in the area have the innovative potential to respond to the emerging need for scientific dissemination, especially in compliance with Open Science and the right of access to information.

CAPES, in the document presenting this area, points to its expansion, which accompanies the growth in the number of postgraduate programs and scientific journals in Brazil, essentially since the year 2000, in parallel with social transformations, the modernization of ICTs and the media (CAPES, 2019).

In the evaluation of the C&I area for the 2017-2020 period, 273 and 288 journals were identified as Qualis A1 and Qualis A2, respectively, of which 115 and 140 are Brazilian.

Social problems, the main motivators for research in the scientific fields of C&I, namely Communication, Information Science, Museology, Librarianship, Archivology and the like, have highlighted a contemporary characteristic, the multi/multiple, inter and/or transdisciplinary nature of scientific research, which means that researchers from one thematic area publish the results of their research in scientific journals with a variety of focuses and scopes. This justifies the increase in the number of Brazilian journals evaluated within the C&I area, when comparing the last two Qualis Capes evaluations (Graph 1).

Graph 1. Number of Brazilian journals evaluated in CAPES' C&I area.



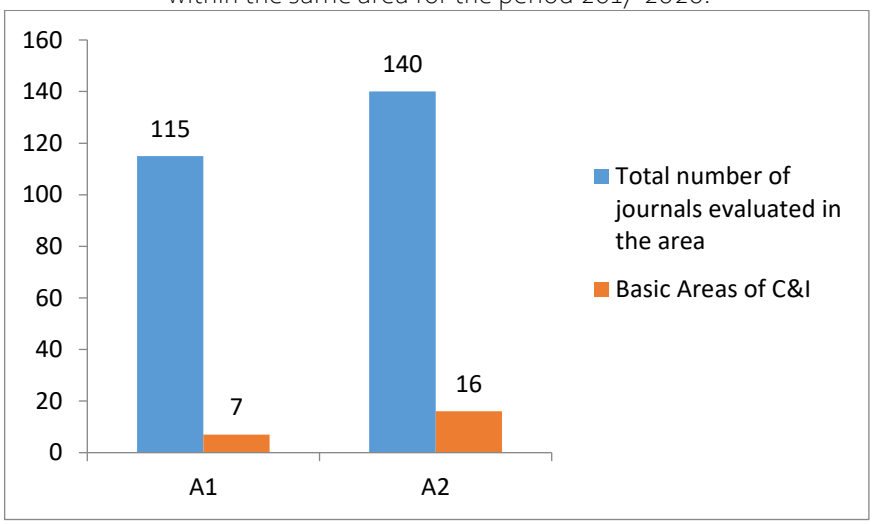
Source: Sucupira/Capes Platform. Prepared by the authors.

It's worth noting that the quantities shown in Graph 1 exclude repetitions, as some titles appear in both print and electronic versions. Furthermore, although the figures for the 2017-2020 evaluation are higher, when we analyze the focus and scope of the journals on their websites, we see that those related to the S&I area appear in smaller numbers (Graph 2).

This was made possible by consulting the websites of each of the 255 Brazilian journals rated A1 and A2 in this area. When checking the focus and scope of each journal, it was noted that they aim to publish on a variety of topics, namely: Administration and related subjects;

Education, teaching and the like; Anthropology; History; Geography; Social Sciences; Politics; Law; among others and that only 23 journals publish articles on Archivology, Librarianship, Information Science, Communication, Journalism and Museology, concerning the Communication and Information Area of CAPES.

Graph 2. Comparison of the number of C&I journals in relation to the total number of journals evaluated within the same area for the period 2017-2020.



Source: Sucupira/Capes Platform. Prepared by the authors

According to Graph 2, the seven Brazilian journals rated A1 are: Collection: National Archives Magazine; Annals of the Paulista Museum; Scientific Station; Matrices; Public Opinion; Free Text; Transinformation, of which three publish links to their public social networks on their websites, as shown in Chart 3.

The 16 journals rated A2 in the same area are: Brazilian Journalism Research; E-Compós (Brasília); Em Questão; Encontros Bibli; Habitus; Infodesign; Informação & Informação; Informação & Sociedade; Intercom (São Paulo); Perspectivas em Ciência da Informação; Politics; Revista CPC (USP); Revista do Museu de Arqueologia e Etnologia; Revista Famecos; Revista Memória em Rede; Revista Observatório, of which four were selected for providing links to their social networks (Chart 3).

Chart 3. Journals used in the study

Magazine	*Instagram*	*Facebook*	*Twitter*
A1 - COLLECTION: JOURNAL OF THE NATIONAL ARCHIVE, Rio de Janeiro/RJ, (ISSN: 2237-8723)		X	X
A1 - FREE TEXT, Belo Horizonte/MG, (ISSN: 1983-3652)	X	X	X
A1 - TRANSINFORMATION, Campinas/SP, (ISSN: 2318-0889)			X
A2 - IN QUESTION, Porto Alegre/RS, (ISSN: 1807-8893)	X	X	X
A2 - BIBLIOGRAPHIC ENCOUNTERS, Florianópolis/SC, (ISSN: 1518-2924)	X	X	
A2 - PERSPECTIVES IN INFORMATION SCIENCE, Belo Horizonte/MG, (ISSN: 1981-5344)	X		X
A2 - OBSERVATORY MAGAZINE, Palmas/TO, (ISSN: 2447-4266)		X	

Source: the authors.

Chart 3 shows that only two journals have profiles on the three public social networks surveyed. However, in general, those that have a page on more than one social network make the same posts on both, with slight variations, usually made possible by the functionalities of that network.

Chart 4 shows the characteristics of the journals in the sample, as well as their social media pages. It should be noted that posts from August 2022 to January 2023 were analyzed.

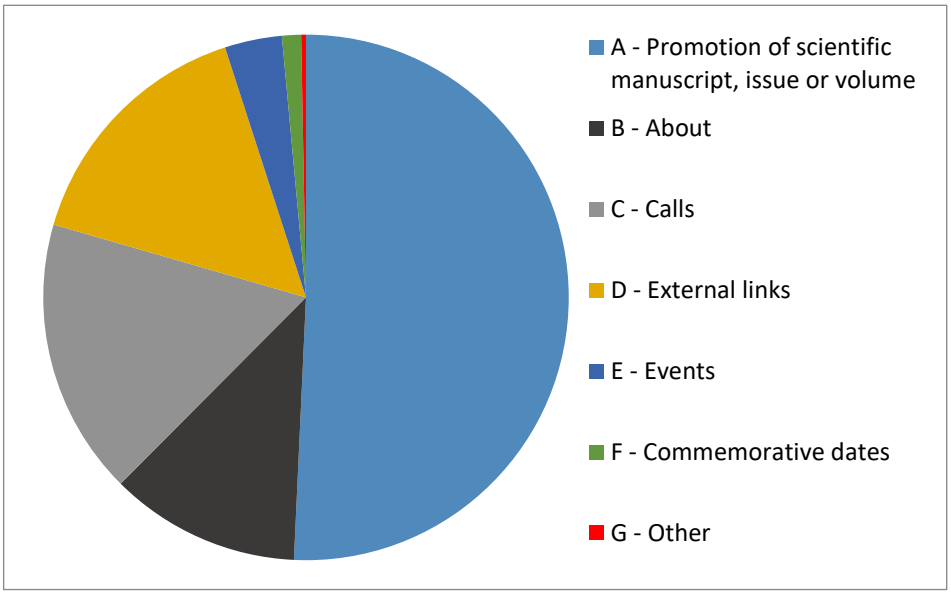
Chart 4. Characteristics of the journals and their profiles on the social networks surveyed. Period August 2022 to January 2023.

Magazine	Frequency of publication of scientific manuscripts	Number of posts on social networks in the period analyzed	Observations on the frequency of posts
A1 - COLLECTION: JOURNAL OF THE NATIONAL ARCHIVE	Continuous flow	249	Daily posts, some repeated.
A1 - FREE TEXT	Continuous flow	1	Single post in Jan. 2023.
A1 - TRANSINFORMATION	Continuous flow	12	All posts on Sept. 12, 2022.
A2 - IN QUESTION	Quarterly	43	On average, more than one post a week.
A2 - BIBLIOGRAPHIC ENCOUNTERS	Continuous flow	9	On average, more than one post a month. No posts in Nov. 2022 and Jan. 2023.
A2 - PERSPECTIVES IN INFORMATION SCIENCE	Quarterly	21	Posts only in Dec. 2022 and Jan. 2023.
A2 - OBSERVATORY JOURNAL	Quarterly	6	1 post in Aug. 2022, 4 in Oct. 2022 and 1 in Dec. 2022.

Source: Instagram, Facebook and Twitter. Prepared by the authors.

All the posts (Chart 4) were categorized into one of the following options: A - Promotion of scientific manuscript, issue or volume; B - About; C - Calls; D - External links; E - Events; F - Commemorative dates; G - Other, with categories A and C being the most expressive in all the profiles analyzed (Graph 3).

Graph 3. Categorization of posts from all pages analyzed



Source: the authors

According to the analysis that generated Graph 3, more than 50% of the posts from August 2022 to January 2023 (in blue in the graph) refer to new journal publications, either a new article or a new issue (or volume). Secondly, calls for upcoming publications are common (17% - in green on the graph) or reposts of content related to the journal's area of interest, with links to other pages or websites (16% - in purple on the graph).

As mentioned, journals that have more than one social network make the same posts on both. In this case, the post was only computed once and the interactions on the different networks, if any, were recorded. For example: Post X (interactions on Instagram; interactions on Facebook; interactions on Twitter).

Based on this survey, we returned to the initial objective of analyzing the engagement of the content disseminating the results of scientific research, published on the public social networks by the journals, seeking to verify whether they are aimed at the lay public or just a transposition of scientific communication to these media.

Thus, this study focused on posts categorized as "A - Promotion of a scientific manuscript, issue or volume", analyzing the following number of posts for each journal: Collection: National Archives Magazine - 107; Transinformação - 12; In Question - 34; Bibli Encounters - 4; Perspectives on Information Science - 15; Observatory Magazine - 1. The journal Free Text, did not post any content in this category during the period analyzed.

As the study provides for a quantitative-qualitative analysis, a calculation of information engagement was carried out, as proposed by Silva and Gouveia (2021) in Figure 2 and an analysis of the language used in the posts, checking whether it uses only scientific terms to promote the journal's content or whether there is an effort to communicate it in an intelligible way to the non-specialized public.

Figure 2. Calculations for Total Sample Engagement (TSE)

$$ETA = \sum reações + \sum compartilhamentos + \sum comentários \quad (1)$$

$$pesodasreações\,(pr) = \frac{1}{\sum Reações/ETA \times 3} \quad (2)$$

$$pesodoscompartilhamentos\,(pcome) = \frac{1}{\sum compartilhamentos/ETA \times 3} \quad (3)$$

$$pesodoscomentários\,(pcome) = \frac{1}{\sum comentários/ETA \times 3} \quad (4)$$

$$Engajamento = reações \times (pr) + compartilhamentos \times (pcomp) + comentários \times (pcome) \quad (5)$$

Source: Silva; Gouveia, 2021, p. 97.

According to Silva and Gouveia (2021), using the five formulas shown in Figure 2 allows for a calculation of informational engagement applicable to the different social networks, since weights are defined for each of the tools available on that network. On Twitter and Facebook, for example, there is the option to retweet / share content posted by another profile on your own page, but on Instagram this sharing is only possible via direct (private messages), which makes it impossible to count this type of interaction. In this way, the formula can be adapted according to the number of tools available. In the case of Instagram, in the denominator of formulas (2), (3) and (4), ETA was multiplied by two.

Charts 5, 6 and 7 show the scenario of category A content posted on the social networks Instagram, Facebook and Twitter, the engagement found by applying the formulas presented in

Figure 2 and, in the last column, a simple proportion between the engagement found and the number of followers on the page of the journal surveyed.

Calculating the proportion was necessary since the formulas developed by Silva and Gouveia (2021) were initially designed to create a ranking of engagement between posts. In the study proposed here, all the posts analyzed at this stage of the research are of the same type (category A), which does not justify establishing a ranking. On the other hand, the study is interested in a relationship between the engagement found and the visibility (number of followers) of the page.

Chart 5. Analysis of posts promoting a scientific manuscript, issue, or volume (Category A) on Instagram.

Magazine	Followers	Total Likes	Total Comments	Commitment	Followers versus Commitment
A2 - IN QUESTION	625	758	5	763	122,08%
A2 - BIBLIOGRAPHIC MEETINGS	683	72	5	77	11,27%
A2 - PERSPECTIVES IN INFORMATION SCIENCE	120	80	0	40	33,33%

Source: Instagram, Prepared by the authors.

When comparing Chart 5 with the other charts (6 and 7), it can be seen that the Followers versus Engagement ratio is more significant on Instagram. In Chart 6, for example, all the journals in the sample that have a Facebook page have a number of followers above 1,000, but for the same calculation of the Followers versus Engagement ratio, the results are below 10%.

Chart 6. Analysis of posts promoting a scientific manuscript, issue or volume (Category A) on Facebook.

Magazine	Followers	Total Reactions	Total Shared	Total Comments	Commitment	Followers versus Commitment
A1 - COLLECTION: JOURNAL OF THE NATIONAL ARCHIVE	11.000	430	178	4	612	5,56%
A2 - IN QUESTION	1.000	134	15	0	99,33	9,93%
A2 - BIBLIOGRAPHIC MEETINGS	1.200	3	1	1	5	0,42%
A2 - OBSERVATÓRIO MAGAZINE	28.000	17	5	0	14,67	0,05%

Source: Facebook. Prepared by the authors.

As in Charts 5 and 7, Chart 6 also shows that "comment" type interaction is rarely used and, when it does occur, it is generally praised or tagged of other users' profiles on the network. The number of followers on Observatory magazine's Facebook page is noteworthy - 28,000, which means it has a good reach and the possibility of disseminating science on this channel. However, as can be seen in Chart 4, the magazine made only six posts in the period analyzed and, of these, only one referred to the announcement of a new issue.

Another journal with a significant number of followers is Acervo - Revista do Arquivo Nacional, which is also present on Twitter (Chart 7) with over 1,000 followers.

Chart 7. Analysis of posts promoting a scientific manuscript, issue or volume (Category A) on Twitter

Magazine	Followers	Total Likes	Total Retweets	Total Comments	Commitment	Followers versus Commitment
A1 - ARCHIVE: JOURNAL OF THE NATIONAL ARCHIVE	2.162	295	120	0	276,67	12,80%
A1 - TRANSINFORMATION	36	15	2	0	11,33	31,48%
A2 - IN QUESTION	48	53	12	0	43,33	90,28%
A2 - PERSPECTIVES IN INFORMATION SCIENCE	136	1	0	13	4,67	3,43%

Source: Twitter. Prepared by the authors

Bearing in mind that journals with pages on more than one social network make the same posts on both and that a total of 173 posts were analyzed to promote a scientific manuscript, issue or volume, it was found that 169 of them combine image and text, with a poster with the title of the new publication and, in the case of a scientific manuscript, the names of the authors and a textual description, with excerpts from the abstract of the work and a link to the journal's website, like all the posts analyzed in Chart 7.

The Instagram and Facebook pages of the journal "Encontros Bibli" differ in that the four posts referring to the promotion of scientific manuscripts are short videos, produced by the researchers and explaining the content of the research. In addition, the video is accompanied by text with the title and abstract of the manuscript.

These analyses make it possible to return to the Brazilian survey on the public perception of science, in which it is noted that, in the historical analysis, the fraction of Brazilians who are able to mention the name of a Brazilian scientist or research institution has remained low (Brasil, 2019). Open Science is considered to mitigate this gap, by increasing the general community's confidence in the results of scientific research, carried out collaboratively, transparently and communicated widely, both among peers and to the non-specialized public.

If scientific manuscripts, the fruits of scientific research, are still mostly published through scientific journals, these are the actors with the best resources, such as contact with scientists and first-hand access to research results. In addition, "the intense and accelerated adherence of Brazilians to social media is an indisputable fact" (Bueno, 2018, p. 55), which allows scientific journals to use these spaces for scientific dissemination.

This scientific dissemination can be encouraged by the journals' affiliated institutions, research funding agencies and the indexers most highly regarded by the scientific community. These bodies are concerned with the quality of what is published in scientific journals and the impact of scientific publications. The alternative impact indicators, such as visibility and engagement, used in this study, are metrics that can help journals consolidate their social media pages.

5 CONCLUSION

This study aimed to analyze the pages and posts on Instagram, Facebook, and Twitter of Brazilian scientific journals rated Qualis A1 and A2 by CAPES in the 2017-2020 assessment in the C&I field. The objective was to measure the engagement of the posts, from August 2022 to January 2023, and whether they had content that was understandable to non-specialist audiences. When presenting the results in the previous section, it was noted that the most significant visibility of the journals is on Facebook, with a number of followers above 1,000, but the "followers versus engagement" ratio remains below 10%. The other social networks, even with a lower number of followers, have higher values for the same ratio calculation.

It is therefore considered that the three social networks have the potential to expand the values of alternative metrics of the impact of scientific productions, but they must also take into account another aspect: the content of the posts.

As we have seen, with the exception of one journal, the posts selected for the study sample, i.e. those categorized as "Promotion of scientific manuscript, issue or volume", combine an image with textual elements (title of the article and names of the authors) and a description, also textual, with a summary of the scientific manuscripts published on the journal's website. This combination is useful for informing peers about the publication of new scientific manuscripts, but it is not the most appropriate for communicating science to non-specialists.

The statements in the previous paragraph could wrongly suggest that text is a villain in science communication practices, especially on social media. However, it should be made clear that this type of format has the potential to reduce barriers that other formats require, such as mastery of image or video editing tools, physical structure, sound and image recording equipment, and others. In this context, it seems correct to say that what is essential in science communication is not the format, but the answer to the following question: Who is your contribution aimed at?

If the answer to the above question is "peers", then the way in which journals have published content on social networks is likely to remain the same. However, if the intention is to move forward, in the sense of aligning with Open Science practices, especially in the final stages of scientific communication, dissemination, and use, and thereby strengthen the democratization of scientific knowledge, there are some possibilities for scientific journals to consider when using public social networks.

Obviously, the practice of science communication requires a specialized professional, such as a science journalist, or a team and specific training courses, but it is known that the reality of journal teams, especially those managed by higher education institutions, is limited, with professionals involved in numerous other academic activities. For reasons such as these, it is important not to lose sight of the audience you want to reach, as well as the need to plan what you want to communicate, with basic elements such as a general theme, a specific theme, relevant information, a conclusion with possible reflections and, above all, understandable language.

Another essential aspect of using social networks is interacting with followers, using tools such as "follow back", responding to comments and questions, sharing third-party content about the journal's scope to attract followers, using simple language and respecting the specifics of the different networks. These actions, aligned with the quality of the content published, have the capacity to improve alternative metrics such as visibility and engagement, and consequently the impact of scientific productions, especially since a presence on social networks can attract new readers to the journal's website, generating citations and also strengthening traditional metrics.

Among the limitations of the study is the fact that 16 journals in the C&I field, rated A1 and A2, were not included in the sample because they did not disclose the existence of profiles in the social networks studied on their websites.

As a complement for future studies, we envisage the possibility of applying online questionnaires to editors of scientific journals in order to determine how committed they are to Open Science and how interested they are in promoting effective scientific dissemination.

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