Science and media as a field of study: an analysis of the Brazilian scientific production

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Abstract
A recent mapping of academic articles about science communication in Latin American shows that the media is the focus of the largest number of studies in the field, with 31% of 609 articles identified (MASSARANI et al, 2017). In this article, we analyse specifically the articles published by Brazilian authors. Our corpus consists of 154 articles that had as their theme the coverage of science by different means of communication. The results show that there is a concentration of articles in Brazilian magazines (88%). Most articles (60%) evaluate print media, such as newspapers and magazines, and 52% of articles use qualitative methodologies in their analysis. The authors' community is concentrated in institutions in Rio de Janeiro and São Paulo. Although they are geographically close, these authors collaborate with few pairs, resulting in a fragmented scientific community.
Keywords: Science communication. Media. Scientific production

Introduction

The media coverage of science in Brazil began in the 19th Century, with the arrival of the Portuguese Court, at which time the ban on printing in our country was suspended (MASSARANI; MOREIRA, 2016). The first newspapers, such as *A Gazeta do Rio de Janeir*o and *O Patriota*, already published texts about science (OLIVEIRA, 1999). In the course of time, this communication expanded and other media such as radio, television and the Internet gained importance as tools to communicate science to the general public.

In the 1970s, there was an effort to organize this practice, resulting in the creation of the Brazilian Association of Science Journalism in 1977 (MASSARANI; BAUER; AMORIM, 2013). Not by chance, the research in science communication had in the studies

in scientific journalism the foundations of its origin in Brazil. Apparently, the first PhD thesis in the area was the one by Wilson da Costa Bueno, entitled "Science Journalism in Brazil: the commitments of a dependent practice", and defended in 1984 (BUENO, 1984), supervised by José Marques de Melo, one of the main responsible for the institutionalization of communication research in Brazil and Latin America.

According to Moreira (2007) and Massarani and Moreira (2016), the last decades were marked by a significant expansion of science communication in Brazil. Among the changes that have taken place are the initiatives such as the emergence of magazines and websites, and the greater coverage of science subjects by the media. However, the authors also point out that, although the history of science communication in the country has at least two centuries of history and that the growth of the field has been expressive, the policies of incentive to Brazilian science communication still date from recent times.

One of the landmarks was the creation, in 2004, of the Popularization and Diffusion of Science and Technology Department (DEPDI) as part of the Secretary of Science and Technology for Social Inclusion (SECIS), in the then Ministry of Science and Technology. This department – which, with the merger in 2016 of the Ministry of Science, Technology and Innovation with the Ministry of Communications, was demoted in the institutional hierarchy – aims to contribute to improving the science communication in the country, especially in less privileged regions.

Another recent initiative that was significant for the field was the creation of the National Science and Technology Week in 2004, held annually in October (MOREIRA, 2006; MASSARANI; MOREIRA, 2016)scientific institutions and societies are making efforts for organizing national activities for the popularization of S&T. The main purposes are to promote scientific culture, to collaborate with the improvement of science education, to attract young peoples for S&T careers and to stimulate public engagement in science. The rich cultural diversity, the enormous social inequalities and the bad situation of science education put many challenges to these intentions. Recently large events for discussing and promoting public communication of science were organized, such as the IV World Congress of Science Museums, national and regional meetings of the Brazilian Society for the Advancement of Science and the World Year of Physics. A program for stimulating the creation of new science museums started recently. The National Week of Science and Technology was established two years ago; in 2005 about 7000 activities were organized in 350 cities, with the involvement of 850 research institutions, universities, scientific societies and high schools. We discuss here the present status of public communication of science in Brazil and the dilemmas and challenges for developing a national program for popularization of S&T.","author":[{"dropping-particle":"","family":"Moreira","given":"Ildeu de Castro","non-dropping-particle":"","parse-names":false,"suffix":""}],"container-title":"9th International Conference on Public Communication of Science and Technology

(PCST. The Week counts on the participation of science and technology institutions and offer activities, such as exhibitions and science events in public squares, universities open to visitation, scientific expeditions, activities that bring together science and art, among others. Other actions to be carried out have been described in the book of the 4th National Conference on Science, Technology and Innovation for Sustainable (BECKER et al, 2010) and include initiatives such as scientific popularization programs involving research institutions, government agencies and civil society; training programs for science communicators; improvement of science communication by the Brazilian media.

In turn, the academic area of communication in Latin America played a fundamental role to pave the way of consolidating research in science communication in Brazil and in other Latin America countries. Constantly expanding, this field of research is anchored in different disciplines, sometimes fragmented, which represents a challenge for those who work in this field. A study about the state of the art in science communication research in Brazil presents data that indicate the multidisciplinary nature of the field, demonstrating that science communication shares concepts with areas such as Education, Language and Science History (CALDAS; ZANVETTOR, 2014).

Even with this plurality, a mapping of research papers in science communication in Latin America showed that the use of the media to communicate science is the focus of most studies in this field, accounting for 31% of 609 papers analysed, followed by researches related to museums, which were 20% of the total (MASSARANI et al, 2017).

Therefore, the objective of this paper is to provide indicators on the research papers that analyse the relationship between science and mass media, carried out by Brazilians or in the Brazilian context, as will be further detailed in the next section.

Methodology

This study[1] was carried out as part of a broad survey that consisted of a general mapping of 609 research papers about science communication written by Latin Americans or carried out in the Latin American context, published in scientific journals (MASSARANI et al, 2017).

The papers that were part of our study were collected during six months, between March and September of 2016, and included papers published since the 1980s. The papers were collected in stages. In the first stage, we selected national and international research journals known for publishing articles on science communication studies and ran a full scan of the articles available on their websites. We also accessed online scientific repositories to search for terms such as science communication, popularization of science,

1 This study had the support of the by then Department of Popularization and Diffusion of Science and Technology of the then Ministry of Science and Technology, though CNPq.

communication of science, science museums, and science journalism, among others, in Spanish, Portuguese and English. In the second stage, we consulted researchers from the science communication area so they could indicate papers published by them and their peers, besides science journals to be consulted. In a last stage, we scanned the bibliographic references of the papers already collected, searching for studies and journals not yet listed in our research initially. Finally, we identified 154 papers about media and science in Brazil. After a general reading of all papers, we identified common categories and developed a protocol of classification. The papers were, then, categorized according to various aspects: the studied media; the methodology; the institution to which the authors are affiliated and in which region of the country it is located; among others.

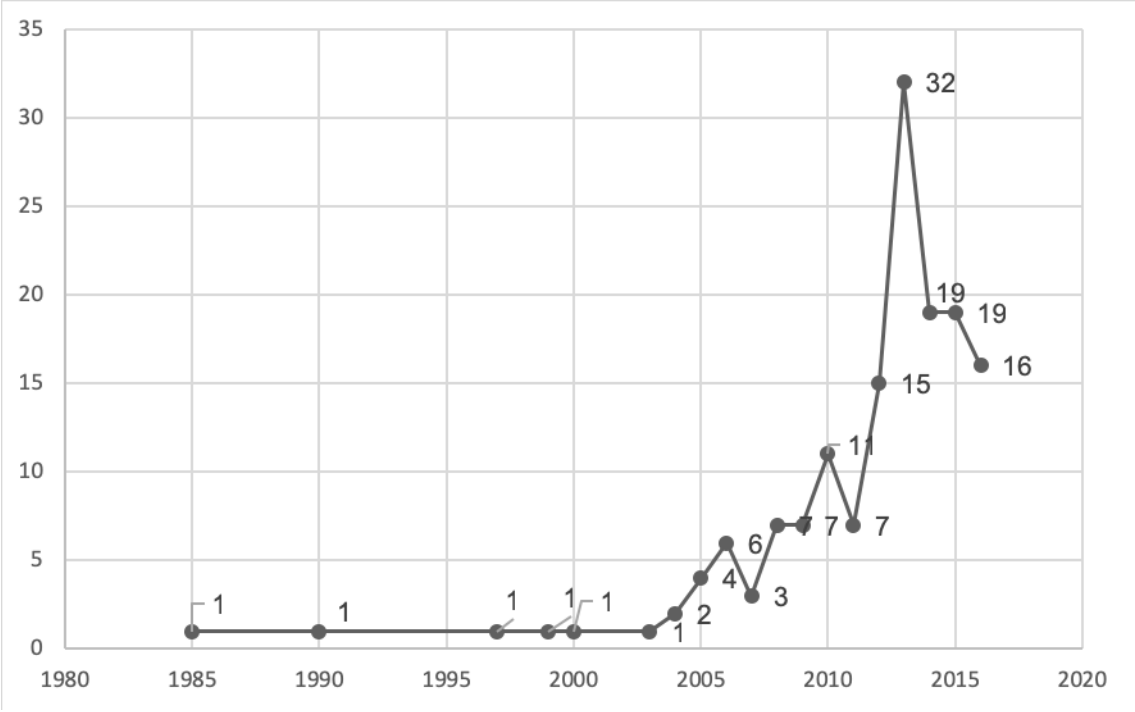
Although we have sought to collect as many articles as possible, our *corpus* is not exhaustive. The science communication is an area of multidisciplinary research, whose publications are distributed in several journals, as well as books and other means. Our search was limited to the online search, and journals that were not available in that format were not part of this review. In this process, important journals were left out, such as *Ciência e Cultura*, created in 1949 by the Brazilian Society for the Advancement of Science (SBPC), and *Revista Anhembi*, in which the scientist and science communicator José Reis published articles. Nevertheless, our research presents important trends about the study of science communication in Latin America from the academic perspective, still little known in our region. We collected papers published in 38 journals and the results are presented in the following section according to the periodicals in which the articles are published, the methodologies used and the authors of the articles.

Results

Characteristics of the journals

As mentioned before, a total of 154 scientific papers were collected from 38 journals. These papers refer to the relation between media and science in Brazil, and may have authors affiliated or not to Brazilian institutions. Initially, the papers were evaluated according to the year of publication of the journal. The oldest article was published in 1985 by Wilson Costa Bueno and describes how the printed newspaper *Jornal da Tarde* published information on science and health on the background of the state of health of then-President Tancredo Neves. There is a peak of publications in the year 2013, with 32 papers. It is important to highlight that our collection was completed in September 2016, and therefore, all papers published in that year were not collected (Graph 1).

Graph 1: Distribution of articles according to year of publication (n = 154 articles)



Source: Research data, 2017.

The results show that 32 of 38 scientific journals are Brazilian (88% of the collected papers were published in Brazilian journals). Of these journals, 21 only publish papers in Portuguese.

Chart 1 shows the distribution of papers according to the journal, considering a minimum of five papers – 28 journals had four or fewer articles.

Chart 1: Distribution of papers according to the scientific periodical (minimum of 5 articles)

Journal	Number of papers	Language
Revista Eletrônica de Comunicação, Informação & Inovação em Saúde	27	Portuguese
Intercom	16	Versions in Portuguese and English
Brazilian Journalism Research	11	Versions in Portuguese, English and Spanish
Alexandria	10	Portuguese
Bakhtiniana	9	Versions in Portuguese and English
Areté	8	Portuguese
Comunicação & Informação	5	Portuguese
Comunicação & Sociedade	5	Portuguese

Journal	Number of papers	Language
E-Compós	5	Portuguese
Revista Electrónica de Enseñanza de las Ciencias	5	There are papers in Portuguese, others in English, and others in Spanish

Source: Research data, 2017.

A significant part of the papers, about 35%, is concentrated in three Brazilian journals: *Revista Eletrônica de Comunicação, Informação & Inovação em Saúde*; *Intercom*; and *Brazilian Journalism Research*. About 12% of papers were published in eight international journals (Chart 2). Of these, four come from Latin American countries: two periodicals are Ecuadorian (three papers), one is Argentine (one paper) and one journal is Colombian (one paper). There is also a Spanish journal (five papers). We found few papers published in the three major journals in science communication research on the international scene (GUENTHER; JOUBERT, 2017), namely Science Communication (four papers), Journal of Science Communication (three papers) and Public Understanding of Science (one paper).

Chart 2: Distribution of papers by scientific journal according to the country of publication

Journal	Number of papers	Publisher country
Revista Electrónica de Enseñanza de las Ciencias	5	Spain
Science Communication	4	United States
Journal of Science Communication	3	Italy
Razón y Palabra	2	Ecuador
Revista CTS	1	Argentina
Revista Académica de la Federación Latinoamericana de Facultades de Comunicación Social	1	Colombia
Chasqui	1	Ecuador
Public Understanding of Science	1	United States

Source: Research data, 2017.

Thematic and methodological characteristics

The papers were classified according to the type of media that served as object of study: *Newspaper*, *Magazine*, *Television*, *Internet*, *Media in general* or *Others*. In the *Journal* and *Magazine* categories, we only include print vehicles. In the *Television* category, studies on television programs and newspapers were included. The *Internet* category included several forms of science communication made possible by the worldwide computer network, such as electronic news sites, electronic magazines, blogs, social media etc. *Media in general*

was used to classify articles that did not specify a type of medium but discussed in general the relationship between media and science. The *Other* category was used to classify media present in less than 5% of papers, such as *Radio* and *Advertising*.

In some cases, papers were classified into more than one category – when, for example, the study evaluated more than one communication vehicle, such as a newspaper and a magazine. Some studies have been classified as *Media in general*, as they discuss and reflect on the role of the media in science communication, without analysing a specific means of communication. We have identified a concentration of studies on printed media, as can be seen in Table 1.

Table 1: Classification of articles on science communication according to the means of communication evaluated (n = 154 papers)

Media	Number of papers
Newspaper	31%
Magazine	29%
Internet	21%
Television	17%
Media in general	6%
Others	14%

Source: Research data, 2017.

An evaluation of the papers' methodologies shows that most of the methods used in the analyses carried out by the studies use qualitative methods. Only 5% use exclusively quantitative and 42% use both types of methodology (Table 2).

Table 2: Distribution of the papers according to the methodology used (n = 154 papers)

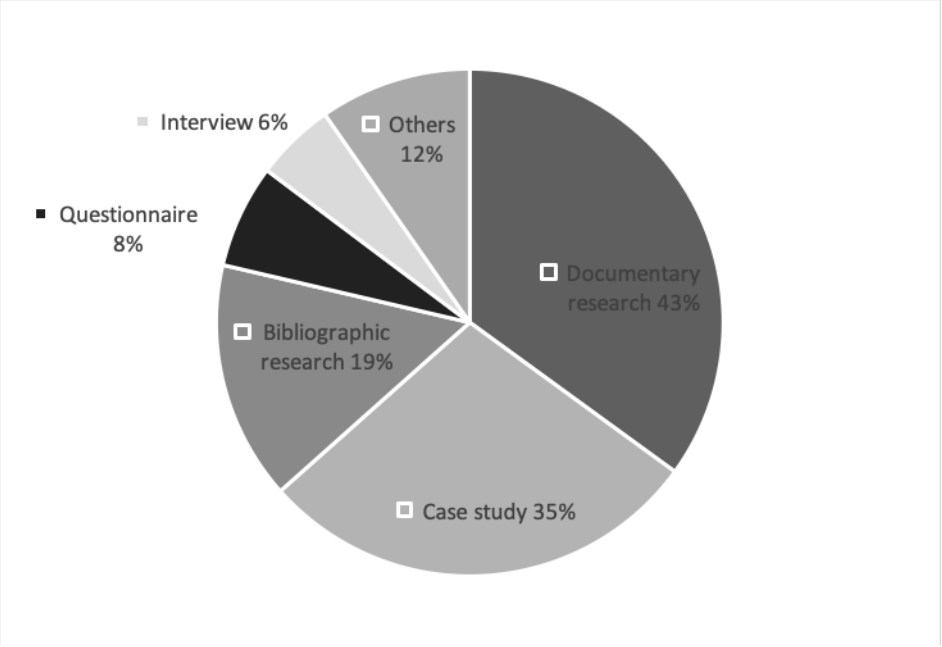
Methodology	Number of papers
Qualitative	52%
Quantitative	5%
Mixed	42%

Source: Research data, 2017.

A number of 16 different methods were identified and many papers used more than one of them. However, almost half of the articles (43%) used Documentary Research as methodology (Graph 2). Of these, the majority (86%) evaluate documents referring to traditional media. About 39% of articles do Documentary Research on printed newspaper articles; 28% evaluate printed magazine articles; 19% evaluate television programs and TV newscast. The rest (14%) evaluate science communication on the Internet, including websites and social media. Following, 36% of the papers selected Case Study as a method

of analysis, choosing and analysing specific titles from newspapers, magazines and other communication vehicles. About 32% of the papers that used Case Study as a method combined it with Documentary Research.

Graph 2: Distribution of articles according to the method used (n = 154 papers)



Source: Research data, 2017.

We also evaluated the keywords used by the authors of the papers. We found 623 keywords and “science communication” is the most used one, as shown by the word cloud illustrated by Figure 1. Considering that science communication is the focus of the collected papers, it is natural that such expression was the most used keyword. However, we also observe a high frequency of “science journalism” and “communication” as keywords, showing that papers also evaluate the presence of scientific topics in the media by the journalistic production and communication point of view.

Figure 1: Word cloud illustrating the frequency of each keyword found in the papers (n = 623 keywords). The larger the word size, the higher its frequency

Source: Research data, 2017.

In addition to the keywords, we compute the terms used to refer to the field, such as Science communication, Science popularization, Public communication of science etc. Sometimes the same paper used more than one term. The list is extensive, but most papers used the terms Science communication (72%) and Communication of science (58%), as shown in Table 3. To understand the use of these two main terms, we cite here definitions proposed in a glossary developed by the Mexican researchers Carmen Sánchez Mora and Ana María Sánchez Mora (MORA; MORA, 2003). According to the authors, the Science communication is a multidisciplinary field that, through a variety of media, seeks to communicate scientific knowledge to different audiences, recreating this knowledge with fidelity in order to make it accessible. The Communication of science, on the other hand, is the transmission of the scientific knowledge of its sources to diverse publics, with different educational levels. It is important to highlight, though, that there is no consensus among scholars and practitioners in the field about the definition of these terms.

Table 3: Terms used to define science communication and the percentage of articles that use each term (n = 154 papers)

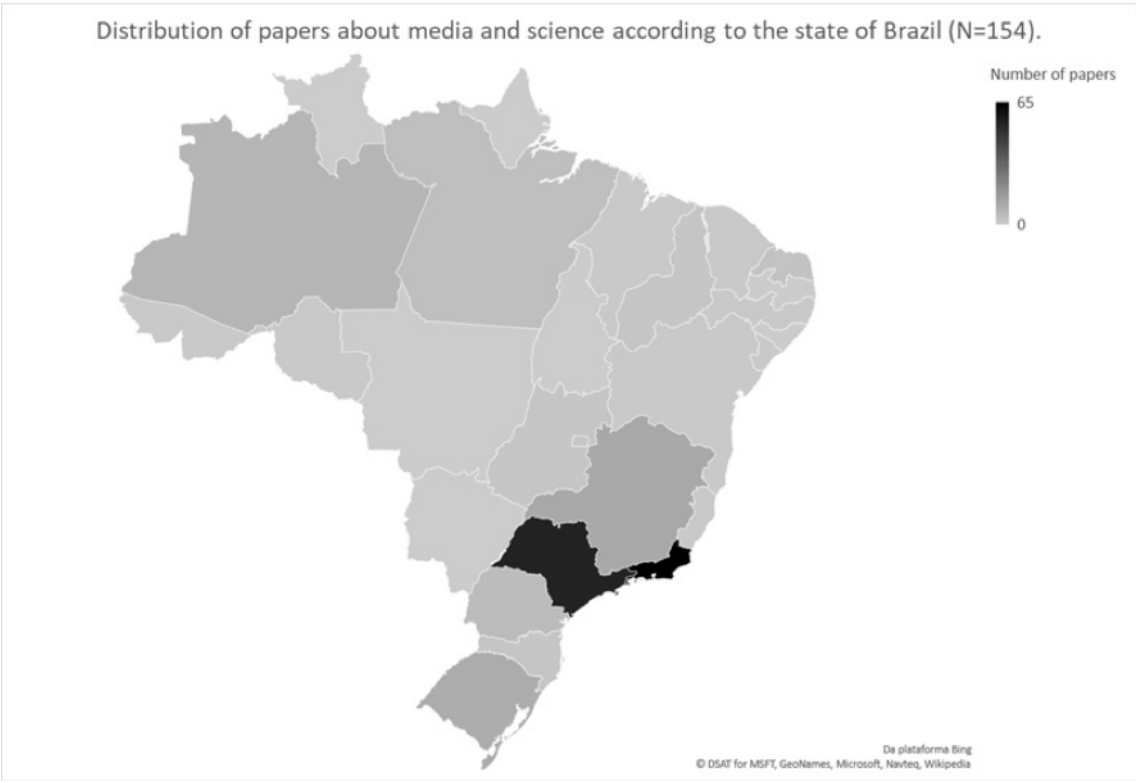
Term	Number of papers
Science communication	74%
Communication of science	58%
Science education	22%
Science popularization	13%
Science literacy	7%
Public communication of science	5%
Non-formal Science education	3%
Social perception of science	1%

Source: Research data, 2017.

Characteristics of the authors

The collected papers have 269 authors, most of them affiliated to institutions from the Rio de Janeiro-São Paulo axis (Figure 2). Rio de Janeiro is the state with the majority of institutions (41%), followed by São Paulo (34%). The most important institution is the Oswaldo Cruz Foundation, in Rio de Janeiro, responsible for 28% of all publications. Next comes the University of São Paulo, with 12% of publications, and the Federal University of Rio de Janeiro, with 10% of the total. Of the 154 articles collected, only six are the result of collaborations with authors from other countries. These collaborations were made between Argentina, Colombia, the United States, France, Portugal and Russia and three institutions from Rio de Janeiro, two from São Paulo and one from Paraná. When we looked at collaborations among states, we identified that about 13% of the articles result from collaborations made by scientists from different states – 65% of whom were authored by an institution researcher from Rio de Janeiro and/or São Paulo. Only two papers were published by researchers from three different states.

Figure 2: Distribution of papers about media and science published according to the state of Brazil (n = 154 papers)



Source: Research data, 2017.

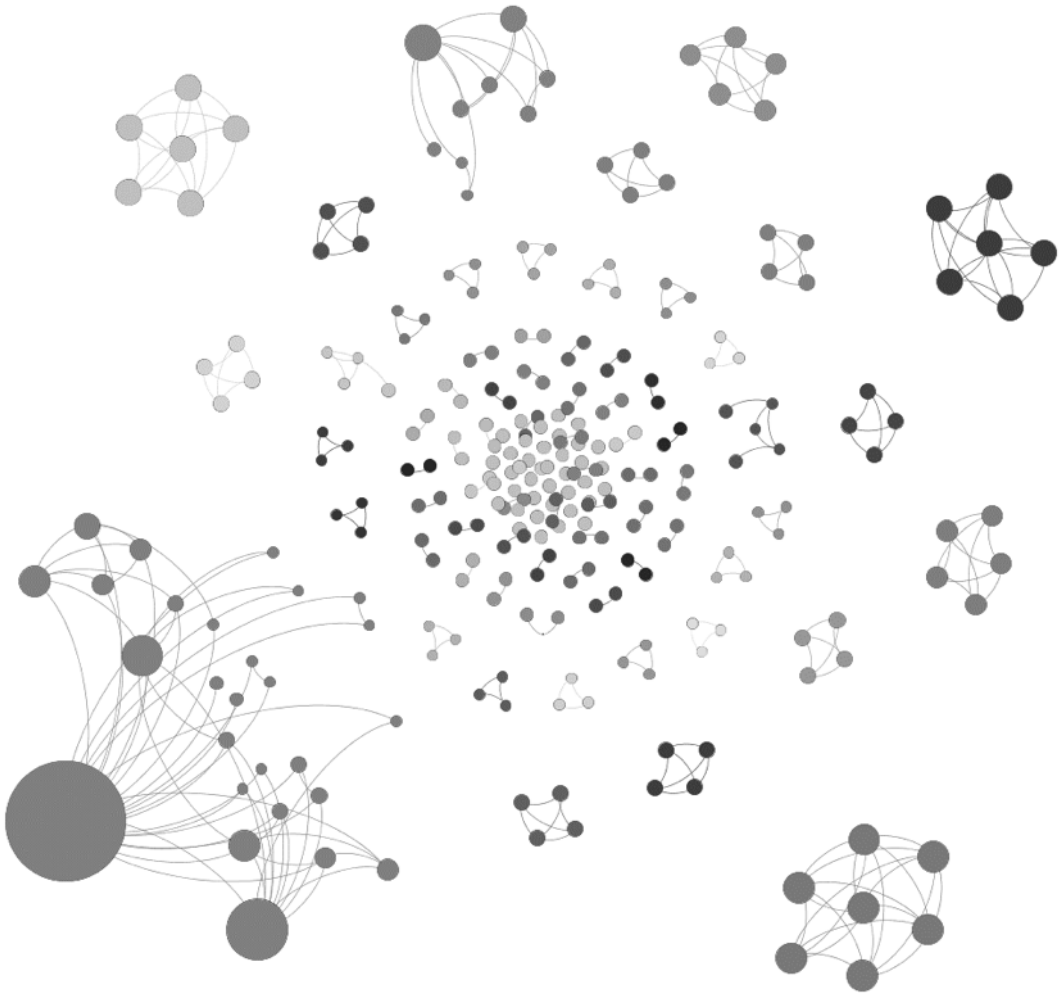
To understand how the collaboration between these authors occurred, we used the methodology of social network analysis. According to Liben-Nowell and Kleinberg (2004, p.1), a social network can be defined as the structure in which "we represent people or other entities embedded in a social context, and edges represent interaction, collaboration, or influence between entities". For the co-author analysis made in the present study, each author was represented by a node, while the published papers functioned as the connections between these authors (edges). Initially, we used the Table2Net[2] tool to process our data, organized it into an Excel spreadsheet, and turned the data into a social network to be read by Gephi software, an open tool used for graphing and statistical analysis of social networks (BASTIAN; HEYMANN, JACOMY, 2009). The network of co-authors evaluated in this study is illustrated in Figure 3. The most connected nodes are shown in larger size.

The nodes are grouped according to sets of authors who collaborate in one or more papers, representing communities of scientific collaboration. The group located in the lower left corner of Figure 3 shows the largest scientific collaboration community with 27 authors.

2 Available at: http://tools.medialab.sciences-po.fr/table2net/. Accessed on: 08 jul. 2017.

The results show that the co-authors network of our study has 269 nodes (authors) and 287 edges (co-authorship). The network is little connected and each node has an average of connections of 2,134 – that is, on average, each author has published papers with only two other authors. However, for many authors, this average would be even lower, since 30% of papers were published by only one author. Authors with no collaboration are represented by the isolated nodes found in the center of Figure 3. We also identify a large number of small communities within the network (109), which do not communicate with each other.

Figure 3: Representation of the social network of co-authors of papers on media and science communication in Brazil (n = 269 authors)



Source: Research data, 2017.

Figure 4 shows the largest community of scientific collaboration, that is, the group of nodes with more authors who published papers together. Of these authors, 44% are affiliated to the Oswaldo Cruz Foundation, in Rio de Janeiro. This community has 27 nodes and 58 edges, and each author has an average of 4,296 connections. It contains the author with more collaborations, being connected to the other 26 nodes.

Figure 4: Representation of the most integrated community within the co-authorship network (n = 27 authors)

Source: Research data, 2017.

Discussion and final considerations

This paper presents an analysis of the Brazilian academic production on the theme media and science. Considering that there is a centrality of the media in the construction of the social imaginary about science (PECHULA; GONÇALVES; CALDAS, 2014), our work investigated how the relationship between media and science has been constructed as a field of research.

Our results showed that most of the papers that make up our *corpus* are published in Brazilian academic journals, expressing an appreciation of national journals. However, a counterpoint to this scenario would be a possible lack of visibility of the studies carried out in this field of knowledge in the international scenario, a fact that has been to some extent minimized, since 23% of papers are published in other languages and almost all the

journals analysed here are open access via the Internet. Nevertheless, there is a low level of publications in renowned international journals in the area of science communication. In a survey of 1.803 science communication research papers published in the international journals *Science Communication*, *Public Understanding of Science* and *Journal of Science Communication*, Guenther e Joubert (2017) identified that only 1,6% of these were published by authors from Brazilian institutions.

The most studied media are print, such as newspapers and magazines. However, the Internet appeared ahead of the television, a much more traditional medium. This shows that scientific research accompanies a change that is occurring in the Brazilian science communication: the use of the Internet as a source of scientific information doubled between 2006 and 2015 (MOREIRA et al, 2017). It is necessary, however, to advance in the studies on social networks, considering that only three of the articles that we analysed had these platforms as an approach.

Regarding the research methodology, we identified that most studies are based on qualitative research. Considering the social and cultural context in which the researcher is (REES, 2008), qualitative research is widely used in studies of the human and social sciences. In this scenario, it is possible to include research in science communication, especially those that consider the media as a mean of communication, since this modifies depending on the social context, which brings aspects that must be considered by the researcher. The methods often used in research in media and communication talk with both qualitative research and the most commonly used media. The fact that most of the papers that were part of our analysis have documentary research as the chosen method suggest that the authors have an interest in evaluating science communication texts, especially printed ones, in order to understand aspects such as language. The second most used method is the case study, which is very present in mass media vehicle analysis.

We have identified that the most used term in our corpus is *Science communication*. According to the literature, in general, this is the most used term in Brazil, not being a specific case of the academic production in communication and media (GERMANO; KULESZA, 2007; MOREIRA; MARANDINO, 2015; ROCHA; MASSARANI; PEDERSOLI, 2017). However, papers with a greater focus not on the content to be communicated but on the media used to do so tend to adopt the term science communication (ROCHA; MASSARANI; PEDERSOLI, 2017), which is aligned with our analyses of publications on media and science. Although the term science popularization received more attention at the end of the eighteenth century, the term science communication gradually became more used. In Brazil, the National Council for Scientific and Technological Development (CNPq) uses the term to refer to its Adviser Committee and to José Reis Prize for Science Communication. However, in the scope of the Science ministry, to which CNPq is linked, the sector related to the field uses the terms Science popularization.

The academic production on the media and science communication reflected a regional inequality, since most of the articles were published by authors of institutions in São Paulo and Rio de Janeiro. It is important to note that these states host the main postgraduate courses in the area. In São Paulo, at the University of Campinas, the Laboratory of Advanced Studies in Journalism, created in 1994, was the first to offer a master's degree in science communication (MASSARANI et al, 2016). Six of the nine postgraduate programs in science communication (or with areas focused in this field) of Brazil are concentrated in Rio de Janeiro – among them, the Education, Management and Diffusion in Biosciences Program of the Institute of Medical Biochemistry of Federal University of Rio de Janeiro, created in 1995, and the master's degree in Science, Technology and Health Promotion, launched in 2016 by the Casa de Oswaldo Cruz.

This imbalance reflects a reality that also affects other fields of research. A ranking of the Brazilian universities that published the most between 2007 and 2011 is led by three universities in São Paulo (TOLEDO, 2013). In an analysis of papers published between 1992 and 2009 in Brazil, Sidone, Haddad and Mena-Chalco (2016) showed that there is an expressive concentration of publications from the Southeast region of the country. However, a biannual analysis made by these authors identified a decentralization: between 1992 and 1994, this region concentrated 68% of academic production, while between 2007 and 2009, it concentrated 54.3%. It is important to consider the regional differences in studies on science communication, since the topics of interest of the population, the way in which science communication is made and how the media are used are aspects influenced by the cultural context.

However, although the majority of the authors of the papers analysed in our study are from the same region of the country, the scientific community that studies science communication and the media seems little articulated. The social network analysis of co-authorship suggested that the authors published in an isolated way or collaborated with few authors. Based only on the analyses carried out in the present study, it is not possible to say if this fragmentation is due to differences in theoretical and methodological postures or different research themes. This result calls for a deeper evaluation, opening possibilities for future studies, such as an analysis of the references used by these authors. In addition, it is important to reflect on possible tools that reduce the fragmentation of this network and to increase collaborations, which would allow a synergistic action in this area of knowledge.

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