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SOCIAL SCIENCES

Science communication activities at research institutes in Brazil: Recent expansion on the way to professionalization

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Abstract: This study was designed to analyze the science communication activities geared towards the general public undertaken at Brazilian research institutes. We identified how often such activities are carried out and what human and financial resources are available for them. The results suggest that between the years 2013 and 2017 there was an increase in science communication by research institutes responsible for a wide range of activities. To communicate with the public, the 169 institutes studied tend to use traditional communication channels more than social media. However, most of them did not have designated communication teams, drawing on specialized personnel from their host institution. Although they do engage in intensive communication activities, Brazilian research institutes still lack more a structured approach to science communication.

Key words: science communication, science and technology, communication, research institutes.

INTRODUCTION

Higher education was late to be introduced in Brazil. Unlike in some countries in Hispanic America, where universities were founded in the sixteenth century, in Brazil no educational establishments under colonial rule. The first local institutions appeared in 1808, when the Portuguese Court was transferred to the country. Three schools were initially founded: the Bahia School of Surgery and Anatomy (now the Faculty of Medicine, Federal University of Bahia), the School of Surgery and Anatomy (now the Faculty of Medicine, Federal University of Rio de Janeiro), and the Marine Guard Academy, also in Rio de Janeiro (Martins 2002, Durham 2005).

Until the 1920s, the only higher education establishments in Brazil were independent and provided specialized training for liberal professionals such as lawyers, doctors or engineers who held positions in the state apparatus or in the service of the interests of the local elite. The only research was carried out at Brazilian and foreign institutes and geared primarily towards investigating issues of public interest (Durham 1998). These included the Campinas Agronomic Institute (Instituto Agronômico de Campinas), founded in 1887, the Oswaldo Cruz Institute (Instituto Oswaldo Cruz), founded in Rio de Janeiro in 1900, and the Butantan Institute (Instituto Butantan), founded in 1901. The latter two were both geared towards public health.

It was in the 1920s, as the country entered a period of social transformation, that scientists and educators from the Brazilian Academy of Sciences and the Brazilian Academy of Letters came together to spearhead a movement for the creation of a university that combined professional training with the development of basic science and research. The two universities that already existed, in Paraná and Rio de Janeiro, were nothing more than an agglomeration of isolated schools (Martins 2002).

The year 1930 saw the creation of the Ministry of Education (originally the Ministry of Education and Public Health). The following year, it was established through the signing of a decree that the university system was preferable to having isolated schools of higher education. In 1934, Gustavo Capanema took over as the minister, a position he would hold until 1945. During this period, the ministry counted on the involvement of highly regarded intellectuals in providing consultancy, designing projects, advocating educational proposals, and devising government programs. Under Capanema, the ministry became known for its promotion of major reforms, one of which, in 1937, resulted in the founding of the University of Brazil, today the Federal University of Rio de Janeiro. Two other important universities came into existence at the same time: the University of São Paulo (1934) and the University of the Federal District (1935)[1].

According to Pacheco & Corder (2010), science, technology, and innovation was consolidated at Brazil's institutions in four distinct periods. In the 1950s came the first wave of important institutions; this was followed, in the 1960s and 1970s, by a second wave under powerful state presence; in the 1980s, a third wave was marked by institutional weakness and economic instability; then, between the 1990s and 2000s came the emergence of new institutions in the context of increased economic openness.

Brazil's first policies for S&T development date back to the 1950s. It was in this decade that its scientific policy was first institutionalized, with the creation of two important federal institutions designed to support research and graduate education. Conselho Nacional de Pesquisas (National Research Council), now known as Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Council for Scientific and Technological Development, CNPq) was tasked with coordinating and stimulating the development of scientific and technological research in the country, while Coordenação de Aperfeiçoamento de Pessoal de Ensino Superior (Coordination for the Improvement of Higher Education Personnel, Capes) had responsibility for the training of specialized personnel. From then on, scientific development was a stated goal of state policy (Pacheco & Corder 2010).

After the university reform of 1968, research was undertaken within a new departmental structure at the country's universities and graduate education was institutionalized. The system of tenured professorships adopted in the following decade, prohibiting those who held these positions from working elsewhere, created more favorable conditions for the development of research at the public universities. With encouragement from Capes and funding from CNPq, this new institutional model transformed Brazilian science by increasing the number of people with master's and doctoral degrees and consolidating research groups in association with advanced degree courses. Public universities became the institutional mainstays of research and researcher training (Durham 1998).

S&T research was also undertaken in non-university settings at federal and state entities and R&D centers. The strong involvement of the state in the 1960s and 1970s prompted the creation of new national institutes and the reformulation of existing ones. Some were

[1] A Era Vargas, Centro de Pesquisa e Documentação de História Contemporânea do Brasil, https://cpdoc.fgv.br/producao/dossies/AEraVargas1/anos30-37/IntelectuaisEstado/MinisterioEducacao (Accessed on April 23, 2020).

linked to industry, like Instituto Nacional de Propriedade Industrial (National Institute of Industrial Property, INPI) and Centro de Pesquisa e Desenvolvimento (Center for Research and Development, CPqD), while others were geared towards scientific development, such as Instituto Nacional de Pesquisas Espaciais (National Institute for Space Research, INPE) and Instituto Nacional de Pesquisas da Amazônia (National Institute for Amazonian Research, Inpa) and for agricultural research, such as the Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Research Company, Embrapa) (Pacheco & Corder 2010).

The 1980s were marked by economic instability. In 1985, the Ministry of Science and Technology was created with the mission of coordinating the country's S&T system, and its international cooperation policy, sector policies, and the national research policy. From 1990 on, the S&T policy was incorporated into the overall process of economic opening. Reforms were introduced in a bid to ensure adequate coordination between scientific policy, industrial policy, and economic development (Pacheco & Corder 2010). In the 2000s, the relative macroeconomic stability enabled public investments in S&T to be resumed. However, the last few years have seen periods of discontinuity and shortfalls in R&D funding. The instability of the country's S&T policies is linked to a broader inability to build a long-term state project (Pelaez et al. 2017).

Science communication in Brazil

Science communication in Brazil should be seen within the broader context of the development of science in several Latin American countries, where it first appeared, albeit sporadically, in the eighteenth century. The country's earliest, relatively organized science communication initiatives date back to the early nineteenth century, driven by the political, cultural, and economic transformations wrought by the arrival of the Portuguese Court. The first institutions of a scientific and technological ilk were founded and the first science education texts were published in small numbers after the establishment of the Royal Press (Imprensa Régia) (Massarani & Moreira 2002). As of the mid-nineteenth century, science communication was intensified in various parts of the world as optimism burgeoned in the wake of recent scientific and technological advances. In Brazil, such activities were generally carried out by individuals and tended to be applied to the industrial arts (Massarani & Moreira 2002, 2016).

Science communication grew significantly in the 1920s in Rio de Janeiro, then the capital of the country. It was pursued by a small group of people linked to scientific and educational institutions, who adopted a variety of strategies to take science to the people across the country (Moreira & Massarani 2001, Massarani & Moreira 2016). One important move was the creation in 1923 of Rádio Sociedade, the first radio station in Brazil dedicated to broadcasting programs on science.

The 1940s witnessed the first initiatives in scientific journalism (Massarani et al. 2018). An important pioneer in this area was the biologist José Reis, who began writing a column about science in the newspaper *Folha da Manhã*, now *Folha de São Paulo*, every Sunday – a column that lasted for five decades. He also wrote for magazines, penned books for children and youth, and devised scientific radio programs for the general public. José Reis was also one of the founders, in 1948, of the Sociedade Brasileira para o Progresso da Ciência (Brazilian Society for the Advancement of Science, SBPC). One of its objectives, much like its US and British counterparts created in the previous century, was to contribute to science communication. In the

1970s and 1980s, SBPC became the leading entity in the promotion of science communication events and publications (Massarani & Moreira 2016).

In 1977, the first training for science communication professionals came with the founding of the Brazilian Association of Scientific Journalism, which by the 1980s had given rise to science editorials in the mainstream newspapers and new science magazines and television programs, such as *Nossa Ciência* (“Our Science”) (Massarani & Moreira 2016).

In the 1980s, new communication activities began to emerge. Alongside a greater presence of science in newspapers and magazines and on television, in line with international trends, new museums and science centers were founded: Centro de Divulgação Científica e Cultural (Center for the Communication of Science and Culture, 1980), in São Carlos, and the Espaço Ciência Viva (Living Science Space, 1982), a non-profit non-governmental organization in Rio de Janeiro, which was one of the first to develop the idea of an interactive museum (Massarani & Moreira 2016).

Although the field continued to grow, policies to foster science communication in Brazil only came later (Massarani & Moreira 2016). The area gained government support with the creation, in 2004, of the erstwhile Department for the Popularization and Spread of Science and Technology, linked to the Ministry of Science, Technology, and Innovation (ST&I). With specific funding, new S&T communication initiatives were possible. Another important initiative was the creation of National Science and Technology Week, held annually since 2004, with the broad participation of S&T institutions and a variety of science events and exhibitions in public venues, open days at universities, scientific expeditions, and activities combining science and art. (Massarani & Moreira 2016). However, with the merger of the Ministry of ST&I with the Ministry of Communications in 2016, the department lost status and funding, and was eventually extinguished in 2019.

When it comes to academia, Brazil is the leader in Latin America in the study of science communication, as measured by the number of articles published (Massarani & Rocha 2018). A recent study of scholarly publications in the area until 2016, focusing on the relationship between media and science, shows a predominance of articles in Brazilian journals, which account for 88% of Latin America’s production in this field. The most prominent topics are mass media, museums, science centers, and the relationship between science communication and the school environment (Massarani & Rocha 2018).

Academia has played a key role in paving the way for the consolidation of science communication research in Brazil and elsewhere in Latin America. Thanks to advanced degree programs in education and communication, scholarly publications in science communication in Brazil have risen since 2002. Even so, the work of Brazilians rarely appears in international publications (Barata et al. 2018).

Brazil is the Latin American country with the highest number of publications in the three most important international journals, *Science Communication, Public Understanding of Science*, and *Journal of Science Communication*, even if they are still few in number. According to Orozco (2018), only 40 of the 945 articles published in the three journals between 2008 and 2017 come from a country or group of countries in Latin America. Brazil is the most representative of these, accounting for 17 of the articles either individually or in partnership with authors from other countries.

Despite Brazil’s increased academic output in the area of science communication, very limited use is made of the knowledge generated for its economic, social, and technological development, and the gap between this knowledge and the practice of science communication remains. For Caldas & Zanvettor (2014), only through the widespread dissemination of science, highlighting its risks and benefits, will Brazilian society be able to participate in the national debate and take a stance on issues of public interest.

Also in the Latin American context, the role of Brazil stands out alongside countries such as Argentina, Chile, Colombia, and Mexico in the Red de Popularización de la Ciencia y Tecnología en América Latina y el Caribe (RedPOP), created in 1990 to connect museums, science centers and scientific outreach programs on the continent. The actions implemented by these countries contributed to the adoption of policies and instruments for the promotion of science, technology, and innovation in Latin America (Fernandez et al. 2015).

MATERIALS AND METHODS

This study is part of the international collaboration Mobilisation of Resources for Public Engagement with Science and Technology (MORE-PE)[2], whose aim is to evaluate the performance and mobilization of resources available for public engagement with S&T at research institutions from ten countries: Portugal, the UK, Brazil, the US, Germany, Italy, the Netherlands, Poland, Japan, and China (Entradas et al. 2020)[3]. As in the other nine countries, here the focus is on the middle level of the research structure, as opposed to the macro-level of universities or the micro-level of individual researchers and research groups. The Brazilian part of the study, which results are presented in this paper, was hold in the scope of the Brazil's National Institute of Public Communication of Science and Technology,

Sampling frame

The first stage in forming the sample was to get an overview of higher education in Brazil. To identify the country's institutions, we used the 2014 Higher Education Census conducted by the National Institute of Educational Studies and Research (Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira, INEP). Under the auspices of the Ministry of Education, INEP is responsible for policymaking and the production of statistics on the sector. At the time of the study, Brazil had 2,368 higher education institutions, including 195 universities (105 public and 90 private), 147 university centers, 1,986 faculties or colleges, and 40 federal institutes and federal centers of technological education (INEP 2016).

To define our sample, we crossed two university rankings: one international – The Times Higher Education ranking[4] – and one from Brazil – the Folha University Ranking[5]. After discarding duplicates, we selected the 50 best universities in the country according to the two rankings. As in Brazil the quality of universities is associated with the research they do, our hypothesis was that we would identify more research institutes at the top-ranked universities in order to reach the pre-established number of 1,200. In possession of the list of universities,

[2] https://morepe.my-free.website/.

[3] The results of the MORE-PE project were published in PLoS ONE in an article entitled "Public communication by research institutes compared across countries and sciences: Building capacity for engagement or competing for visibility?" (Entradas et al. 2020).

[4] Annual evaluation of the performance of universities around the world: https://www.timeshighereducation.com/world-university-rankings/2017.

[5] Annual evaluation of higher education in Brazil conducted by the newspaper *Folha de São Paulo*: http://ruf.folha.uol.com.br/2016/ranking-de-universidades.

we ascertained whether in fact the selected institutions did indeed conduct research. To do this, we visited the websites of all 50 universities and government research institutes. We analyzed the organizational infrastructure of each university and listed all the research institutes.

When we analyzed the research infrastructure at the Brazilian universities, we found that there was no uniform pattern. Each university had a different configuration, dividing its research into institutes, centers, departments, faculties, or sectors. In order to decide what criteria to use to select the institutes, we had to evaluate the structure of each university individually, observing what each institution called its institutes. Here, we refer to them either as "institutes" or "units."

The list of university research institutes was augmented by the list of federal research institutes (not at universities) and research and development centers run by state entities linked to government ministries. To enable comparative analyses, all the research institutes identified were listed. This gave a total of 945 institutes from 10 government ministries and 47 universities (three having been discarded because they did not have an organized or clear research infrastructure on their websites). Of this total, 899 research institutes were linked to public and private universities and 46 to government institutions. The institutes were also classified into to the Organization for Economic Co-operation and Development areas of knowledge.

We sent out our questionnaire for the first time to this final list of institutes in September 2017. We then resent it in October 2017, November 2017, and January 2018. The final collection date was February 2018. The questionnaires were sent to the professionals who were most familiar with the science communication activities of their research unit. In total, 169 valid questionnaires were collected, which form the core of this study: 149 linked to universities and 20 linked to government ministries.

As for the profile of the professionals who filled out the questionnaire, 50% were directors, coordinators or heads of the research unit; 15% were members of the science communication and engagement team; 15% were part of the management or administrative team; 15% were researchers; 4% were professors and researchers or professors and unit directors or journalists; and 1% were PhD students. Regarding the areas of knowledge of the units, 27% were from the exact and natural sciences, 20% were from the medical and health sciences, 19% were from the humanities, 18% were from the social sciences, 11% were from engineering, and 5% were from agrarian sciences.

The institutes were further classified according to criteria of excellence as indicated by the ranking of the universities to which they belonged. For this classification, the Folha University Ranking was used, which gives each university a score according to its educational, research, internationalization, innovation, and market performance. The Times Higher Education ranking was found to be insufficient for this classification, as it lists only 27 Brazilian institutions among the best in the world. The 149 university institutes in our sample were linked to 37 institutions, which were divided into two groups: "higher excellence," which encompassed the 22 top-ranked universities in the *Folha* ranking, and "lower excellence," with the 15 remaining universities.

Analysis

Principal Component Analysis (PCA) was used to analyze the data. Its function is to reduce the number of original variables to a smaller set of statistical variables (factors) with minimal information loss. In the analysis of the data on the institutes, the variables from each of the five blocks of questions were grouped into components using PCA. The first block was composed of variables related to the research institutes' science communication activities; the second combined the variables related to the audiences targeted by the different activities; the third block consisted of variables related to the human and financial resources intended for science communication; in the fourth block were the variables related to motivations, perceptions, and ethos; and the fifth block contained general information about the institutes.

Using PCA, we analyzed the activities of all the institutions that answered the questionnaire. Three types of science communication were identified: "public events," "traditional communication channels," and "social media." The frequency of the activities was measured on a 6-point scale: "never" (none), "annually" (once a year), "quarterly" (2 to 6 times a year), "monthly" (7 to 20 times a year), "weekly" (more than 20 times a year), and "I don't know." In the case of social media, given its characteristic speed, "daily" was used instead of "annually." There were nine public event variables: lectures, exhibitions, open days, science festivals, National Science Week, science cafés, international events such as International Years, and meetings for public policymaking. Traditional communication channels included 13 variables: newspaper, radio, television, other TV programs, press conferences, press releases, newsletters, publications, articles in magazines and newspapers, multimedia (videos, films), popular science books, policymaking documents, and educational materials (syllabuses, textbooks, etc.). Social media included six variables: blogs, Facebook, Twitter, Google+, YouTube, and podcasts.

PCA is justified when many correlated variables have to be analyzed. The higher the degree of correlation between them, the more appropriate this data reduction technique becomes (Figueiredo Filho et al. 2013). The analysis model enabled us to establish correlations between the variables and group them in fewer components, reducing them to a smaller number of factors for a better understanding of the results.

We also verified the adequacy of the sampling using the Kaiser-Meyer-Olkin test and Bartlett's test of sphericity, both of which are used in factor analysis. In all the analyses, adequacy values of over 0.70 (lowest acceptable value) were found: events (0.82); traditional communication channels (0.85); social media channels (0.86); internal and outsourced activities (0.72); types of audience (0.76); obstacles facing researchers (0.81); motivations (0.84); perceptions (0.88), and ethos (0.78). These values show that the data were significantly correlated and that factor analysis was appropriate. In all the analyses in this study, the communalities associated to each variable were considered reasonable (Ribas & Vieira 2011).

In this study the communalities of the variables of each block of questions were analyzed. Studies by Hair et al. (2009) indicate that communalities of less than 0.5 can be eliminated because they have insufficient extraction power, although they point out that in some cases such values can be retained because of their particular behavior. According to the communality values associated with each variable observed in the block, this was not an issue as all of the values were 0.5 or higher.

Using Varimax rotation, we identified similarities between the blocks of questions. This technique allows the variables' loadings to be distributed by principal components, eliminating intermediate loadings and identifying the components defined by the highest variable loading.

MAIN RESULTS

Science communication activities at the institutes

Most of the research institutes in our sample (63%) reported an increase in the number of science communication activities in the previous five years. The results obtained showed that they engaged in a wide range of activities aimed at the non-specialized public. One of the most frequent activities reported by them was lectures open to the public, which 28% held weekly and 29% held monthly. Some 53% also reported participating or collaborating in traditional annual events such as National Science and Technology Week. They also reported regularly holding other events such as exhibitions, science fairs and festivals, workshops, and open-doors events. Table I shows the frequency with which the research institutes were involved in these different activities over the course of twelve months.

Table II presents the principal components related to the activities. Three principal components were found to explain 67.12% of total variation. Using Varimax rotation, we identified that the first principal component combined the following science communication events: lectures open to the public, exhibitions, workshops, and guided tours. We labeled this group "Deficit." The second group, which

Table I. **Matrix of components of participation as an organizer or collaborator in science communication events.**

Questions	Rotated Component Matrix		
	Components		
Characteristics	Deficit	Contextual	Public Engagement / Lay Expertise
Lectures open to the public	.893	.355	.127
Exhibitions	.687	.084	.333
Open days, workshops, guided visits, and similar events	.899	.341	.138
Science fairs/festivals	.425	.493	.083
National Science Week and similar national events	.369	.786	.217
Events put on by private entities (businesses, industry)	.140	.598	.491
Lectures and workshops at schools	.158	.885	.193
Science cafés and other events for discussion with the public held outside the institution	.480	.215	.345
Events such as the Unesco international years, Fame Lab, and other international events	.214	.144	.754
Deliberative and participative public policymaking events (consensus conferences, citizens' juries, public consultations, hearings, etc.)	.511	.050	.550
Citizen science project (collaborations between researchers and the non-specialized public)	.125	.340	.699

**** Kaiser-normalized Varimax rotation.**

we labelled "Contextual," includes National S&T Week, events for private companies, and activities in/for schools. The third group covered the Unesco International Years, Fame Lab, and similar events, public policymaking events, and citizen science projects, and was labelled Public Engagement / Lay Expertise.

If we compare our results with the models of public understanding of science mapped by Brossard & Lewenstein (2010), it can be seen that the three blocks of activities analyzed in our study are different, with activities initially more related to the deficit model, like lectures ("Deficit" in Table II); a second block of activities more adapted to a specific audience, like school visits ("Contextual"); and a third block designed to be more dialogical and geared towards public engagement, enhancing public participation through public policy debates and lay knowledge through citizen science activities ("Public Engagement / Lay Expertise").

Communication channels

Traditional communication channels (magazines and newspapers) were used more frequently than social media. In order to address the general public, the Brazilian institutes made more use of mainstream media, especially in newspaper, radio, and television interviews. They also published articles in magazines and newspapers designed for a lay readership, as well as leaflets and institutional catalogs. However, press releases and newsletters – both used by institutions to communicate information they are keen to publicize – were exploited less. The least used communication means was the press conference. Table III shows how often the research institutes used traditional communication channels.

Using Varimax rotation, we describe below the blocks of questions related to the use of traditional communication channels (Table IV). The three principal components explain 71.69% of total variation. Each of the principal components uses similar communication channels for science communication, as previously described (see Table II). The first principal component ("Press Officers") combines TV interviews, participation in television shows and programs, press conferences, press releases, newsletters, brochures, catalogs, and other institutional publications. This group presupposes the involvement of a journalist, press officer or press office for their execution. The second principal component ("Engaged") combines the institutes that conduct radio interviews, publish articles in non-specialized magazines and newspapers, produce multimedia products and documents for public policymaking and industry. It combines individuals who are aware of and engage in science communication, and may include researchers who come into direct contact with the media or write for newspapers or magazines. The third principal component (Educators) is formed of popular science books and educational material (syllabuses, textbooks, etc.). This last group includes activities at the formal/non-formal interface, with books and educational material.

Interestingly, social media was largely overlooked by the units studied, as can be seen in Table V, which shows its frequency of use. Twitter, Instagram, Google+, podcasts, and blogs were little exploited as communication channels, with more than 50% of the institutes making no use of such media to communicate with the public. More frequent was the use of Facebook and the updating of institutional websites. Indeed, Facebook was the exception when it came to social media, being used to communicate with the public on a daily and weekly basis by 35% and 28% of the institutes, respectively. They also regularly updated their

Table II. Matrix of components of participation as an organizer or collaborator in science communication events.

Questions	Rotated Component Matrix		
Characteristics	Components		
	Deficit	Contextual	Public Engagement / Lay Expertise
Lectures open to the public	.893	.355	.127
Exhibitions	.687	.084	.333
Open days, workshops, guided visits, and similar events	.899	.341	.138
Science fairs/festivals	.425	.493	.083
National Science Week and similar national events	.369	.786	.217
Events put on by private entities (businesses, industry)	.140	.598	.491
Lectures and workshops at schools	.158	.885	.193
Science cafés and other events for discussion with the public held outside the institution	.480	.215	.345
Events such as the Unesco international years, Fame Lab, and other international events	.214	.144	.754
Deliberative and participative public policymaking events (consensus conferences, citizens' juries, public consultations, hearings, etc.)	.511	.050	.550
Citizen science project (collaborations between researchers and the non-specialized public)	.125	.340	.699

** Kaiser-normalized Varimax rotation.

Table III. Frequency of different science communication events.

Events	Weekly	Monthly	Quarterly	Annually	Never	Don't know
Citizen science projects	6%	8%	24%	28%	24%	10%
Talks and workshops at schools	8%	15%	28%	28%	17%	4%
Events organized by private institutions	2%	8%	17%	26%	41%	6%
Deliberative and participatory events on policy-making	3%	8%	26%	30%	27%	6%
International events	1%	1%	13%	37%	38%	10%
Science cafes and similar events	1%	5%	17%	20%	51%	6%
National Science Week and similar events	1%	2%	22%	53%	19%	3%
Science festivals and fairs	1%	3%	31%	30%	30%	5%
Open days, workshops and guided visits	16%	11%	36%	29%	7%	1%
Exhibitions	6%	8%	37%	31%	16%	2%
Public lectures	28%	29%	25%	14%	4%	-

Table IV. Frequency of communication through different channels.

Traditional channels	Weekly	Monthly	Quaterly	Annualy	Never	Don't know
Materials for schools	4%	8%	14%	32%	36%	6%
Policy papers/briefings on policy issues	1%	7%	18%	29%	36%	9%
Popular books	5%	11%	25%	40%	14%	5%
Multimedia/videos/Films/ podcasts	9%	8%	31%	25%	22%	5%
Articles in magazines, newspapers	13%	14%	34%	23%	12%	4%
Brochures/leaflets/publication	5%	15%	24%	31%	20%	5%
Newsletters	19%	15%	12%	19%	32%	3%
Press releases	15%	12%	23%	18%	28%	4%
Press conferences	2%	4%	8%	20%	59%	7%
Interviews for the TV	10%	9%	40%	24%	14%	3%
Interviews for the radio	8%	15%	35%	27%	12%	3%
Interviews for newspapers	14%	17%	35%	24%	8%	2%

Table V. Frequency of communication through social media channels.

Social media channels	Daily	Weekly	Monthly	Quaterly	Never	Don't know
Podcasts	3%	5%	7%	7%	65%	13%
YouTube	6%	12%	17%	26%	32%	7%
Instagram	7%	11%	5%	11%	56%	10%
Google+	7%	7%	5%	10%	59%	12%
Twitter	15%	13%	5%	6%	51%	10%
Facebook	35%	28%	17%	9%	8%	3%
Blogs	6%	10%	10%	9%	56%	9%
Website updates	32%	28%	18%	14%	5%	3%

institutional websites, 32% doing so daily and 28% doing so weekly.

Profile of science communication teams

A high proportion of the institutes reported having some science communication experience, with 46% performing such activities for over ten years. Regarding the institutional affiliation of the professionals responsible for science communication and engagement, most of them worked for the host institution. However, 44.5% of them did not have their own teams, making recourse to the host institution's infrastructure and specialized personnel, while 39.5% had a team in their own research unit. Only 16% of the units did not have their own team or have access to professionals from the host institution for their science communication activities.

Although most of the institutes used their host institution's communication resources because they did not have their own, they still managed to put on a lot of activities. The most common of these were: updating websites (82%), organizing and managing events (75%), preparing printed matter (61%), and website building (57%).

Table VI shows the types and frequency of activities performed by the communication teams either at the institute itself or at its host institution. Once again, online communication

Table VI. Frequency of communication activities.

Communication activities	Very frequently	Frequently	Ocasionally	Rarely	Never	Don't know
Assist researchers on planning research applications	9%	16%	11%	11%	51%	2%
Organize/offer communication training	6%	8%	14%	25%	45%	2%
Organize public events	22%	38%	22%	10%	8%	-
Manage the website and online communication	59%	30%	3%	5%	2%	1%
Compose/edit/stream audiovisual materials	32%	40%	13%	13%	-	2%
Compose/edit/print communication materials	35%	37%	14%	13%	-	1%
Intervene in moments of institutional reputation 'crisis'	5%	16%	29%	25%	22%	3%
Motivate researchers to get involved in public communication events	18%	41%	16%	17%	8%	-
Create/propose public communication action plans	13%	41%	27%	14%	5%	-
Decide on public communication policies	14%	46%	21%	13%	6%	-

was important, with the maintenance and updating of institutional websites and the editing and broadcast of audiovisual material (photographs, videos, etc.). The professionals were also involved in planning institutional communication, and proposing communication action plans in with their management team. Conversely, the units did not engage much in organizing training for researchers in science communication and media relations.

Human and financial resources devoted to science communication

For the three years from 2014 to 2016, the estimated amount of funds channeled into research at 46% of the units was less than R$ 330,000; 16% received R$ 330,000 to R$ 830,000; 13% received R$ 830,000 to R$ 1.65 million, 10% received R$ 1.65 to 3.3 million, and 15% received over R$ 3.3 million[6]. Most of the institutes relied on a mixture of internal and external funding to compose their budget, as shown in Figure 1.

Most of the institutions devoted less than 5% of their annual budget to science communication (Figure 2). Interestingly, a high proportion of the institutes were unaware of how much of the budget was allocated for science communication, or did not even have resources allocated throughout the year to carry out such activities (12%). In this context, the vast majority of the institutes studied (70%) advocated a higher allocation of resources for this purpose

[6] 1 United States Dollar / USD = 5.0606 Real / BRL (see https://www.bcb.gov.br/conversao, Accessed on December 17, 2020).

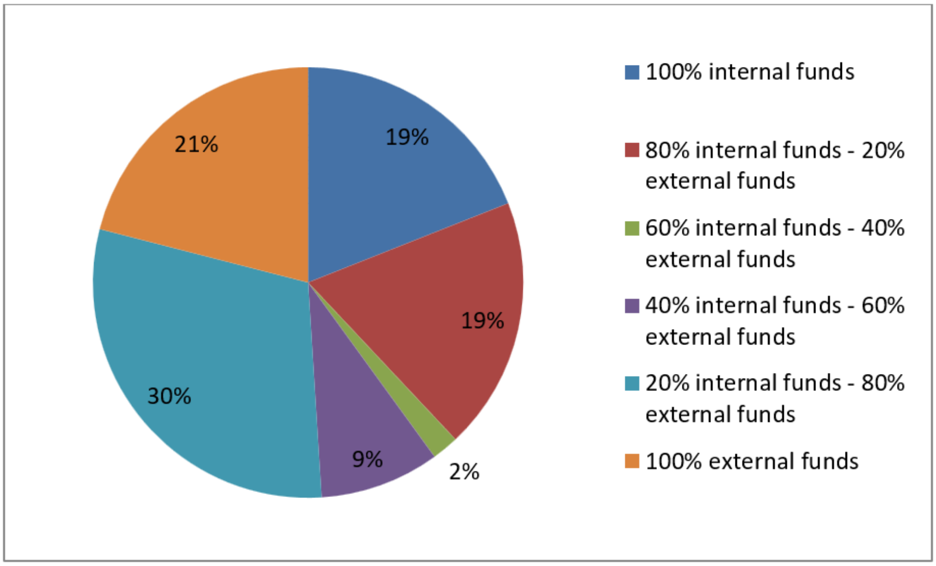

Figure 1. Internal and external funding.

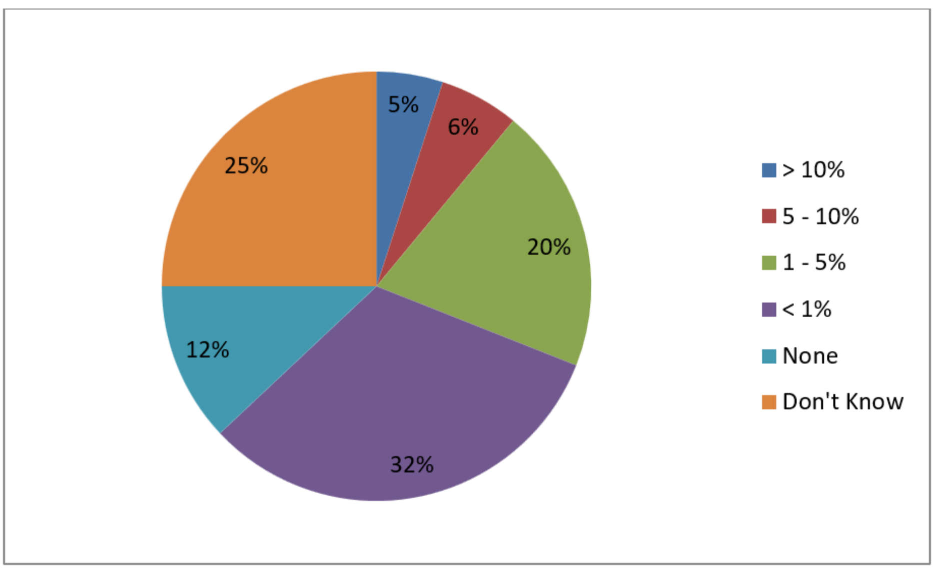

Figure 2. Proportion of the annual budget available for communication.

Relationship between institutes and the media

In this study, we also ascertained how the institutes interact with the media by assessing the interest and frequency with which journalists made an effort to find out what research they were doing or to contact sources for interviews (Figure 3). According to the results, the institutes received journalists' requests with a certain regularity along the year: 35% were asked to collaborate with the press more than ten times a year and only 5% did not receive any press interest.

Despite establishing regular contact with journalists, a good number of the units did not maintain a list or database of journalists and members of the media whom they could contact: 37% had no such contact list and 32% did not have a list or database, but did keep a list of personal contacts with journalists. When the press needed to contact the unit in search of sources, in 40% of the institutes the journalists alternated between making contact with the institute's or host institution's communication team or contacting a researcher directly. In only 17% of the cases would journalists contact the

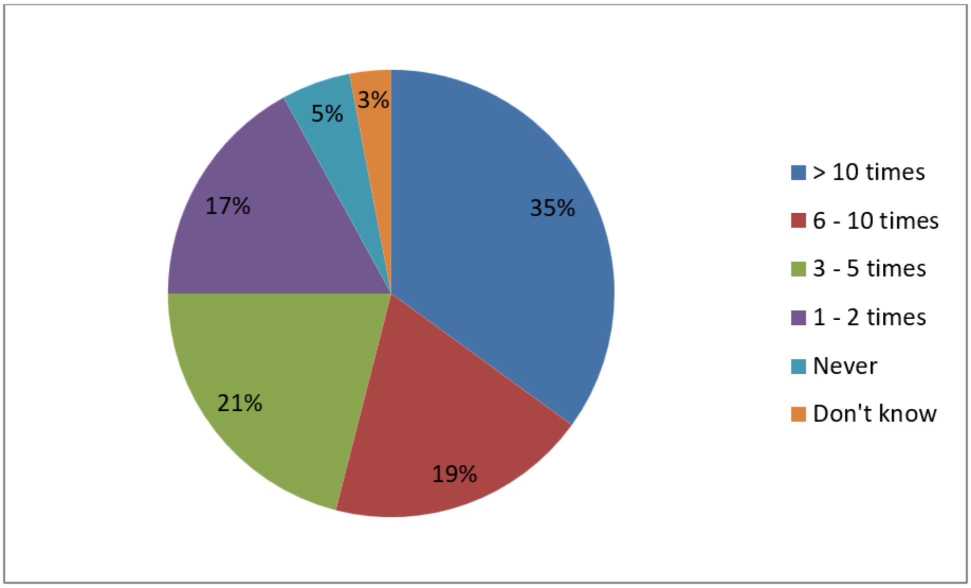

Figure 3. Media/ journalists' enquiries.

communication or administration team of the research institute. In all, 47% of the institutes believed that their communication efforts were successful in fulfilling the institution's mission.

Target public and reasons for communicating

The non-specialized public was the primary target of the science communication activities, although media and schools were also targeted. To a lesser extent, the institutes directed their activities towards NGOs, public officials, and industry representatives, which were identified as occasional audiences by one third of them. The main motivations for communicating with the public, in decreasing order, were the fulfillment of the institute's or university's mission, followed by publicizing its research and promoting its scientific profile.

Researchers play a key role in science communication, which implies that institutes rely on them to enhance their public profile. A significant number of Brazilian institutes (47%) reported that their primary mission in engaging in communication activities was driven by institutional policy. The overwhelming majority (92%) expressed the expectation that their researchers would engage in such activities, while 55% stated that they did not have either a communication plan or an institutional communication policy, but still communicated with the public. However, the perception was that they received little institutional support to engage in such activities.

Although the sample already includes units belonging to the top ranking universities in the country, we observed that the ones of greater academic excellence engaged in more science communication activities than their counterparts ranked less highly. Of the 149 university institutes in our sample, 109 were from the higher-ranking universities and 40 to the lower-ranking ones; 56% of the former institutes organized and participated in weekly or monthly lectures open to the public, while just 35% of the latter did so. Traditional communication channels such as newspaper interviews were used weekly and monthly by 63% of the higher-ranking institutes (vs. 50% of the lower-ranking ones) and television interviews were used weekly and monthly by 56% of this former group (vs. 42% of the lower-ranking group). When it comes to social media, Facebook was used daily and weekly by 61%

of the higher-ranking institutes (vs. 47% of the lower-ranking institutes). Institutional websites were updated daily and weekly by 60% of the higher-ranking institutions (and by 40% by of their lower-ranking peers).

The data therefore indicate that the top-ranking institutes are also the ones that engage in more science communication in its different forms.

Brazil stands out in the context of the international project MORE-PE due to the intensity with which it develops science communications activities. Such a highlight could be related to the size of Brazilian institutes when compared to other participating countries (Entradas et al. 2020). In general, the research institutes in Brazil, Italy, and the Netherlands were the ones that organized more events and used traditional media to communicate with the public. While institutional websites were the most used channels in digital media by the countries participating in MORE-PE, Brazil can be highlighted as the main user of Facebook among social media. Although countries with more specialized teams have achieved greater visibility in digital media, further studies are needed to identify whether this is a trend of change in the culture of institutions (Entradas et al. 2020).

DISCUSSION

The results of our study show that Brazilian institutes generally engage widely in science communication, organizing and participating in a variety of activities: lectures open to the public, exhibitions, events such as the National S&T Week, etc. At this point, it is worth pointing out that our data show that a group of Brazilian research institutes have taken part not only in traditional activities such as lectures, school visits, and website maintenance, but also in more dialogical activities designed to engage the public in debates about public policies and the importance of citizen knowledge.

The institutes' high rate of communication activities reflects the construction in recent decades of a favorable environment, despite the decline in recent years, which makes even the lower-ranking institutions present a good performance.

The National S&T Week was created by presidential decree in 2004 and since then has gained the support of several institutions throughout Brazil. In terms of public policies, the creation of the Department for the Popularization and Communication of Science and Technology, linked to the then Ministry of Science, Technology and Innovation, despite no longer existing, has consolidated public policies aimed at science communication, including the allocation of financial resources through public calls for projects (Massarani & Moreira 2016).

Science communication has grown since the 1980s with the creation of science museums throughout the country, as well as science-oriented magazines and television programs (Massarani & Moreira 2016). Brazil is also the country that publishes most scholarly articles on science communication in Latin America (Massarani & Rocha 2018).

When they seek to communicate with the public, Brazilian research institutes use traditional media more than social media. The exceptions are the updating of their websites and the use of Facebook. These practices are largely in line with the latest trends in the behavior of the Brazilian public when seeking S&T information. According to a recent survey on public perceptions of S&T in Brazil (CGEE 2019), the two media most used by Brazilians to seek information on science and technology are the television (47%) and the Internet (39%). On the Internet, they seek information primarily through search engines (21%), followed by Facebook (13%) and YouTube (11%).

The regular use of Facebook could also be explained by a recognition of its popularity in Brazil and its potential to reach a wider audience, providing greater institutional visibility among funding agencies and society in general. According to a study done by London-based GlobalWebIndex[7] (2019), the Brazilian population are second only to the Philippines in social media usage. In 2019, the average Brazilian spent 225 minutes a day on social media. In the United States, which ranks 25th, the average is 117 minutes a day, while the global average is 150 minutes. As the public moves increasingly online in search of scientific information, researchers, their institutions, and the scientific knowledge produced by them become more and more inseparable from social media such as Facebook and YouTube and a multitude of new platforms (Brossard 2013).

Regarding the relationships established between the institutes' communication teams and the media, the results suggest the need for stronger ties in order to provide greater visibility for the research they do. Despite the fact that research institutes engage in diverse forms of communication, they need more structured communication teams at their disposal, with the allocation of more resources for communication activities and closer, better-organized media relations.

This still unconsolidated relationship between institutes and the media could also be attributed to the need to adapt the way science communicators are trained in the country. Although the first course in the area was created in 1972 – an outreach course in scientific journalism at the University of São Paulo (USP) – the first advanced diploma course in the area only came in 1999: the Specialization in Scientific Journalism, run by the Laboratory of Advanced Studies on Journalism at the University of Campinas (Labjor/Unicamp). In 2007, Labjor/Unicamp again took the lead by offering the country's first master's degree in science communication (Caldas et al. 2005), followed by Casa de Oswaldo Cruz in 2016. Currently, these are the only master's degree courses specifically geared towards this field in Brazil, even though hundreds of dissertations and theses on science communication have been defended in the country in different academic areas.[8] Another barrier is the regional concentration of the offer of graduate education in the southeast of the country (Massarani et al. 2016). Despite the various initiatives that have emerged for the training of scientific journalists since the 1970s, the different course formats and their effectiveness have not been assessed consistently (Caldas et al. 2005).

The results of this research show that although Brazilian research institutes engage actively in a variety of communication activities, they still lack a robust structure for science communication, require more funding for this activity and greater professionalization of their communication teams.

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