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BRAZIL

History, significant breakthroughs and present challenges in science communication

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1. Introduction

From the 16th to the 18th centuries, systematic scientific activities and the communication of ideas of modern science were almost non-existent in Brazil, which at that time was a Portuguese colony of exploitation. The country had a small population, most of whom were illiterate. Furthermore, in the 18th century, the press and the publication of books were prohibited in Brazil. New scientific knowledge was accessible only to a few individuals belonging to an elite of people who had been educated abroad.

The first, yet still very limited, consistent expression of science communication in Brazil occurred in the early 19th century. It was due to an overriding political motive: the Portuguese Court[1] had arrived in Brazil and it was necessary to create suitable conditions for the administration of the metropolis and the colony. Ports were opened, the ban on printing was lifted, and the first institutions linked to science and technology (S&T) were created. These included the Real Horto [Royal Garden] (1808), the Real Academia Militar [Royal Military Academy] (1810) and the Museu Real [Royal Museum] (1818). All these institutions were located in Rio de Janeiro, which was the capital of Brazil until 1960, when the capital moved to Brasília.

1 The court moved to Brazil in 1807, when Napoleon threatened to invade Portugal. It remained there until 1821.

The Museu Real, later called Museu Nacional [National Museum] and whose images collapsing in fire in September 2018 shocked the world, was created by the Emperor Dom João VI to stimulate scientific knowledge in Brazil. Initially it hosted collections of stuffed animals, biological materials and machines, among other objects.

Since then, science communication activities have taken place in Brazil, with higher or lower intensities according to different times and initiatives, including stories in the mass media, science communication magazines and popular conferences.[2] The 1920s in particular should be highlighted, because this was when science communication was used as a tool by the embryonic scientific community (led by the then recently created Brazilian Academy of Sciences) to promote the basic sciences (see Massarani and Moreira, 2016). In 1923, in the saloons of the Academy of Science, Radio Sociedade (Society Radio) was born. It was the very first radio station in Brazil, set up only a couple of years after the first radio broadcasts in the world, and aimed to broadcast information, science content and music.

2. After World War II

New spaces for science communication emerged in Brazil after World War II (WWII) as part of a global movement in which science gained prominence. An expression of the concerns of the time was the creation of the Brazilian Society for the Advancement of Science (SBPC, from the acronym in Portuguese) in 1948. Public engagement was an important part of its activities.

Some newspapers (mainly in Rio de Janeiro and São Paulo) created science sections (Esteves, 2011), such as *A Noite* and the newspapers of the Folha Group. In the latter, José Reis—an icon of science communication in Brazil—was a columnist for about six decades (Massarani et al., 2018). Many of the stories that appeared in the newspapers described activities of the Brazilian research institutions and advocated for better conditions for science practice in the country: funding, resources, infrastructure, status, recognition.

By the 1950s, public interest in the physical sciences was awakened due to debates about the use of nuclear energy for military and civilian purposes, and also because the Brazilian scientist Cesar Lattes participated in the discovery and identification of the pi-meson in the years 1947–48. Popular newspapers and magazines with wide circulations, such as *O Cruzeiro* and *Manchete*,

2 It is worth mentioning the Popular Conferences of Gloria in the 19th century (see Correia, 1876).

published science stories highlighting activities of Brazilian institutions and researchers and the advances made in the field of nuclear energy. An example of the popular interest in Cesar Lattes's work can be found in the lyrics of the samba *Ciência e arte* [Science and Art], written by Cartola and Carlos Cachaça, for the Mangueira samba school (1948), in which Lattes and the painter Pedro Américo are honoured:

> You are my Brazil everywhere.
> Whether in science or art
> Portentous and towering …
> There are sages like Pedro Américo and Cesar Lattes.[3]

The influence of the atomic bomb and its consequences led to many references in the Brazilian literature of this period, particularly in the poetry of Carlos Drummond and Vinícius de Moraes.

An example of best practice was the supplement *Ciência para todos* [Science for All]. It was published monthly by *A Manhã*, between 1948 and 1953. Having as editor Fernando de Souza Reis—brother of the abovementioned José Reis—it had the participation of key scientists, such as the biologist Oswaldo Frota-Pessoa (Esteves et al., 2006). Its editorial line was renowned for its appreciation of Brazilian science, for encouraging research activities and for its particularly positive outlook on science and scientists.

The *Jornal do Commercio* took a similar approach on its Sunday page *Ciência* [Science], published between 1958 and 1962 (Moreira and Massarani, 2011). Coordinated by the scientist Walter Oswaldo Cruz and supported by other scientists and professors, it emphasised the role of science for the development of Brazil. Its presentation shows the mentality of the time:

> This supplement, inaugurated today, is a mild gesture to awaken the country on this morning of its industrialization era. Its soft villager´s sleep of citizens from a few centuries ago, needs to end since the machines wait them for multiplying the richness to be shared, by means of the industry. Brazil will not develop without technicians, and technicians are the human product of science. The development, the prestige, the understanding and the advancement of science will open the only path towards the growth of real economic independence of our country.[4]

3 www.vagalume.com.br/cartola/ciencia-e-arte.html.
4 *Jornal do Commercio*, 16 November 1958, Third Section, p. 3.

3. Science museums and centres: The post-war years

Science museums and science centres are important to Brazil. For more than a century, the science museums in Brazil were mostly natural history, such as the Museu Nacional in Rio de Janeiro, destroyed by fire in September 2018, and the Goeldi Museum in Pará, both created in the 19th century. They fell within the typical model of museums endowed with material objects intended for preservation, static displays and no hands-on activities.

Since the 1920s, science museums with more dynamic characteristics have been proposed. For example, Edgard Roquette-Pinto, one of the most enthusiastic science-communicator scientists of the 1920s (his voice was frequently heard on the first Brazilian radio programs) proposed a museum similar to the Deutsches Museum (Venâncio Filho, 1995). New attempts were made in the 1950s and 1960s in Rio de Janeiro and São Paulo: illustrative of those attempts is a story in a newspaper about the proposal of a Science Museum and a Planetarium in the Ibirapuera Park, in 1954.[5] The Planetarium of São Paulo, the first in Brazil, however, was set up in January 1957.

In Rio de Janeiro, the scientist Carlos Chagas Filho systematically tried to persuade stakeholders (such as the dean of the Federal University of Rio de Janeiro and state authorities) to create a designed space based on the Palais de la Découverte (France) and Chicago Museum (US), with the objective of 'spreading scientific knowledge into the public and enhancing secondary education, by providing students with basic ideas mainly with regards to practical demonstration'.[6] The museum was intended to 'present issues related to physics, genetics, nuclear power, tropical diseases and a few aspects related to oil'.[7] A working group with representatives from the Brazilian Centre for Physics Research (CBPF) and the Municipality of the Federal District was created in Rio de Janeiro and an agreement signed in November 1956 for the building of a Science Museum in Guanabara.[8] It was also to have a planetarium and an aquarium. But none of these attempts succeeded (Valente, 2008). The Planetarium of Rio de Janeiro was finally opened in 1970 by the State Secretary of Science and Technology, but the very first science museum of Brazil was created in Bahia, the Museu da Ciência e Tecnologia [Museum

5 See, for example, *Diário da Tarde*, 6 February 1954.
6 *Jornal do Commercio*, 14 May 1961, Third Section, p. 1.
7 ibid.
8 *Jornal do Brasil*, 24 May 1956; *Diário da Tarde*, 3 November 1956.

of Science and Technology] in 1979.[9] Still, due to the fact that it is not very interactive, some scholars and practitioners prefer to consider Ciência Viva [Science Alive] the first hands-on science museum. It was created in 1982 in Rio de Janeiro, in a project led by a group of scientists and educators, some of them linked to the Brazilian Society for the Advancement of Science, and was the result of a partnership with the Exploratorium in the United States.

The movement that lead to the emergence of science centres throughout the country is part of a bigger movement in the 1960s, triggered by the influence of transformations in science education in the United States and is based on the importance of experimentation for science teaching.

4. Dictatorship and resistance

In 1964, a military coup occurred. This had profound social, economic, educational and scientific effects on the country and greatly decreased the momentum of several initiatives in public engagement in science. The dictatorship severely hit sectors of the scientific community, forcing many people into exile, including scientists and students.[10]

Within that scenario, the SBPC took on an important role in government resistance. Its annual meetings clearly became the basis of an opposition movement and had political impact on the public and on the mass media (Fernandes, 1990). In favour of democracy and in defence of an alternative development for Brazil, the SBPC supported the idea of science being an important tool to overcome underdevelopment and to address the social issues faced by the country at that time.

The annual meetings of the SBPC began to play an important role in science communication, attracting thousands of students, scientists, teachers and other participants—over 20,000 people per meeting. The mobilisation around SBPC in the 1970s and 1980s resulted in groups of scientists, professors, teachers and students starting movements in several parts of the country. They organised seminars and science communication events to promote the implementation of scientific-cultural places and to create new science communication tools.

9 See www.guiadasartes.com.br/bahia/salvador/museu-de-ciencia-e-tecnologia.

10 See the special issue of *Ciência e Cultura*, 'University in dictatorship', *66*(4), 20–53, available at cienciaecultura.bvs.br/scielo.php?script=sci_issuetoc&pid=0009-672520140004&lng=pt&nrm=iso.

5. Science journalism: A post-war Latin American movement

In Brazil, the very first newspapers in the 19th century published science stories, and since then media have provided (at different levels) room for science. An important development in science journalism as a field occurred in the 1960s and 1970s, inspired by the Spaniard Manuel Calvo Hernando, together with a group of Latin Americans including Jacobo Brailovsky (Argentina), José Reis (Brazil), Arístides Bastidas (Venezuela), Sergio Prenafeta (Chile) and Antonio Cacua Prada (Colombia) (Massarani et al., 2012).

This movement led to the creation of science journalism associations in the region, in countries such as Argentina (1969), Venezuela (1971), Chile (1976), Colombia (1976) and Brazil (1977). Calvo Hernando played an important role in Brazil in the training of science journalists, delivering a course in 1972 at the University of São Paulo. During the hard days of the dictatorship, science journalism kept a low profile and did not come to the attention of the authorities as individuals in an association. According to Julio Abramczyk, who chaired the Brazilian Association after its first president José Reis, the efforts of this association in its first decade were largely geared towards attracting professional journalists.[11]

As an expression of the value of the field and in honour of José Reis, the Brazilian government created the José Reis Award for Science Communication in 1978. It is an annual award through the National Council for Scientific and Technological Development (CNPq), and is awarded alternately between journalists, scientists and institutions.

6. The recent decades

The military dictatorship ended in 1985, and Brazil reverted to a democracy with a new constitution and free elections in 1988. The science community was once again free to express its views, and the years since then have been a period of growth in science communication, particularly rich in diversified experiences. Despite this, Brazil is still far from developing an extensive and qualified program that would reflect consistent public policy support for this field.

11 Interview granted by Julio Abramczyk to Luisa Massarani on 4 January 2012.

7. Media in a post-coup era

It has been a tumultuous era for the media in the past 30 years. Threats to traditional media have come from the internet and the rise of new media, and later from the global financial crisis. Brazil has been affected like other countries. A prominent action was the creation of the *Ciência Hoje* [Science Today] magazine in 1982[12] by the SBPC. *Ciência Hoje* later expanded to include printed and online publications and a magazine for children (*Ciência Hoje das Crianças*), which had widespread circulation.[13] In the following years, other science communication magazines emerged. From 1981 to 1984, Abril Publishing launched a Brazilian version of the *Science Illustrated* magazine, published by Reader's Digest. In 1987, the same publisher created the *Superinteressante* [Super interesting] magazine, following the model of the Spanish magazine *Muy Interesante.* In 1991, the magazine *Globo Ciência*, now called *Galileu,* was launched. However commercial interests together with a distorted vision regarding what science communication really is have led to an unfortunate situation today: the scientific credibility of many of the publications is poor and often favours pseudoscience.

In 2002, the magazine *Scientific American Brazil* was launched, and it includes articles by Brazilian scientists and journalists. Recently, several research-supporting State-Foundations (FAPs or Fundação de Amparo à Pesquisa) such as Fapesp (State of São Paulo), Faperj (Rio de Janeiro), Fapemig (Minas Gerais) and Fapeam (Amazonas) began publishing science magazines.

Despite its extensive reach throughout Brazil, radio broadcasts still rarely cover S&T issues. There were innovative initiatives such as the *E por falar em ciência* [And speaking of science] program, broadcast by Radio MEC between 1992 and 1997 (Werneck, 2002). The total number of science programs is about three dozen, most from short-range university stations. The Federal University of Minas Gerais has excelled in the production of science communication programs for its radio and TV stations.

The first attempt at creating a science program for television occurred in 1979, when *Nossa Ciência* [Our Science] was broadcast by the government channel in Rio de Janeiro. It lasted only 10 episodes. *Globo Ciência* [Globo Science], a television program on the Globo channel supported by the Roberto Marinho Foundation, was more successful: it was created in 1984 and lasted

12 It is not a coincidence that the interactive science centre Ciência Viva was created in the same year; it represents the efforts and concerns of scientists and educators in engaging with society.

13 In recent years, however, the publications have been facing economic problems and challenges in keeping up to date with the new context for science communication.

until 2014. In the beginning, *Globo Ciência* had a more journalistic format, but since 1984 its ratings and audience numbers have gone up and down as it has rethought its goals and formats and the best way to communicate science.

The public TV station Cultura of São Paulo has also broadcast several science communication programs. *Tome Ciência* [Take Science] ran news and interviews on S&T issues from 1987 to 1990 on the public TVE channel. It resumed in 2004 and is currently broadcast by several university channels. Some of these programs were produced in Brazil, such as the *Minuto Científico* [Scientific Minute] (1996–97) or *Ver Ciência* [Watching Science] (2002–05), while other programs aimed at a younger public (such as *The World of Beakman,* 1994–2002) were imported and translated into Portuguese. Some state or university channels, such as the TV Educativa of Espírito Santo or the UFMG TV, have also broadcast science communication programs.

Even though there are only a few science communication–focused programs on TV, science does find space in other programs. Television is present in about 97 per cent of Brazilian households,[14] so Brazilians see science on programs such as newscasts, where science stories occupied an average of 7.3 per cent of the daily time of *Jornal Nacional* from April 2009 to March 2010 (Ramalho et al., 2012) and 3.8 per cent of the daily broadcast of *Repórter Brasil*, broadcast by the public channel TV Brazil over the same period of time (Reznik et al., 2014). Other television programs such as the variety Sunday program *Fantástico* also convey issues of S&T (Medeiros et al., 2013).

The International Festival of Science in TV, *Ver Ciência* [View Science], an annual festival of TV science programs produced in Brazil and abroad, was created in 1994. From 2004, the festival became part of the National Week of Science and Technology and had spread throughout all Brazil. Several cable channels have programs related to S&T but the access to these programs is limited to a relatively small proportion of the Brazilian population.

Although some best practices can be observed, the quality of the science presented in the mass media does not reach adequate levels, even though it has improved over recent years. Science is often presented as a spectacular occurrence, where scientific discoveries are episodic and made by particularly gifted individuals. Real or imagined applications of science are given great emphasis, but the processes of its production, its contexts, its limitations and its uncertainties are usually ignored, and simplified conceptual models of the relationship between science and the public prevail. Quality varies significantly, but in general it can be said that Brazilian science journalism is

14 National survey carried out by IBGE, in 2011.

still largely based on a limited vision of scientific activity, with little mention of the contexts of its production and of its social impacts. The image of the scientist in the media is predominantly male, and we have stereotypical roles for men and women scientists: while men go out to literally explore other worlds, women take care of health and the body. This is the case, for example, of the *Jornal Nacional* and the *Fantástico* program (Castelfranchi et al., 2014).

In the 1980s, new sections devoted to science appeared in the pages of the daily newspapers. In the following years they underwent intermittent questioning processes, that resulted in reduced or increased content. National newspapers with the largest print runs, such as *O Globo*, *Jornal do Brasil*, *Folha de São Paulo* and *O Estado de São Paulo*, and local newspapers such as the *Jornal do Commercio* in Recife, *Correio Brasiliense* in Brasília and *Zero Hora* in Porto Alegre, have provided space for the science communication and may have expert journalists writing science stories (Almeida et al., 2011). At a national level, space provided in newspapers for science stories is generally limited and there are very few journalists with adequate competence in the field.

However, some subjects have generated general public interest due to their major impact on the public (such as genetically modified food, climate change or embryonic cells) and have led to an increase of space dedicated to S&T in different sections of newspapers (Massarani et al., 2003). A significant portion of the coverage of S&T issues follows the agenda of developed countries. Several newspapers provide little space for national scientific production and do not give room for science from other Latin America countries. This emphasis on non-local science does not seem to be as prominent on television, especially on television news, which often addresses local scientific production (Ramalho et al., 2012). Discussions about S&T policies and communication about the results of public actions related to science communication are often excluded from news coverage. This causes the public sphere to be less influential than it could be in the discussion about public policies in this field.

8. Internet and new media

The use of the Internet for science communication in Brazil mainly occurs when science centres and museums, scientific institutions, research groups on science communication and a few governmental agencies become involved. There have been an increased number of bloggers, and we have observed the growing engagement of scientists and science communicators similar to Europe and United States, yet at a lower level. The *ScienceBlogs Brasil* gateway is associated with the largest gateway of science blogs in the world and has

about 40 blogs.[15] The use of social media networks such as Facebook has grown and dominates communication with quick information, but its full potential is still unexplored. Recently, YouTubers such as Atila Iamarino have attracted followers on the channel Nerdologia, and Pirula, with Canal do Pirula. In 2016, the network ScienceVlogs Brasil (SvBr) was created by combining 47 channels of science videos.

The quantitative use of the Internet to search for information about S&T is already close to the use of TV. Webvideo has the potential to have a significant impact on the communication of information about S&T, and new communication tools and procedures on the horizon will certainly arise.

An important feature of the new science centres and science museums created in the country, following an international trend, was their interactivity with the public. Currently there are about 260 museums registered in the 2015 Brazilian guide of museums and science centres (Almeida et al., 2015). Most are small or medium in size and have very low levels of interactivity, and very few are big enough to receive over 100,000 visitors a year. They are mostly financed by public funds with very limited private participation.

One of the country's largest science museums is the Museu de C&T [Museum of Science and Technology] at the Pontifical Catholic University of Rio Grande do Sul in Porto Alegre. Its pre-history starts in the year 1967, with a collection of animals, rocks and minerals collected by biologist Jeter Bertoletti. In 1993, the museum moved to a new building, with a display area of 17,500 square metres. It became one of the most visited museums in the country. More recently in São Paulo, the Catavento Cultural e Educacional (2010) and Museu do Amanhã [Museum of Tomorrow] (2015) were created. The latter attracted more than 3 million visitors in less than two years. In the meantime, one of the first and most important science museums in Brazil, Estação Ciência [Science Station], closed its doors. It was created in 1987 in the city of São Paulo and linked to the University of São Paulo.

Considering the size of the country and its population, the number of scientific-cultural spaces in Brazil is still low in comparison to more advanced countries. The geographical and social distribution of museums in Brazil is very uneven, with a greater concentration in the wealthier areas in the southeastern part of the country. These institutions have a limited capacity to boost science communication, considering the size of the Brazilian population. Attendance is small, although increasing: surveys show the percentage of Brazilians who claim to have visited a science museum in the last 12 months is 12 per cent, lower than the average of European countries but triple the rate of 10 years ago, according to a 2015 survey (Moreira et al., 2015).

15 See sciencevlogsbrasil.com.br.

The survey indicated that a large number of Brazilians (41 per cent) visit locations for contact with nature, through botanical gardens, zoos and environmental parks. Very few of these spaces, however, promote science communication and environmental education programs. Policies and public actions in favour of these would engage a large number of Brazilians in activities focused on environmental education and science communication.

9. Organisations, events and public policy

From the point of view of professionals and institutions related to science communication, some organisations and events stand out. In addition to the Brazilian Association of Science Journalism, created in 1977, there exist representative bodies for zoos and aquariums (1977), botanical gardens (1991) and planetariums (1996). The Brazilian Association of Science Centres and Museums was created in 1999. At a larger scale, the Red de Popularización de la Ciencia y la Tecnología en América Latina y el Caribe (RedPOP) [Network for the Communication of Science and Technology of Latin America and the Caribbean] was created in 1990, as a network that links science communication centres and programs of the region (Massarani, 2015). The activities of some prominent Brazilian science communicators have been recognised with the Kalinga Prize, an international prize granted by the United Nations Educational, Scientific and Cultural Organization (UNESCO) for science communication. Brazilian recipients of this prize are José Reis (in 1974), Oswaldo Frota-Pessoa (1982), Ennio Candotti (1988), Ernest Hamburger (2000) and Jetter Bertoletti (2005).

From 2003, institutions, scientific organisations and stakeholder groups have urged the establishment of broader public policies in science communication. This occurred when organised movements and activities focused on valuing and strengthening communication actions.

The Department of Popularization and Diffusion of Science and Technology was established as one of the tools of this public policy in 2004. It was located within the Ministry of Science, Technology and Innovation (MCTI). This led to a significant increase in the incentives for science communication, including new programs and financial support, and national coordination. Over the following 10 years, nearly three dozen calls were made through the National Council for Scientific and Technological Development (CNPq) to support science communication projects, including the creation and development of science centres and museums, the development of science Olympiads, science fairs and exhibitions.

There are now about 10 national science Olympiads, in subjects including astronomy and astronautics, physics, mathematics, chemistry, history, health and the environment. They are organised by scientific societies and/or research institutions. The Brazilian Mathematics Olympics of the Public Schools is noteworthy for its huge scope and educational impact, since it reaches nearly 20 million students, rendering it the largest event of its kind in the world.

In recent years, many celebrations regarding the international years proclaimed by the United Nations/UNESCO have been supported by the government and carried out by scientific societies and educational and research institutions. Many initiatives were developed in the World Year of Physics (2005), the International Year of Astronomy (2009) and the International Year of Chemistry (2011), reaching millions of people throughout the country. Another program supports 'mobile science', with trucks, buses and vans designed to take science out to remote areas of the country.

Several state funding agencies launched calls for science communication over the past years and promoted initiatives within their states, in line with the federal actions and often linked to them. Among these states are Minas Gerais, Rio de Janeiro, São Paulo, Bahia, Amazonas, Rio Grande do Norte, Espírito Santo, Ceará, Maranhão and Rio Grande do Sul. But in recent years such calls are less frequent or have even been discontinued. This is in a general context where the science sector has been losing funds and status within the Brazilian government: less than 24 hours after the Temer government took over the Presidency in Brazil in 2016, the science ministry was collapsed with the communication ministry and the funds for science were cut to one-third of their 2013 levels in the budget. In 2019, a further reduction of about 40 per cent in the budget of the ministry was announced. The Department of Popularization and Diffusion of S&T had its status increasingly downgraded in the structure of the ministry; at present, the activities related to science communication and science education are split across different sectors.

The National Week of Science and Technology was created by presidential decree in 2004 and nationally coordinated by the science ministry. Its objective is to get the public, especially children and teenagers, engaged in activities related to science and to encourage creativity, scientific attitude and innovation. Universities, research institutions, schools, science centres and museums, funding agencies, the media, non-government organisations and businesses have increasingly been participating in the National Week of Science and Technology. A decentralised structure stimulates the involvement and participation of the local-level public institutions of research and education.

Another significant political milestone was reached when science communication was included in three key documents for the formulation of public policies, namely the National Plans for Science, Technology and Innovation (ST&I) for years 2007–10 and for 2011–15 as well as in the so-called *Blue Book*, a summary of the discussions of the Fourth National Conference on ST&I held in May 2010 (Livro Azul, 2010). Major challenges for the country identified by the conference were to promote a radical change in science education and to improve the actions focused on communicating science to the general public. However, the program was not put into practice.

In 2009, the CNPq, one of the leading governmental funding agencies, created a Science Communication Advisory Committee to support science communication projects. CNPq also created the Lattes Platform, an online curriculum vitae (CV) platform that records the scientific production and researchers' activities throughout the country, with a specific section for activities focused on education and popularisation of S&T.

Another important indicator of how activities of science communication are increasingly being valued is that they are now present in the program of the National Institutes of Science and Technology, created by the science ministry with several state funding agencies in 2008. The program aims to articulate and mobilise researchers, boost internationally competitive basic and fundamental research, encourage scientific and technological research, promote innovation and entrepreneurship, and establish programs that contribute to science education and public engagement with science.

Over the last few years, the interest in science communication in universities and research institutions had increased significantly. The Ministry of Education created a National Outreach Programme geared towards public institutions of higher education in 2003 to support university outreach, including science communication activities. Today in most cases only isolated individuals or small groups are still active, with little institutional support and little interaction with the institutions themselves. When we analyse the higher education offered to specialists in this field, the situation reveals itself to be even more fragile with a great dispersion of the courses, even though it is improving. On the other hand, the academic field of science communication has been growing in Brazil: a recent study identified that 51 per cent of the 609 scientific papers in science communication published in Latin America are written by Brazilians (Massarani et al., 2017).

In contrast to this general background of science communication—growing, but yet still fragile—Brazilians declare considerable interest in science issues. According to a 2015 survey on public perceptions of S&T in Brazil, the population is interested in science (61 per cent), a percentage similar to those

interested in sports or economics. However, there is a great lack of knowledge regarding Brazilian scientists and Brazilian institutions: the vast majority (87 per cent) of people interviewed could not name any research institution or any important Brazilian scientist (94 per cent).

Overall, the survey showed a noticeably positive and optimistic vision with regards to the role of S&T. Castelfranchi et al. (2013) indicate that optimistic attitudes about S&T do not generally depend on the educational level or the information declared or accessed by those people. Individuals with little schooling and low levels of information generally have positive attitudes; by contrast, people with higher education and greater access to information often have diverse attitudes, being optimistic in some respects, but more critical in others. The overall positive view of the role of S&T and the expressed confidence in scientists do not prevent the public from being aware of the importance of having the whole society participating in the definition of S&T policies. However, this awareness has not lead to a more active engagement of authorities in chasing a greater social participation in decision-making.

10. Current challenges of science communication in Brazil

We have shown that, in recent years, there was an expansion of science communication activities in Brazil, despite the many major limitations.

Although rare in the country, there already exist some diagnostics on the current framework of these activities, including their scope as well as their impact (Moreira, 2006), but we do not have the in-depth analyses that would enable the drafting of consistent public policies. This would require expanded data and perspectives and more in-depth research and collective reflections, and we will not attempt to carry out such a task here. An excellent example of this type of diagnosis—which could serve as an inspiration and a model for a more global and prospective assessment of the field in Brazil—was made in the United States by the Committee on Learning Science in Informal Environments, of the National Research Council of the National Academies. This committee produced a comprehensive study on the state of the art of public communication in S&T (Bell et al., 2009).

We will limit ourselves to indicating general challenges that should be faced decisively, with adequate resources and enthusiasm from researchers and professionals, from educational and research institutions, and from federal and local authorities. Science communication activities are strongly correlated with the quality of basic education, especially science education, and here

the Fourth National Conference on ST&I indicated the need for a real revolution, given the enormous shortcomings in the scientific education of most young Brazilians (Livro Azul, 2010). Such activities can contribute to improving the teaching of science, with emphasis on methods and practices that enhance and promote creativity, experimentation and inter-discipline.

The main challenges for science communication can be divided into three parts. The first one is to reach the entire Brazilian population. The objective would be to reach middle sectors and poor and excluded sectors—both in urban and rural areas: a total of over 150 million people. This challenge requires time, resources and a lot of trained people. An important contributing action would be to promote science communication in a network. This would improve and integrate science centres and museums and other stakeholders. It would tackle the problem of an unequal distribution of effort, in both a regional and social sense, and encourage a closer interaction with the formal education system. Public events for science communication, such as the National Week of S&T, should be extended to all corners of the country: those involved with the public communication of science should go where the people are. Another aspect, within the goal of a greater social engagement, is to use the mass media in a much more intense and qualified way, particularly the Internet and social networks. There is the need to greatly expand science communication in the public channels and within the research institutions.

Public policies constitute the second part of the challenge for the development of science communication. Despite the advances of the last decade public policies are still vulnerable to change in political attitudes. Existing structures need to be strengthened and new stimulatory policies created, and to do this both continuity and expansion of means and resources are needed.

Science communication is already part of several government agendas and many education and research institutions. Politically, however, this has not been done to the necessary extent, and the level of investment is not enough to get a socially broad, inclusive and qualified performance (Moreira, 2006; Ferreira, 2014). A drastic decrease in the stifling bureaucracy that plagues S&T and its communication in the country is not a minor challenge. Administrative processes need to be simpler and clearer.

The third aspect of the challenge is to improve the quality of today's science communication. One goal is to increase and improve the training of science journalists, science communicators and scientists, as well as academically valuing these activities. Undergraduate students, particularly those in the fields of science and engineering, should be given more encouragement to participate in public communication actions of S&T. With regards to science centres and museums, some of the permanent challenges are to incorporate

new technologies into their practices, to increase accessibility, to encourage public engagement in big issues of science and society, and to improve the training of their staff (Marandino, 2005). It is hoped that innovative initiatives are stimulated and supported, such as the new path for natural science museums, linked with environmental and social concerns.[16]

We need more studies and analyses to guide science communication activities. Outreach activities of S&T are still in their early stages, and greater understanding of the best strategies, practices and impacts of the outreach activities are required. Similar research should examine the characteristics, attitudes and expectations of the audience and on public perceptions of S&T. Academic assessment of education activities, particularly in the field of science communication, is still low, despite recent actions of universities and funding agencies; these actions should be encouraged. Cooperation with other countries, through partnerships with groups and researchers from abroad who conduct research and high-quality science communication can also provide advances and significant improvements for this field in Brazil, particularly in the training of qualified personnel.

Cultural aspects are important in any communication process, and an improved interface between art, science and society should be taken into consideration in science communication activities. Another goal is to recognise the value of the cultural and humanistic aspects of science, as well as the acknowledgement of popular and traditional knowledge. Citizen science, which favours the collective learning and construction of knowledge and its social appropriation, has significant potential, indicating the role of scientific education integrated with a public engagement with science.

One of the most effective ways to educate the young and the public about science is to put them in the role of researchers and make them use, even at a restricted level, the methods of science in an effective dialogue between science, its actors and the public.

11. Final considerations

There is still a long way to go until we can declare the existence of high-level science communication and an adequate social appropriation of scientific and technological knowledge encompassing all of Brazilian society. But the journey began long ago, with faltering steps in previous decades. One of the biggest hurdles in science communication in Brazil—actually, in science

16 A nice example is the Museum of Amazonia (MUSA), in Manaus.

in general and other aspects—is the vulnerability of the initiatives, actions and policies. Much of what was built has been destroyed. Our field requires a continuity of action and purpose in which tiredness is not an option. Overcoming the great challenges outlined here is a fundamental collective task, depending on the creation of effective public policies. But also, and most importantly, it depends on the collective action of scientists, teachers, science communicators, journalists, museum experts, students, and all the people involved with scientific work and its communication.

As João Cabral de Melo Neto beautifully poeticised: 'A rooster on its own does not weave a morning; it will always need other roosters … so that the morning, starting from a fine web, can be woven among all the roosters'.[17]

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17 In Portuguese: 'um galo sozinho não tece uma manhã, ele precisará sempre de outros galos … para que a manhã, desde uma teia tênue, se vá tecendo, entre todos os galos'.

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Timeline

Event	Name	Date	Comment
First interactive science centre established.	Museu da Ciência e Tecnologia [Museum of Science and Technology] in Bahia	1979	The more interactive Ciência Viva [Science Alive] was created in 1982 in Rio de Janeiro
First national (or large regional) science festival.	National Week of Science and Technology	2004	
Association of science writers or journalists or communicators established.	Brazilian Association of Science Journalism	1977	
First university courses to train science communicators.	A one-year diploma course in science journalism at the State University of Campinas	1999	There were earlier short courses

Event	Name	Date	Comment
First PhD students in science communication graduate.	Probably Wilson Bueno	1987	
National government program to support science communication established.		2004	
A journal completely or substantially devoted to science communication established.	*Ciência e cultura*	1949	
First significant radio programs on science.	*Radio Sociedade*	1923	
First significant TV programs on science.	*Nossa Ciência* [Our Science] was broadcast in Rio de Janeiro	1979	The more successful *Globo Ciência* [Globo Science], ran from 1984 until 2014
First awards for scientists or journalists or others for science communication.	José Reis Award for Science Communication, CNPq	1978	
Date hosted a PCST conference.	Salvador, Brazil	2014	

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