

SCIENCE AND TECHNOLOGY: YOUTH PERCEPTION IN THE CITY OF RIO DE JANEIRO

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ABSTRACT

Numerous challenges faced by contemporary democracies are related to circulation, social appropriation, and debate on and use of technoscientific knowledge. As such, the study of science and technology perceptions, as well as attitudes and practices in knowledge appropriation across diverse strata of the population, are today a central theme in both academic and administrative contexts regarding indicator and policy design. In this context, one demographic stands out for its peculiarities: individuals between 18 and 24 years old, born and raised in the presence of the internet in Brazil, arriving at adulthood through a socialization process in which online platforms, along with school and family environments, played a central role. This study adopted a qualitative approach to explore, investigate, and contextualize this demographic's opinions and perceptions of science and technology, conducting five in-depth interviews followed by five group discussions with young residents of Rio de Janeiro city. We collected a rich trove of data from these individuals that presents a positive perspective on science and technology, recognition of its benefits and risks, and connections of related activity to social context, eliciting reflections and potential for establishing dialogue and communication.

KEYWORDS

science communication, youth, young people, science and technology, science and society

CIÊNCIA E TECNOLOGIA: PERCEPÇÕES DE JOVENS DA CIDADE DO RIO DE JANEIRO

RESUMO

Muitos dos desafios das democracias contemporâneas estão ligados à circulação, à apropriação social, à discussão e ao uso do conhecimento tecnocientífico. Nesse sentido, estudar

percepções sobre a ciência e a tecnologia, atitudes e práticas de apropriação do conhecimento de diversos públicos é hoje um tema central tanto no contexto acadêmico como para gestores, para a construção de indicadores de avaliação e criação de políticas. Nesse contexto, um público se destaca pelas suas particularidades: os jovens com idade entre 18 e 24 anos, que nasceram e cresceram juntos com a internet no Brasil, chegando à vida adulta a partir de uma socialização em que não tiveram papel central apenas a escola e a família, mas também os fluxos de informação e as práticas de sociabilidade em redes online. Com o objetivo de explorar, aprofundar e contextualizar opiniões e percepções destes jovens sobre ciência e tecnologia, realizamos neste estudo, de caráter qualitativo, cinco entrevistas em profundidade, seguidas de cinco grupos de discussão com jovens residentes da cidade do Rio de Janeiro. Coletamos um rico corpus junto a esses jovens que apresentaram uma visão positiva da ciência e tecnologia, reconhecendo seus benefícios e riscos, vinculando a atuação da área ao contexto social e trazendo-nos reflexões e possibilidades para estabelecer diálogos e processos comunicacionais.

PALAVRAS-CHAVE

divulgação científica, juventude, jovens, ciência e tecnologia, ciência e sociedade

1. INTRODUCTION

Complex scientific issues are currently in constant debate in the public sphere, and understanding these debates should be possible for all members of society (Brossard & Lewenstein, 2009). The relationship of the scientific community with the lay public primarily manifests through public science communication initiatives composed of individuals involved in creating and producing scientific knowledge. Aside from its influential utility in quotidian decision-making and the strengthening of democracy, the diffusion of scientific culture also carries aesthetic, intellectual, and moral connotations (Castelfranchi, 2010).

According to Castelfranchi et al. (2016), surveys¹ of public perception and scientific culture indicators aid in improving science communication and dissemination practices, as well as the social appropriation of science. In this context, the study of diverse populations, with their peculiar characteristics and repertoires, contributes to the consolidation of a body of knowledge, establishing formats for public science and technology (S&T) communication that are better tailored to each of these demographics. Such studies have been performed in numerous countries (Dudo & Besley, 2016) with the objectives of understanding scientists' public engagement and their challenges and priorities in science communication, contributing to the formulation of indicators for the monitoring of S&T social appropriation practices (Daza-Caicedo et al., 2017).

In Brazil, perception studies were most notably carried out on a national level in the years 1986, 2006, 2010, 2015, and 2019. The most recent survey, performed by the Center for Administrative and Strategic Studies (Centro de Gestão e Estudos Estratégicos, 2019), confirms what other studies had already indicated: that the average Brazilian is

¹ The term "survey" is adopted in Brazil for quantitative opinion research, while the term "inquiry" is not usual, and the term "poll" is preferred when it comes to research without a representative sample, or not based on scientific methodology.

interested in S&T subjects, recognizes the importance and benefits of scientific research, and lacks information regarding science and scientists, as well as confirming extremely unequal levels of access to scientific knowledge.

The first step of this study was identifying studies/surveys that made at least partial data available on individuals between 18–24 years of age and that did not focus on formal, scholastic science education or restrict participants to currently enrolled students. The following were identified: *Science in My Future* (Haste, 2004), *Percepção Pública da Ciência e Tecnologia no Brasil* (Public Perception of Science and Technology in Brazil; Ministério da Ciência e Tecnologia, 2006), “Percepção Pública da Ciência e da Tecnologia no Estado de São Paulo” (Public Perception of Science and Technology in the State of São Paulo; Vogt, 2011), *Young People and Science* (European Commission, 2008), “Ciencia y Tecnología: ¿En qué Piensan los Jóvenes 2.0?” (Science and Technology: What Do Young People Think 2.0?; González, 2011), *Os Mineiros e a Ciência: Primeira Pesquisa do Estado de Minas Gerais Sobre Percepção Pública da Ciência e Tecnologia* (Citizens of Minas Gerais and Science: The First State Level Study in Minas Gerais on Public Perceptions of Science and Technology; Castelfranchi et al., 2016), and *A Ciência e a Tecnologia no Olhar dos Brasileiros: Percepção Pública da C&T no Brasil – 2015* (Science and Technology in the Eyes of Brazilians: Public S&T Perceptions in Brazil – 2015; Centro de Gestão e Estudos Estratégicos, 2017). Upon identifying the lack of studies focused on young people at a national level, the National Institute of Science and Technology and Science and Technology Public Communication (INCT-CPCT) performed the first study of this kind that focused on young Brazilians: *O que os Jovens Brasileiros Pensam da Ciência e Tecnologia?* (What Do Young Brazilians Think About Science and Technology?; Massarani et al., 2021). The qualitative results presented in this article are part of one of the phases of this project.

The concept of youth varies in its definition throughout history and is molded to social, economic, and cultural contexts (Abramovay & Castro, 2015; Cassab, 2011). With regard to the design of public policy and empirical studies, many institutions and national and international organizations have established socio-demographic criteria for the study of youth. The United Nations Organization for Education, Science, and Technology (Organização das Nações Unidas para a Educação, Ciência e Tecnologia, 2004), following the United Nations guidelines defined at the 1985 General Assembly, assumes an age range of 15 to 24 years, flexible at both extremes and considering contextual specificities.

Brazilian youths who, in 2018, were between 18 and 24 years old (this study’s target demographic) present relevant and peculiar characteristics made possible by the advances in science and information technology. These individuals were born and raised in the presence of the internet in Brazil. Their language, tone, and forms of communication are influenced by various online socialization processes. They typically intensely interact with and appropriate the information — and disinformation — present on the internet ecosystem, experiencing ease in finding, editing, publishing, sharing, and discussing diverse subjects.

Castells (1996/1999) has previously indicated that humanity is engaged in a network communication system that permeates society, establishing a universal language

that promotes global societal integration that simultaneously incentivizes the potential for personalization and generates spontaneous communications with various goals and motives for specific individuals' participation. According to Castells (1996/1999), "interactive computer-based networks are growing exponentially, creating new forms and channels of communication, molding life and, at the same time, being molded by it" (p. 40).

According to the *Pesquisa Brasileira de Mídia 2016: Hábitos de Consumo de Mídia Pela População Brasileira* (Brazilian Media Research 2016: Media Consumption Habits in the Brazilian Population; Brasil, 2016), carried out in 2016 among young people between the ages of 18 and 24 years old, the internet is the primary informative medium for subjects related to Brazil (50%), followed by television, which, though in decline, continues to be relevant (44%), radio (3%) and print news (2%). Social networks cannot be excluded from this conversation, as they are strongly present in the daily routines of individuals in this age range. In 2019, the Fundação Telefônica (2019) published a study titled *Juventudes e Conexões* (Youth and Connections), revealing that 97% of young people between the ages of 15 and 29 years old that had used the internet in the previous 3 months had accessed at least one social network an average of 5.5 times per week, with 80% creating/posting content on these networks at an average frequency of three times per week.

In July 2018, the Facebook group released its first quarter performance report indicating that the Facebook platform had 127,000,000 active users in Brazil (Valente, 2018). The *Mídia Dados Brasil 2018* (Brazil Media Data 2018; Grupo de Mídia São Paulo, 2018)² publication discusses the importance of the transit of content across different platforms:

one-third of young people post what they watch on TV to social networks.
They are impacted by this and search for more information on the internet.
That is to say, these conversations continue and circulate between platforms,
demonstrating the necessity of understanding this context. (p. 45)

Themes involving S&T are present in this ecosystem of information access and sharing, provoking reflections on the necessity of the construction or consolidation of orientations and connections between public communication apparatuses and young people, taking their repertoire and an understanding of the changes brought about by the development of information and communication technologies into consideration.

This study explores young people's perception of S&T in the city of Rio de Janeiro, the cultural diffusion of technoscientific themes in these young people's priorities, and the sources of information that they use to inform themselves on such subjects, as well as possible connection points between these young people and public science communication.

2. METHODOLOGY

This article is the result of a study incorporated into a larger project carried out by the INCT-CPCT with support from the National Council for Scientific and Technological

² *Mídia Dados Brasil* (Brazil Media Data), an annual Brazilian media industry publication made available by the Grupo de Mídia São Paulo.

Development, and the Carlos Chagas Filho Foundation for Supporting Research in the State of Rio de Janeiro. It can be characterized as an interdisciplinary and interinstitutional study with national scope and the objectives of exploring, identifying, and establishing — using qualitative and quantitative techniques — what young Brazilians think about S&T (Massarani et al., 2021). This study was approved by the Ethics Committee of the Joaquim Venâncio Polytechnic School of Health/Fiocruz/RJ (Ethics Certificate CAAE 86632218.2.1001.5241/report -2.808.981).

In the stage presented in this article of this larger study, the authors carried out a qualitative research project intending to explore young people's (ages 18–24) methods of scientific cultural appropriation, as well as the perceptions and representations of S&T themes, through in-depth interviews and discussion groups held between October 25th and December 19th, 2018, in Rio de Janeiro city.

This qualitative approach complemented the body of numerical data collected during the quantitative phase of the project. That, according to Minayo and Sanches (1993), contributes to the “exploration of the complexity of the phenomena, facts, and specific processes present in groups that are more or less delimited in their range and capacity to be ‘intensely investigated’” (p. 247). Gaskell (2000/2002) also suggests that “the deeper understanding offered by qualitative interviews can provide valuable contextual information that aids in the understanding of specific findings” (pp. 65–66), though it is clearly an approach that does not endeavor to generalize its results to populations beyond the groups that were studied.

2.1. THE CITY OF RIO DE JANEIRO

In 2018, according to the census estimates published by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística, n.d.), the city of Rio de Janeiro was inhabited by approximately 6,700,000 people, with a population density of 5,300 residents per square kilometer, a labor force participation rate of 40.6%, and 15 to 29-year-olds representing 23.29% of the population.

This exploratory study investigated residents of the north side and south side areas of Rio de Janeiro City aged between 18 and 24; the west side area (the third of the city's three major regions) was not included. The choice to study the north and south sides was made due to their socioeconomic and cultural differences. The north side of Rio de Janeiro is the most densely populated region of the city, containing 87 districts and 42% of the city's population. The downtown/south side area contains 39 districts and is the least densely populated of the city's three geographic regions. Downtown/south side household income was estimated in July of 2010 to be triple that of the north side. Another striking difference between the two regions is that 54% of the city's formal employment is located in the downtown/south side area. Individuals between 15 and 29 years of age account for 22% of the downtown/south side population and 25% of the north side population (Serviço Brasileiro de Apoio às Micro e Pequenas Empresas, 2015).

It is important to highlight that, concerning the 2000 human development index report³, eight of the 10 highest scoring districts in Rio de Janeiro City were located in the south side, and seven of the 10 lowest scoring districts were located in the north side (Prefeitura da Cidade do Rio de Janeiro, 2019).

Data collection procedures for this study involved 20 young residents of the north and south sides of Rio de Janeiro, with five of them participating in both activities (in-depth interviews and discussion groups) and the other 15 participating only in discussion groups, for a total of five individual, in-depth interviews and five discussion groups, each one of which was participated in by the interviewed individual and friends invited at their discretion. The selection of in-depth interview subjects was initially guided by recommendations of social workers and residents of the areas studied, modified regarding the socioeconomic differences of the individual's place of residence (north and south sides) as well as their and their parents' levels of education, seeking to establish a diversity of viewpoints, cultural capital, and forms of access to and use of technology and information, as well as differences in socialization.

The five selected individuals invited two to four friends each from their social circle to participate in the discussion groups that fit the criteria of being 18–24 years old, owners of cell phones with internet connectivity (Wi-Fi or network provider plan and/or access to computers, laptops, or tablets), and residents of Rio de Janeiro City, with at least one member of each sex. The discussion groups' compositions were developed using the “snowball” technique.

The choice to study peer-groups, the familiarity of which, according to Gaskell (2000/2002), “at times... is an advantage” (p. 82), provided great value given the characteristics of this demographic and the theme being explored. The discussion groups used the *Nesse Dia das Mães, Vamos Protegê-las* (On This Mother's Day, Let's Protect Them) video to stimulate discussion, posted to youtube by Brazilian influencer Jout Jout Prazer (2018)⁴. In that video, she discourses about the risks that mothers are exposed to through fake news, Facebook check-ins, and sharing who they are with and what they are doing, provoking reflections on fake news and S&T. Moreover, the following nine statements from the national-level survey were used as discussion material (Massarani et al., 2021), covering current themes and controversies in S&T and structured regarding the benefits, risks, and relationships of public policy and citizenship with S&T as follows.

Risks of science and technology:

- Science and technology are responsible for the majority of current environmental problems.
- Science should concern itself with understanding the natural world and not try to change it.
- Science and technology do more harm than good to humanity.

³ Human development index — a unit of measurement used to determine the degree of development of a given society in the areas of education, health, and income. It was created by Mahbub ul Haq, with the collaboration of Indian economist Amartya Sen, winner of the Nobel Prize in Economics in 1998, and has been adopted by the United Nations Development Programme.

⁴ Jout Jout: Julia Tolezano is a Brazilian vlogger, writer, and journalist. She is known for her YouTube channel, *Jout Jout Prazer*, directed toward young people, which currently has over 2,000,000 subscribers. In 2016, the Companhia das Letras (a major Brazilian publishing house) published her first book: *Tá Todo Mundo Mal* (Everybody's Down), which became a national bestseller.

Benefits of science and technology:

- Science and technology will help eliminate poverty and hunger in the world.
- Science and technology are making our lives more comfortable.
- Science is the only trustworthy source of knowledge about the world. Explore: do others exist? If so, what are they?

Science and technology, public policy, and citizenship:

- The people's voice should be heard on big decisions in the areas of science and technology.
- As all governments' resources are limited, and spending more on one thing means spending less on others, the government should increase or at least maintain its investments in scientific and technological investigations over the next few years.
- If science didn't exist, my day would look very different. Explore: how? Why? Would it be better? Would it be worse?

Techniques used in the analysis of the collected material include interpretive textual analysis and thematic analysis based on transcriptions of the in-depth interviews and discussion groups, as the results obtained from the two phases were convergent and treated as a single "body of data", using the three following analytical dimensions as references: attitudes about S&T (exploring, for example, how this demographic expressed their perceptions about what science and technology are, the roles that they play in contemporary society, their risks, benefits, forms of social control, etc.); interest in S&T and access to scientific information and culture (searching for where and how this demographic is impacted by S&T themes and information, the role of the internet as a research resource, the role of social media as a discussion forum and propagator of information, and the dynamics involved in the sharing and content of S&T fake news); and, lastly, forms of social S&T appropriation and their impacts on day-to-day life, as well as potential future results expected from S&T.

These dimensions were enriched with sub-themes that emerged during the participants' mutual interactions.

3. RESULTS AND DISCUSSION

3.1. PERCEPTIONS OF SCIENCE AND TECHNOLOGY

In a period in which the media seems to confuse and/or conflate S&T more and more frequently, the young residents of Rio de Janeiro interviewed in this study recognized a deep relationship between the production of knowledge and technological development, though they also believed that significant differences exist between science and technology. For many of those interviewed, science was perceived as a producer of questions, knowledge, and perspectives on the world. It was defined by them with the terms "base", "knowledge", "research", "study", and "foundation", and comprises all knowledge areas: the exact sciences, the humanities, and life itself. The conversations showed that, for these young people, scientific discoveries do not necessarily have to

have a direct or immediate application, allowing instead for nuanced perceptions of the world, nature, the human body, new lifestyle conditions, innovation, and development. Many described it as a common good, a body of knowledge assimilated by society over time⁵. “I think it’s also the basis of evolution, really, isn’t it?! I think it’s the basis!” (Group 3, participant 4, male, 24 years old, south side). “Explanation! It’s... study. Basically, the studying part itself (...) maybe a phenomenon that occurs” (Group 4, participant 4, female, 18 years old, north side).

The interviewees demonstrated strong associations of technology with innovation, gadgets, devices, computing, communication apparatuses (the internet, computers, cell phones, and mobility), and immediate applications present in day-to-day life, leisure, transportation, and communication. They, in synthesis, understood technology as integrally tied to the development of products with immediate applications and the objective of generating profit: “it comes from technical really, technology! It can be many things. But the really recent things come to mind: computers, video games, things like that” (Group 4, participant 1, male, 20 years old, north side). “It’s connected to companies’ production processes” (Group 5, participant 2, male, 20 years old, north side).

The interviewees demonstrated a predominately positive view of S&T, understood by them as inherent parts of what it means to be human, present “since the time of cavemen”, representing a competitive edge and, when combined, fostering innovation, progress, and evolution. “Like a guy who loses an arm. They put on a new arm and, with his mind, the guy can move his hand? (...) The progress of science! An insane piece of technology!” (Group 2, participant 3, male, 21 years, north side). “Development, right!? You can create a... a city, sort of, with all these wires and electricity in houses, convenience, comfort, you can have a whole bunch of people living in a small space” (Group 3, participant 4, male, 24 years old, south side).

Such optimistic statements are coherent with results from national and international surveys that confirm a generally very positive view of S&T by young people both in Brazil and in the majority of Western countries (Castelfranchi et al., 2016; Centro de Gestão e Estudos Estratégicos, 2017, 2019; European Commission, 2008; González, 2011; Haste, 2004; Ministério da Ciência e Tecnologia, 2006; Vogt, 2011). A significant portion of the quantitative studies on the subject, as well as the interviews and ethnographies, confirm that young people have a generally positive image of S&T, recognizing its benefits, especially those related to improvements to the quality of life and the convenience that they offer, though they are aware of the risks involved.

The repertoire of S&T themes and subjects of interest mentioned by the interviewees is rich and diverse, comprising new discoveries, scientific findings and experiments, innovation, humanitarian and social issues, psychology, politics, health, education, environmental issues, applied technology and equipment widely used in day-to-day life (such as cars, gadgets, high tech apparatuses, and information technology resources).

⁵ The statements made by study participants are faithfully reproduced throughout this publication, with no alterations to colloquial expressions, jargon, slang, or syntax errors.

The interviewees demonstrated a relatively articulate perception of S&T and the economic, political, and social implications of technoscience. It is seen as part of a social context, with its own directions and objectives depending not only on endogenous forces but also on cultural, political, and economic influences.

Who's going to invest? No one is going to invest because it won't turn a profit! Right? No! Great, hunger in Africa, in the Northeast... Man! There's a load of studies... to collect water in the Northeast that I saw (...), but no one invests any money because they'd be helping a population that won't amount to anything, man! (Group 2, participant 3, male, 21 years old, north side)

3.2. RISKS AND BENEFITS OF SCIENCE AND TECHNOLOGY: A POLITICIZED PERSPECTIVE

An important result emerged from the discussion groups concerning the benefits and ills associated with scientific and technological development. In numerous instances, clear concern was portrayed by young people from different socioeconomic strata as to how S&T may reproduce or accentuate social inequalities and power dynamics: the benefits of technoscientific development tend to be concentrated on and controlled by the rich, while the risks and damages tend to be more serious for those with fewer resources: “the harm is in the poor communities! Now, the benefits? Nowhere to be found” (Group 5, participant 3, female, 22 years old, north side). “Like, science is, sort of... as technology improves, more expensive. So, since it's more expensive, there are fewer people buying... Ah, someone who can't afford, for example, a person who can't pay for an operation” (Group 2, participant 2, male, 18 years old, north side).

The perspective holding that the benefits associated with S&T development are greater than the costs and risks was expressed in numerous instances by many of the young participants, corroborating results from quantitative national and international investigations. In the poll carried out by the INCT-CPCT (Massarani et al., 2021), for example, the majority of young people interviewed stated that they believed that science brought significant benefits to humanity (69%) and only 16% believed that it presented significant risks. International studies also demonstrate that, for young people, science delivers more benefits than it does risks to humanity (European Commission, 2008; González, 2011; Haste, 2004).

When evaluating the risks and benefits of S&T, identifying those responsible for the damages caused by S&T, evaluating the potential of S&T applications to resolve social issues, or discussing whether greater investment in research is necessary, the participants articulately represented their points of view. Politics, economics, and citizens themselves and their behavior appear in the participants' statements as references for understanding how the area functions.

These young people recognize the benefits and risks of S&T. However, “weighing the scale” is considered a difficult task. They understand that what matters is who uses and appropriates S&T and for what purpose. The preeminent benefits mentioned by these young

people are improvements in quality of life, cures for diseases, “fixing past mistakes”, building new perspectives on humanity and nature, convenience in day-to-day activities and communication, solutions to routine problems, transportation, and ample access to information. On the other hand, associated risks include destruction, war, weapons of mass destruction, and also consumerism itself, and the excessive exploitation of natural resources: “it’s just that we’ve come to a moment, a point, where we are damaging everything we live with” (Group 4, participant 2, male, 9 years old, north side). “Like, I don’t know, too much technological and scientific development in the sense of wrecking the planet, you know what I mean? Wrecking, I don’t know... polluting too much, destroying nature and destroying ourselves, you know?” (Group 1, participant 1, female, 18 years old, south side).

The responsibility for the damages caused by S&T is also attributed to the actions of the scientists and technologists themselves, but in many cases, these young people demonstrated that they were not naive: they extended this responsibility to other areas. Politics, for example, is seen by the participants in a controversial way: many of them stated that it does not prioritize projects that would yield returns for society but rather those that serve the interests of the politicians themselves and their companies. The companies, in turn, due to the nature of their activities, prioritize profits without considering the importance of preserving the environment or the well-being of the population, which can lead to the exacerbation of social inequality and environmental destruction. Lastly, citizens that are not willing to change their habits or “give up” the benefits of S&T are also considered responsible: “I think that there are a lot of politicians out there... a lot, a lot, a lot” (Group 1, participant 1, female, 18 years old, south side). “If you look more from the industry side, it’s, like, all a façade” (Group 4, participant 1, male, 20 years old, north side). “Not giving up the experience, not letting go... I didn’t, say, give up my comfort, my house, driving my car” (Group 4, participant 4, female, 18 years old, north side).

Another important implication of the extensive and contextualized perspective of these young residents of Rio de Janeiro is the application of S&T to urgent social challenges. They believe that the technology already exists to attenuate problems such as hunger, disease, sustainable means of production, security, and mobility, among others, though they understand that this technology also depends on the interests of politicians and social context: “I think it’s more a question of changing how we think about human beings and not simply creating technology. Because we have a lot of different technology, and this doesn’t eradicate hunger” (Group 3, participant 4, male, 24 years old, south side). “It’s weird! Just that, like, so many studies on cancer and AIDS [acquired immunodeficiency syndrome], and it’s not there... that they don’t discover! It’s incredible” (Group 2, participant 2, male, 18 years old, north side).

The statements of these young interviewees are aligned with Beck (1986/2011), who indicates that risk factors resulting from the collateral effects of reflexive modernity are industrially produced, globally externalized, legally individualized, scientifically legitimized, and politically minimized. Society at large is exposed to these risks. However,

their capability to confront them or protect themselves varies according to their differing socioeconomic and cultural statuses, accentuating the contradictions of capitalism.

Lastly, as a final, previously indicated implication, there is support for greater investment in the area. The results of the national study carried out by the INCT-CPCT (Massarani et al., 2021) reveal that 60% of participants support increased investment in the area, despite being aware that investment in one area signifies cuts from another, and 34% stated that investments should not be reduced. The discussion groups, however, showed interesting declines in this general support for S&T investment. For the participants of this study, such investment must occur but must also prioritize the areas of S&T that are oriented towards solving the population's most pressing problems. These young people confronted the dilemma of "where can you take the money from?", uncomfortable with the possibility of transferring resources to S&T from other areas such as education, health, and security. For them, the solution lies in better management of public resources: "I think that it depends on research like this! I think that... the government is investing in some studies or others like this; I think it's worth it! But also... man! We're behind on health, education, security" (Group 2, participant 2, male, 18 years old, north side). "But that's the thing! If we're going to keep it or not keep it... the question is: is what is being spent being spent well?" (Group 4, participant 1, male, 20 years old, north side).

Taking this critical and contextualized perspective as a whole, these young people demonstrated a desire for a humanized S&T, oriented towards the common good, that makes more significant efforts towards collaborating in the reduction of social inequalities, as well as democratization and access both to the dissemination of information and to knowledge, such as in the right to enjoy the benefits of achieved results: "I think that science and technology today should have to reach the whole world as a big challenge and a big objective" (Group 1, participant 1, female, 18 years old, south side). "Ah! A way of eliminating inequality, social and (...) because we think of rich countries more in terms of development, in terms of health, it's unstable" (Group 3, participant 3, male, 18 years old, south side). "The proposal that I have, like, the main one, is about more big projects and more teaching methodologies so that citizens, on a global level, grow up more human" (Group 5, participant 2, male, 20 years old, north side).

The participants also demanded that efforts be made towards the resolution of problems in their daily lives, such as mobility, transportation, cures for diseases, drug addictions, and developing new forms of education that better facilitate learning, as well as searching for sustainable alternatives that pay careful consideration to the environment. Their expectations indicate a demand for social outreach and appropriation, along with the democratization of knowledge and its applications in daily life, for, as they stated, some problems could be solved with tools that, though they already exist, are not widely accessible.

These young people demonstrated perceptions and arguments with little variation based on differences in cultural capital when placed into a discussion group that allowed for more time for reflection and elaboration. The most significant polarization was in the possible appropriation of and effective access to the results, concepts, and processes of S&T, which reflects the social inequality resulting from their socioeconomic context.

3.3. THE SCIENCE AND TECHNOLOGY INFORMATION ECOSYSTEM

During the activities performed in this study, a remarkable characteristic emerged that profoundly differentiates the current era from those that came before and especially these digital native research subjects from other cohorts: the idea that information (or disinformation) circulates primarily in streams and fragments and is not searched for, found, or received from official sources. Instead, the participants “were found” by content appearing in their streams, and S&T was part of this scenario: “for example, the YouTube tool that sometimes appears, right?! That’s what I’m talking about, elbowing in. But, a lot of the time, I’m not looking for it, but it comes to me” (Group 3, participant 2, male, 24 years old, South Side). “Sometimes, in a conversation with someone... an article about a certain subject, it comes up... what’s it called... ah! The person recommends it to you! There’s a recommendation” (Group 3, participant 3, male, 18 years old, south side).

The young participants recognized that new communication and information technologies facilitated communication between people, day-to-day tasks, transport, and in-person events, streamlined school work, and offered access to information. On the other hand, they also recognized the discomforts, pressures, and anguish brought on by these technologies: impacts on personal relationships, in-person contact being neglected, considered empty, and having its value questioned, harassment, bullying, unrealistic images of others, celebrities that become successful effortlessly, an excess of stimulation that compromises self-esteem, a sensation of failure, and difficulty in concentrating on important tasks. They also complain of difficulty ascertaining the veracity of circulating information, be it on mainstream media outlets or the internet, and are aware that they are impacted by an avalanche of fake news. Even the strategies to identify fake news, which the participants were aware of, were not considered sufficient to guarantee access to reliable sources of information: “the sources that I get my information from are generally those that I consider trustworthy. But that doesn’t mean that they’re 100% trustworthy” (Group 3, participant 2, male, 24 years old, south side). “A good journalist... a lot of good things, that can alert people, but, since this fake news atmosphere, this atmosphere of mistrust, exists, people don’t believe them” (Group 4, participant 1, male, 20 years old, north side).

One aspect that emerged from the discussions was the perception some participants held of their coexistence with two sets of information that are superimposed on and confused for one another. The first set, which they consider easy to access, is made up of images, people from their daily life, or “celebrities” that can persuade them to adopt perceptions that don’t correspond with reality, including echo chambers marked by disinformation (fake news) and untrustworthy sources. The second set, considered more difficult to access, comprises relationships, representations, and shared experiences (online or not) that correspond to “real life” and accurate information. The participants identified difficulty ascertaining the veracity of the information circulating both on major media outlets and on the internet, leading to the question, “who and what should I believe in?”. Their sensation is one of being “found” insistently in their information streams by the first set of information and struggling to distinguish it from the second set or access the second set effectively. According to the participants, S&T information is embedded into

and transits this superimposition or coexistence of the two sets, indicating that engaging in conversation on S&T themes requires trustworthy and prepared interlocutors.

It is worth emphasizing that the young residents of Rio de Janeiro participating in this study believed that S&T, being a technical area dominated exclusively by experts, have reduced appeal for the dissemination of fake news, stating that they experienced difficulty in identifying fake news on the subject due to the specific knowledge necessary to make such judgments. They highlighted a greater prevalence of S&T fake news in the health sciences due to their broader appeal (diets, miracle cures, etc.). Some participants had previously identified fraudulent research papers and articles published by sources considered to be reliable and affirmed that differing results from experiments on the same theme (climate and diets, among others) generate doubt and insecurity. “Losing weight is a bizarre stimulus now too, isn’t it?... Maybe it’s not even the fake news, but maybe the way doctors have researched that whole deal like that” (Group 1, participant 2, male, 19 years old, south side).

Yes! It happens. I remember the example of my professor who received a Chinese scientific article that said they changed the pH of a stem cell. Then, they replicated it in the laboratory and saw that it was a lie. But, until then, a lot of people, even from the scientific community, believed that. (Group 3, participant 2, male, 24 years old, south side)

3.4. METHODS OF APPROPRIATING S&T INFORMATION

The subjects expressed that contact with S&T themes was made by “being found” by content on the subject during casual reading, “word of mouth”, news on social media, television, or the internet, or even at school (considered by them to be an important reference in terms of access to information and knowledge), and in conversations with family members or among friends (online groups, email, and/or in person). If a subject piqued their interest, they would begin the process of searching for more detailed information, with the internet being their primary means due to its various available tools. The web offers a “web of connections” that is activated through its many links and search alternatives, complicating these young people’s attempts to identify a single source or specific sources: “I think that the subject searches for me. I end up seeing it like that. It comes to me, you know?” (Group 5, participant 3, female, 22 years old, north side).

In this context, the participants in this study struggled to identify the channels through which specific pieces of S&T information were carried to them, rarely being able to cite their sources spontaneously. Few connection points between young people and scientific information were offline, and social networks stood out as central platforms. Internet S&T information sources cited by the participants included simply “the internet”, without further specification, an “online portal”, “online articles”, “online magazines”, Facebook, “scientific pages on Facebook”, LinkedIn, YouTube, TED Talks/TEDx, the Fiocruz site, and emails and WhatsApp messages received from parents. Offline, cited sources included school and schoolwork, print media, TV news, and word-of-mouth communications.

The difficulty that the participants had in identifying their sources is coherent with studies that indicate that content diversity, the increase in the number of distributing channels, and the possibility of sharing through the internet make it difficult to determine the origin of unregulated channel-crossing content, blurring the borders between different types of media platforms (*Grupo de Mídia São Paulo*, 2018; Music Television Brasil, 2010).

3.5. HOW TO DISCUSS SCIENCE AND TECHNOLOGY WITH YOUNG PEOPLE

The previously analyzed discussions provide guidelines for dialogue with young people on S&T. First of all, according to them, credibility must be established: constructing relationships built on trust is fundamental in an environment with so much disinformation and difficulty in identifying verifiable content. S&T information is inserted into and transits the superimposition or coexistence of the two sets of information mentioned above. Furthermore, for the participants of this study, discussing such themes requires that the interlocutors be both trustworthy and well-prepared. In the national poll carried out by the INCT-CPCT in 2019 (Massarani et al., 2021), for example, young people most often cited teachers (50%), doctors (37.2%), and university or public research institute scientists (36.7%; omitted to ensure anonymity) when asked to list what they considered to be the most reliable sources of information.

Aside from being specialized, trustworthy interlocutors with an educational background in the area, the participants emphasized that those who wish to engage in science communication must keep up with the trends and changes among young people in the area and the types of information to which they have access. Lastly, the extensive and critical repertoire of S&T themes that such communicators possess must be taken into consideration, using a tone and aesthetic coherent with the form in which they communicate and interact with their audience: “I think that, after you establish credibility... it’s easier to think about this in terms of the internet, it’d be your page” (Group 3, participant 3, male, 18 years old, south side). “Ah! Depending on the subject, it’d be you spreading information, wouldn’t it?! It’d have to be on all the platforms we use” (Group 5, participant 3, female, 22 years old, north side). “The way you talk! That’s it! I think it helps! Since young people have their own language among themselves” (Group 5, participant 2, male, 20 years old, north side).

It is worth restating here that sharing, interaction, and exchange mechanisms for S&T information (which can be commonly observed in diverse subject areas and conversations) are selective, restrictive, and, as the participants stated, a “melting pot” of friends, family, social network groups of like-minded peers, and specific contexts (tutoring or school, for example). When they take place, these mechanisms must be relevant to the target audience, presenting a great challenge for S&T communication with young people: “how do you get into these bubbles?”. Aside from this, the participants also indicated to the authors that there are no guarantees when it comes to the “success” of shared content: “There’s no real way to force it through! (...) Some things go viral, some things don’t. That’s basically it!” (Group 1, participant 1, female, 18 years old, south side).

Regarding media platforms, despite emphasizing the limitations and dangers of information circulating on the internet, the participants indicated that the web and its tools, including tools that must be paid for, as potential “meeting places” for young people and S&T. However, they also did not discard in-person events, such as expositions, demonstrations, public talks, or personal conversations as opportunities for the construction of credible conversations on S&T (Figure 1).

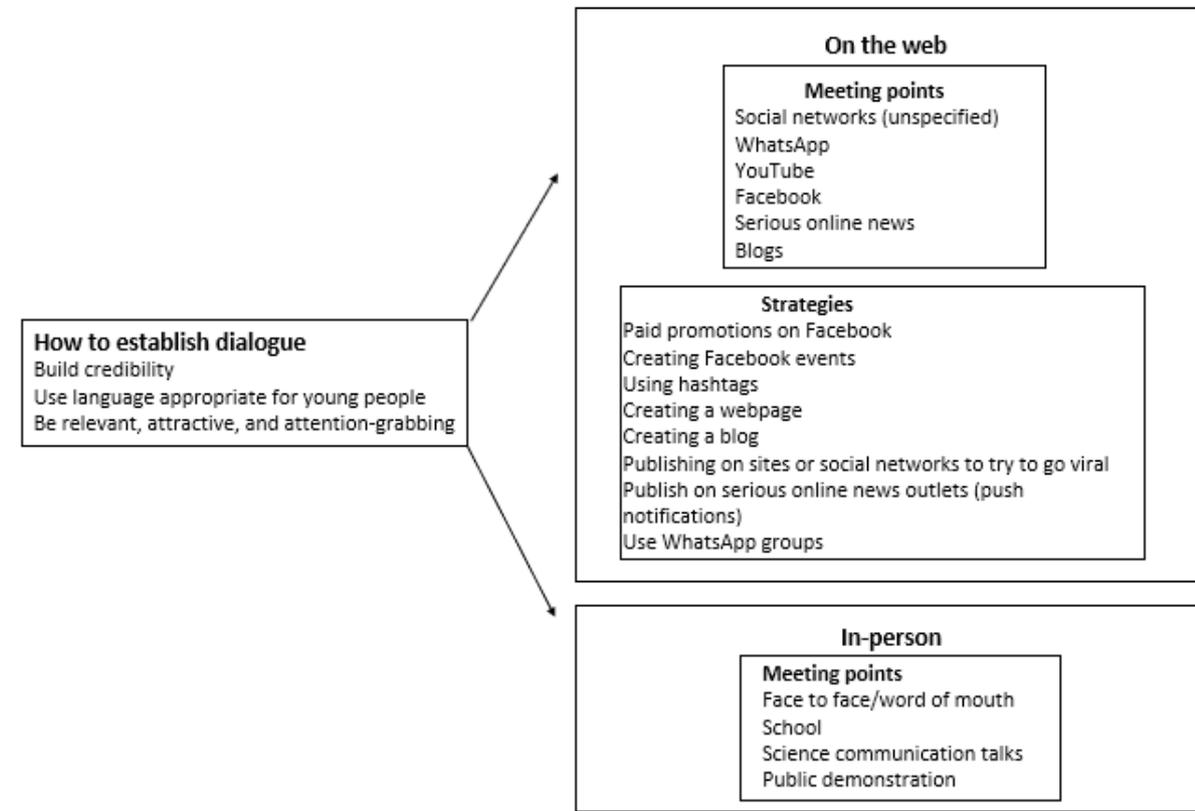


Figure 1 How and where to engage young people in dialogue on science and technology, per themes explored in interviews

4. FINAL CONSIDERATIONS

The empirical research developed from the in-depth interviews and discussion groups with young residents of Rio de Janeiro elicited reflections on the relationship between young people and S&T, as well as indicators and possibilities for establishing dialogue and communication processes with them. The engagement of these young participants in the activities employed was intense and rich, demonstrating their desire to participate in detailed and elaborate discussions on the theme.

Establishing points of connection for S&T themes requires a prior understanding of the perceptions and complex repertoire already incorporated by young people into interactions with these themes. These young people have a positive perspective on S&T, recognizing both its risks and benefits, opening an important window of opportunity for science communication.

This contextualized and relatively critical perspective on S&T has direct implications on the perceptions of these young people on its risks and benefits, which, according to the participants, depend on the purposes, how, and by whom it is used; support for investments is positive. However, it should be oriented towards areas that yield tangible results for the population; the responsibility for damages caused by activities in the area is shared by the government, the companies involved, citizens, and S&T itself; lastly, the application of S&T in the solving of social challenges depends less on development of new technology and more on choices related to political, economic, and social contexts.

Another subject that emerged from the discussion groups is related to these young people's exposure to various areas of uncertainty, marked by information and personal relationships that coexist and are interconnected. Technology and communication apparatuses are seen as welcome and indispensable, though they frequently provoke concerns both in personal relationships and informational searches, expressed well by the question "who and what can I trust?". S&T communication and information are embedded into this context, and the young participants in this study stated that they were frequently impacted by subjects related to the area even without searching for them, with content often arriving to them through unidentified and unsought sources, making the credibility of the communicator of utmost importance. According to the participants, this credibility goes beyond academic preparation and must be constructed, renewed, and strengthened based on attentive listening to the comments and needs of the audience. That supports the relevance of periodical perception studies in the field and, more broadly, the concept that S&T information, in such a dynamic and volatile communication environment, is not necessarily searched for, often making its way to these young people randomly.

Despite their awareness of the challenges presented by information and communication technologies, the participants considered the internet, as a whole, to be the preeminent forum for S&T dialogue, as S&T information appears frequently and prevalently in their streams, competing in an adverse environment where information from both reliable sources and unestablished sources circulate. They also emphasized the importance of in-person activities at school, talks, and expositions, considered important due to their credibility and informational character.

It can be affirmed that the establishment of communication processes with this demographic demands the constant search for points of discussion and connections to their information streams in a complex information ecosystem; credibility built by well-prepared interlocutors, considering young people's repertoires seriously and in-depth; and the utilization of language and aesthetics that appeal to this demographic. The interviewed youths described a complex perspective, indicating the importance of public S&T communication that is not alienated from its social context and can make connections between the information discussed and citizens' daily lives. We as a society face a complex task with no guarantees, necessary and urgent, that is combined with the challenge that young people present us in demanding a more humanistic perspective, more effective democratization of knowledge, and expanded access to benefits generated by the area that, according to them, should be directed towards the resolution of wider social issues.

It should be noted that this study did not aim to formulate results for young Brazilians in general but rather to complement and facilitate the interpretation of the data from the survey mentioned above (which is representative of the young Brazilian population as a whole). This specific geographical area, the qualitative analysis employed, and the choice to focus on discussion groups allowed, in contrast, for a deeper understanding of the reasoning, perspectives, and demands demonstrated by these young people (though not their relative weights). It also helped interpret the quantitative surveys' results, which demonstrate precisely how young people responded to the selected questions but not the motivations behind their answers or the rhetorical resources and representations with which they would support their answers. The authors believe these results clearly indicate the necessity for the completion of larger-scale studies periodically, as well as the necessity of integrating and triangulating qualitative, quantitative, and mixed approaches. Segmentation, cluster analysis, big data text analyses, and interactions with ethnographic studies, for example, can provide a more fine-tuned understanding of these phenomena and allow for more efficient communication with the diverse youth populations, that engage with S&T themes at different levels of intensity.

Translation: Jonathan Edwin Baracho Trindade Hill

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