Ciência & Educação, Bauru, v. 30, e24000B, 2024
https://doi.org/10.1590/1516-73132024000B

EDITORIAL

What if we think of Science Education as science to be popularized?

Isabel Gomes Rodrigues Martins

Federal University of Rio de Janeiro (UFRJ),
Institute Nutes of Education in Science and Health, Rio de Janeiro, RJ, Brazil.
E-mail: isabelmartins@ufrj.br

Translated by P.D. Email: dharma.pedro@gmail.com

The argument

This text puts forward an argument for the importance of popularizing knowledge produced through research in the field of science education. This action is necessary as part of a project to challenge a negative perception of public education that undermines the potential of an empowering education, which may potentially contribute to greater inequality and social exclusion. After providing a defense of the scientific status of the knowledge generated within the field of Science Education, I proceed to analyze the historical and political aspects of science popularization. Next, I go over the specific aspects of sharing research in Science Education, while addressing probable connections between how it happens with scientific research and research in Science Education.

The motivation

Repeatedly, and not just these days, we come across media reports about the poor performance of Brazilian public school students in national and international large-scale assessments. Basic education teachers often face criticism for being portrayed as poorly trained professionals with little commitment to their work. Schools are sometimes seen as anachronistic institutions that have not kept up with the evolution of digital information and communication technologies. Additionally, curricula are often criticized for being outdated and inadequate to meet the demands of the job market. In addition to these criticisms, concerns are raised about the potential for high-quality education in public schools and arguments in favor of redirecting public resources to the private sector. This can be seen in the form of vouchers that allow parents to enroll their children in private schools. There are also centralized curricular proposals that prioritize market-oriented training over a more critical and comprehensive approach that is geared toward exercising citizenship in a broader way.

Though not as common, we sometimes hear about how well Brazilian public school students do in international competitions and school olympiads. Likewise, the media does not give equal emphasis to the outstanding achievements of students from federal schools, which are on par with those from the top-ranked countries in international large-scale assessments. Projects and events of high academic relevance, developed and carried out by professionals from public education networks, are often depicted as the result of exceptional individuals' efforts, highlighting individual achievements. This portrayal adds up to an ideology of meritocracy that overshadows the collective efforts of the multiple individuals and institutions that contribute to the success of such activities.

An important factor in the production of these narratives that discredit public education is linked to the increasing reliance on technology for communication. This enables information to spread rapidly and independently of spatial and temporal relations, making it easily consumed, discarded, and replaced before being properly analyzed and evaluated.

This situation, where educational disparities are not adequately examined or understood, allows for the creation of a perception that undermines public schools, labeling them as deficient: students lacking motivation, teachers lacking proper training, insufficient resources and infrastructure for effective teaching, and a dearth of innovative and meaningful projects.

The portrayal of the public education system as costly, ineffective, corporatist, and burdened by bureaucracy provides a rationale for advocating for the implementation of performance-based management models, fostering competitiveness, and introducing reward systems. According to Ball (2012), this perspective aligns with global political trends where philanthropy, business, and government form policy networks beyond the nation-state framework. In this context, education and educational policy are commodified, and the significant issues of development and quality are addressed through market-oriented solutions (Ball, 2012; Silva, 2019).

Considering the observations made in the context of Brazilian reality, it is important to question the type of society that is being shaped by values like meritocracy, performativity, and accountability, which are characteristic of the neoliberal ideology. This is particularly relevant in a country like Brazil, where education has never been viewed as a right provided by a welfare state.

The intensity and capillarization of narratives that describe the supposed shortcomings of public education and the exaggerated claims of success in private models serve as a reminder of the importance of critically examining the underlying assumptions and arguments behind these perspectives. Is privatization of the education system the best approach? In her insightful work, Chimamanda Adichie (Adichie, 2019) cautions us about the perils of having a limited and shallow grasp of facts. She emphasizes how this hinders our ability to truly understand and envision alternative perspectives that challenge the norms ingrained in society. The author presents a compelling argument about the impact of stereotypes and ingrained perspectives on our ability to challenge dominant narratives. By highlighting the dangers of relying on a single narrative, she emphasizes the need to embrace the complexity of reality.

This provocation is the reason that, as a science educator, I refuse to be complicit in the creation of a single narrative on the problems with (science) education in Brazil and, by extension, on a single solution. I strongly advocate for the creation of alternative narratives that prioritize the autonomy of educators, acknowledge the diverse cultures, aspirations, and identities of students, and foster a deep respect for the knowledge contributed by various groups. A significant portion of our work involves collaborating with educators, administrators, and students within educational institutions. Throughout our work, we have observed their dedication and accomplishments in formulating inquiries, identifying collaborators, defining interests, clarifying expectations, suggesting strategies to address the challenges posed by the absence of professional development policies, and promoting education as a fundamental right. Our work has consistently required the creation of more inclusive environments and a collaborative approach with all stakeholders in the educational process. We strive to challenge traditional practices where knowledge is used to enforce conformity and limit alternative perspectives. This does not imply disregarding the unique and influential academic knowledge produced through educational research. Contrarily, a valuable way to contribute to the development of varied 'histories' is by taking on the duty of sharing our research and the knowledge we generate – beyond our peer community – or, in essence, to 'popularize' the science produced in the field of Science Education.

As a result, the need to engage in a dialogue with society, offering data and reflections that allow us to broaden perspectives and qualify the debate on issues, pervades the daily lives of parents, students, managers, teachers, and public policymakers, and thus appears mandatory for us researchers in (Science) Education.

It is important to not underestimate this idea because it challenges us to go outside of our comfort zones and examine how our discourse is responsive to educational difficulties. How do we see ourselves in connection to these issues? What is the nature of the knowledge we generate? How does it relate to other knowledge and skills? How prescriptive can we sometimes be? This statement underscores the significance of dialogism, which entails several key considerations: the necessity to clearly communicate the motivations and nature of our research practices; the importance of considering the audiences with which we aim to engage; the recontextualization of concepts to facilitate discourse with social groups that we may not regularly intersect with; and the extension of the visibility of our concepts into virtual and physical environments that we may not regularly visit.

The working hypothesis

Allow me to begin with a small disclaimer. In this text, for the sake of argument, we assume that Science Education is a scientific field. We understand that this can be a topic of debate, as some may question whether Science Education constitutes a scientific field or not. However, this dispute, with its social and epistemological implications, is outside the purview of this study and will not be discussed. Nevertheless, to back up our position on the scientific nature of Science Education, we would like to provide a few concise observations on the social and epistemological aspects.

Tackling the epistemological challenges related to the development and establishment of scientific fields can be quite intricate. When it comes to Science Education, careful thought must be given to the nature of its objects and the philosophical traditions that back up the various ways of understanding them. A cursory examination of Science Education, however, shows that it derives from scientific traditions typical of the wide notions of hard and soft sciences, which include not only the natural and life sciences but also the humanities and social sciences. Our field has engaged in ongoing dialogue and pursued a thorough understanding of the epistemological foundations in these areas. We have traditionally engaged with theoretical contributions such as The History and Philosophy of Science, Piaget's Genetic Epistemology, and Pierre Bourdieu's Sociology. These contributions have enabled us to approach research questions on topics like conceptual development or performance from fresh perspectives. Not less important are the field's theorizing efforts, which include: acknowledging its interdisciplinary nature; developing a critical attitude toward the adoption of methodological principles and procedures; focusing on the socio-cognitive, cultural, and political dimensions of knowledge; and proposing and analyzing curricular approaches. These efforts are evidenced by the proposal of concepts such as Didactic Transposition (Chevallard, 1985) and Conceptual Profile (Mortimer; El-Hani, 2014); the investigation of Alternative Conceptions in concept formation (Gilbert; Watts, 2008); the problematization of Science and Technology Studies (STS) (Aikenhead, 2000; Santos, 2011); addressing socioscientific issues (Conrado; Nunes-Neto, 2018); and discussing the notion of scientific literacy (Martins, 2011), among others.

The sociological aspect of the inquiry into the legitimacy of the field of Science Education, on the other hand, can be explored by examining the nature and criteria that define a scientific field, as discussed by Pierre Bourdieu (Bourdieu, 2003) in his theories on the Sociology of Science. In the author's perspective, the scientific field is a dynamic environment where individuals – agents – interact with each other through objective relationships, influenced by their science capital, which shapes their positions and actions. The presence of scientific capital can be seen in its 'raw' form when it is linked to the unique talents, charm, or reputation of individuals, as well as in its 'institutionalized' form. One can achieve the latter through a combination of competitive success, electoral victories, and recognition through awards. The autonomy of a scientific field, is inherently limited, as it succumbs to social pressures that are filtered through its internal reasoning. This approach entails setting up criteria for validation and reliability within the field, including peer review and the dissemination of research findings through events or publications. The field's activities are centered around established institutions, like universities, where training programs for teachers and researchers are conducted. These programs are endorsed, certified, and assessed by government agencies, and the findings are shared through scientific journals.

Still, in terms of the sociological aspect, there has been a significant development in the organization of field agents into professional and research associations. This has led to the establishment of platforms for sharing knowledge through events and periodicals, which have greatly contributed to the advancement of knowledge and the formulation of public policies. More specifically, in Brazil, we delve into a rich history of the field of Science Education: the emergence and growth of postgraduate programs;

the establishment of the area of Science and Mathematics Education by the CAPES foundation; the frequency and extent of scientific events, such as the National Meeting of Science Education Research (Enpec); the increase in the number of specialized publications; the presence of scientific societies, like the Brazilian Association of Research in Science Education (ABRAPEC); the academic distinction conferred by the(National Council for Scientific and Technological Development (CNPq) and the State Research Foundations; our researchers in the field; the experts who take part in the formulation of public policies, including the National Textbook Plan (PNLD), the National Curricular Parameters (PCN), and other programs aimed at improving the teaching profession, such as observatories of education.

Our working premise, that Science Education is a distinct scientific discipline that generates its own body of specialized knowledge and stands apart from related disciplines, seems to have good support from these few points of examination. It is within the potential and limits of this assumption that we will develop our argument that, like what happens in other fields, it is possible and necessary to think about science popularization practices in Science Education.

Science popularisation: customary questions

Science popularization has vital connections to several domains of knowledge. Thinking about the field of Communication, particularly in terms of its ties to scientific journalism, and that of History and Historiography, as these involve projects to create archives and preserve memory, sharing science can be understood in terms of its educational potential. This is particularly evident in museums and science centers that collaborate closely with the school system. Equally significant is the impact of Discourse Studies on examining the way information is shared and communicated, particularly in the realm of scientific discourse. This field delves into the various ways scientific information is presented and made accessible to a wider audience, including non-specialists. Finally, we can observe possible links between scientific popularization and topics investigated by Cultural Studies, like the integration of technology into modern life, the merging of media platforms, and the increased opportunities for connectivity through electronic communication and social networks.

The popularization of science has a long and rich history, dating back to the early days of the natural sciences. It is understood here as a social practice based on inquiry, modeling, and the systematization of knowledge. This practice emerged during Western modernity, challenging traditional thinking and gaining credibility through peer review. This practice emerged during Western modernity, challenging traditional thinking and gaining credibility through peer review. In this historical perspective, significant milestones in the field of science popularization include the establishment of the Royal Society[1] in 1660 and the Royal Institution in 1779[2]. In Brazil, there are historical records of early attempts to popularize scientific knowledge among the public through newspaper articles. These articles emerged following the relocation of the Portuguese court to Brazil and the subsequent lifting of the press ban. Moreira and Massarani (2001) noted that there has been a long-standing interest in science popularization,

[1] https://royalsociety.org/about-us/history/

[2] https://www.rigb.org/our-history/timeline-of-the-ri

as evidenced by various publications and initiatives throughout history. *For instance, the Revista Brazileira: Jornal de Sciencias, Letras e Artes* (Arantes, 2010) was a journal established in 1857, followed by the Conferências da Glória, or Glorious Conferences, in 1873. The Brazilian Academy of Sciences was founded in 1916, and the magazine Sciencia e Educação was introduced in 1929. Since then, there has been a significant increase in scientific popularization practices in our country. Notable individuals include Roquette Pinto, who played a key role in establishing the radio station Sociedade in 1923 and the National Institute of Educational Cinema in 1936. Another influential figure is José Reis, a highly regarded scientist who has become an emblem of science popularization in Brazil. Throughout the latter half of the 20th century, Reis made significant contributions by writing for prominent journals, editing Ciência e Cultura, published by the Brazilian Society for the Progress of Science, introducing innovative formats, proposing guidelines, and amassing an extensive collection, now housed by the Oswaldo Cruz Foundation.

It is readily apparent that the initial goal of science popularization was to convey technological and scientific advancements to society. However, Perrault (2013) notes that there have been notable shifts in the range and characteristics of the agents engaged in these activities over time.

> Understood in terms of the rhetorical situation, the history of science popularization is a history of a changing set of rhetors, exigences, and audiences. Understood in terms of kinds of knowledge, it is a history of shifting relationships between episteme (scientific or specialist knowledge) and doxa (public knowledge) (Perrault, 2013, p. 37).

The decision regarding the content and manner of communication is shaped by our assessment of the audience's conceptual needs, as well as our interests, desires, expectations, and ability for comprehension. Models constructed by the expert community to depict the general population are typically the foundation for these decisions. There is a continuum that includes numerous models that scholars generally agree on when it comes to the public's and professionals' interactions in science: (i) the deficit or dissemination model; (ii) the contextual model; (iii) the lay expertise model; and (iv) the participation model are the four models that are presented. In response to criticisms of the initial model, the final three models were proposed (Hetland, 2014; Lewenstein, 2003).

The *deficit model* posits that science communication initiatives are directed at bridging knowledge gaps for the public, excluding specialists, under an internal scientific agenda. According to this viewpoint, the topic's scientific importance determines what information should be shared. Showcasing the purported 'discovery' of the Higgs boson or the detection of dark matter, for instance, satisfies an alleged requirement for the public to get around an informational or conceptual deficit. From this standpoint, individuals who possess knowledge are considered the agents of popularization, while the public is perceived as an unequal mass in need of said knowledge. Underlying this view is an intellectual valorization of scientific knowledge and its high degree of social legitimacy. A common justification for deficit-based dissemination practices is the notion that all individuals ought to have access to scientific knowledge. This is attributed to the epistemic value of science, which facilitates the cultivation of superior intellectual abilities, or to its capacity to inform public and private decision-making.

As stated by Lewenstein (2003, p. 3), this perspective "[...] overlooks contextual factors and the interconnections between scientific knowledge and other forms of knowledge that are ubiquitous in daily life."

However, *contextual models* acknowledge the significance of experiences and prior knowledge when processing scientific information. Take, for instance, the varying interpretations of the potential carcinogenic effects of ionizing radiation among individuals who are exposed to radioactive materials or reside near nuclear power plants. When considering various audiences, who may have varying levels of knowledge and involvement in science, contextual models highlight the importance of dialogue and value the active participation of the audience in communication. Nevertheless, contextual models can be seen as an advanced iteration of the deficit model. They share similarities in how they perceive public knowledge of science and its impact on society. Because of this, they both refrain from scrutinizing social and political practices when confronted with funding and public policy decisions that may, at times, contradict the welfare of residents or workers (Lewenstein, 2001).

Another model discussed by Lewenstein (2003) is the *lay expertise* model. The concept holds that while scientific and local knowledge can be applied to solve issues, there is no hierarchy between the two. This model therefore functions by elevating public, ancestor, and indigenous knowledge and bolstering its authority and capacity to address societal issues. Such a model challenges the notion of a deficit and emphasizes the importance of sharing knowledge gained through experience. There is a suggestion that, by questioning the authority of scientific knowledge, this model would be more democratic. Nevertheless, the inherent relativism of this approach provokes continuous debates, particularly when considering the importance of comprehending the nature of science and its methodologies. Initiatives identified with this model, which has even been labeled anti-science, have faced resistance, so that the mere opposition or dispute between pieces of knowledge fails to produce ways of achieving a greater degree of understanding (about science) on the part of the public (Lewenstein, 2003).

While it is important to acknowledge the value of local knowledge in decision-making processes, simply recognizing it does not guarantee its effective utilization. This issue is explicitly addressed in publications related to the *participatory model*. They emphasize orientation towards the democratization of science and efforts to promote public engagement and participation in debates and, eventually, in decision-making contexts about scientific policies, such as public hearings. For this hands-on approach, the participatory model, also known as the dialogue model, addresses the issue of public alienation in science popularization agendas and empowers citizens politically.

This brief attempt to historicize some initiatives in science popularization suggests tensions that reflect essentially political issues, in the sense that they involve conflicting worldviews, contrasting interests, and disputes over hegemony. According to Bensaude-Vincent (2009, p. 359), "[...] the recent shift from a deficit model to a participatory model profoundly changes the values underlying science communication. Whereas previously this communication was carried out in the name of science, [now] it is carried out in the name of democracy."

Science Education as an object of science popularization

The importance of democracy in motivating science popularization is crucial for researchers in Science Education who acknowledge the necessity of sharing our knowledge with non-specialist audiences. In this sense, it is important to remember the diverse audiences to which we address and to understand their distinct qualities. We must also consider the social practices that require the knowledge that we generate, as well as our position within the networks of discourse in which we actively engage. It is important to critically examine the knowledge that we produce and how it relates to other forms of knowledge that circulate in society.

These requirements prompt two things: first, an examination of the characteristics of the knowledge we generate, and second, an analysis of how its dissemination can be considered a political act[3].

The nature of Science Education

Concerning the first point, it can be stated that an important aspect of our field is the exploration of unique questions and the development of theoretical and methodological frameworks that go beyond those used in the natural and social sciences. While this aspect may not always be explicitly discussed or analyzed, it has consistently been a factor, whether as a deliberate compromise or an underlying tension. This is evident in the diverse range of theories and methods that are prevalent in the field.

That being said, acknowledging this irreducibility poses a difficulty. If we consider that scientific disclosure extends beyond the dissemination of scientific facts and information to include aspects of the processes by which knowledge is produced, validated, and legitimized within and outside the scientific community, we must consider specific aspects related to the epistemological foundations of the natural sciences, humanities, and social sciences as part of the knowledge to be disseminated. This matter appears significant in my opinion, as research-derived knowledge should be presented as the result of an intellectual and practical effort that is socially situated rather than as a dogma.

The recognition of the scientific nature of our research must not, however, lead to disclosure practices like those identified by the so-called deficit model. Our body of knowledge on the subject of education in the sciences is significant because it engages society in conversation and offers fresh perspectives on problems that are intimately tied to education – a process that can be thought of as "[...] a triple process of humanization, socialization, and entry into a culture, singularization-subjectivation" (Charlot, 2006, p. 15, our translation). On the other hand, the different experiences about educational processes that we have throughout our lives – whether as students, parents, or teachers, for example – convey to those who are not specialists in education a conceptual and experiential repertoire for the interpretation of educational issues. However, this multiplicity of experiences is not enough to characterize secular expertise in education; there are legitimate interests, demands, and interpretations on the part of

[3]Here, we define the term political by differentiating it from party politics and focusing on its connection to power dynamics, ethics, freedom, and pluralism. It, therefore, encompasses issues related to the governance and administration of states, as well as the coexistence of individuals in society and their engagement with public affairs.

different audiences about scientific knowledge in this field. Moreover, the diversity of actors and interlocutors with whom we interact in the field of education, along with our various roles within different educational institutions, calls for a thoughtful approach and emphasizes the importance of collaborating on common goals.

Equally significant is the societal perception of science, scientific research, and the expectations associated with it. True, as opposed to trustworthy, is a common adjective used to describe scientific knowledge. It is interesting to note that some portrayals of science in the media often blur the lines between skepticism and doubt, mistakenly equating the cautious nature of scientific explanations with a lack of precision. In the modern context, Fensham (2015) highlights the importance of addressing these traits, particularly when skepticism is seen as a form of doubt that undermines confidence in scientific knowledge. For the author, science education should have as its horizon the perspective of transforming the public into science *connoisseurs*[4], which includes grasping the concept of uncertainty in science, understanding probability and risk, and distinguishing between correlational and causal relationships, among other important aspects. Such an assessment would also be necessary to adequately understand the scope and limits of educational research results. It is important to ponder these factors when considering how to effectively communicate the knowledge generated in our field and its influence, ranging from small-scale educational initiatives to large-scale government initiatives.

Consider, for instance, one of the many aspects linked to the production of scientific knowledge, such as the ability to generalize research findings. We can say that, when people work in the natural sciences, they often use the reliability of methodological procedures, like making inductive or deductive models or statistical evaluations, to explain why study results might be applicable to other situations. Similarly, in addition to their specific epistemological orientations, research in the field of human sciences also encounters the need for results that can be somewhat generalized. This is particularly important when these findings are used to inform public policies and justify resource allocation. While generalization concepts may not directly address replicability or linear extrapolation of results, they do provide a means to identify patterns and make inferences about the objects being studied and their counterparts (Larsson, 2009).

This makes things more difficult for us researchers as producers of knowledge in science. Put simply, the idea of promoting the spread of scientific research in Science Education raises questions about our understanding of the nature of science in our field. What are the properties of the objects covered in the topic of science education? What is our stance concerning them? How do these positions get translated into research principles and procedures? In other words, how do we refer to ontology, epistemology, and methodology in our field? What is the significance of the axiological dimension in our work? In the domain of natural and health sciences, such problems are frequently linked to hypotheses about the *Nature of Science*. Part of our challenge, therefore, is the discussion of what the *Nature of Science Education* would be.

[4]This concept was introduced by Isabelle Stengers during a conference at the European Science Education Research Association, in Lyon, 2011.

Popularization of Science Education as a Political Act

Grasping the boundaries and potential of implementing educational research findings can be particularly thorny. We frequently encounter the question of why our research findings may not always provide straightforward solutions that can be easily implemented in schools or other educational settings to enhance their performance. Looking at the various audiences we may need to engage with, such as managers, teachers, young students, their guardians, and public policymakers, it is important to address this question thoughtfully and validly. In our current era, education stands as a crucial solution to various societal challenges, including prejudice, unemployment, and violence. The role of education in addressing these and other issues is undeniable. Nevertheless, it is crucial to avoid oversimplifying the complex social issues at hand and to recognize that education alone cannot single-handedly resolve the deep-seated and long-standing problems within Brazilian society.

Delineating the scope and limitations of research is thus critical; failure to do so may jeopardize the credibility of researchers' social contributions to science education and subject them to personal accountability for the challenges encountered by student teachers in classrooms. This position is less prevalent in the natural and health sciences; generally, university researchers are not held accountable for the long waiting times at public clinics or for the failures of the health system. The COVID-19 pandemic demonstrated the intricacy of the systems that allow scientific research to influence public health through the dissemination of prevention and treatment options. On this occasion, we witnessed how ideological guidelines and political decisions negatively affected the population's access to the vaccine, causing delays and harm. In the field of Education, though, the connection between research and practical application may not always be clear. Researchers often face criticism for developing theories that may not directly address educational problems and are sometimes blamed for the challenges faced by schools. Deliberating on this matter, which exemplifies elements of the dichotomy between theory and practice, requires community engagement when our objective is to distribute the findings of our research. It is important to convey the intricate connections between the findings of educational research and the practical settings where these findings may be applicable. From obtaining the results to translating them into recommendations, there is a complex and multistep process that involves various forms of mediation. Insights gained from educational research in the field of science contribute to a complex network of interconnected ideas and perspectives, spanning from government offices to the everyday realities of the classroom. One of the crucial factors in facilitating learning is the role played by educators, particularly teachers, in the classroom. As required by the practice of a critical-reflective professional, they replicate the recommendations they get in an autonomous and qualified manner. Such adaptations and recontextualizations of research findings thus match the specific qualities of the social activities to which they will be applied. These considerations demonstrate that expecting classroom research results in the form of responses derived from the application of a model built on direct uni causality, regardless of how alluring its simplicity may appear, is, at the very least, naive.

Building an agenda for popularizing Science Education

In this text, we invite Science Education researchers to consider the importance of sharing their work beyond community members as a means of deconstructing narratives that undermine public education and educational research. We propose that in the field of science education, it is not only important to share research findings but also to understand the processes involved in producing knowledge in this field. Moreover, we emphasize the need to address a second issue, which is the practice of scientific popularization as a political act.

Consistent with the previous discussion about promoting research in the natural sciences, we emphasize the importance of applying critical and reflective thinking to the dissemination of research in science education. This includes contemplating the construction of knowledge and the validity, reliability, and universality of research findings and educational experiences. Moreover, we urge our community to support our pledge to clearly define our socio-conceptual horizon of enunciation in our speeches. This entails specifying where we speak from and how we construct ourselves through the various discursive practices that we are implied to take part in (Bakhtin, 2014) and in which we are involved, including research, publication, training, and more.

As for the political aspect of popularizing scientific knowledge in the field of science education, it is tightly tied to the principle of dialogism (Bakhtin, 2014), which is embedded within our discourse. Therefore, it is important to examine the perspectives of scientists regarding societal needs and the connections between various groups of people and scientific knowledge. Some of the harshest critiques of the contextual model as well as the deficit model have previously emphasized the need to consider audience characteristics and the dangers of using science as the only foundation for thinking about how to share knowledge. Because many of our findings include connections in places where we have previously participated or been actors, it is crucial that the public's understanding of the settings in which our research occurs be considered when evaluating the quality of the science we provide. In contrast to laboratories and scientific research centers, which are often out of reach for many, most of us have had the opportunity to attend school and are familiar with the daily lives of students. We have firsthand experience with curricula and textbooks and understand the routines of teachers. This familiarity can lead to a kind of naturalization of objective working conditions and the problems faced by the school. It may also cause people to generalize these attributes and develop modes of thinking linked to questions that, by finding resonance in their experience, will serve as a *backdrop* for their understanding of the formulations emerging from educational research. As is often the case with approaches based on contextual models of scientific dissemination, we must be mindful of the need to dismantle preconceived notions that can obstruct the full appreciation of research findings and result in the rejection of their recommendations, creating sterile disputes.

Another vital component to consider is the topic of the distance between universities and schools, which often leads to a disconnect between researchers and educators. It should be made known that initial and ongoing training environments are where a lot of research is carried out. Similarly, it is crucial to highlight the researchers' dedication to enhancing teaching and learning methods, along with their commitment

to creating educational resources and fostering innovation in education. I also think it is important to emphasize that some of our research involves students and teachers alike. In certain approaches, such as action research, instructors and students are involved in the formulation of goals as well as specific parts of inquiry development. This awareness may also assist the public in thinking more contextually and critically about the study findings that are presented. These approaches facilitate communication between the public and experts, encouraging public involvement in significant matters like advocating for public schools and promoting the teaching profession. In other words, these kinds of movements might help create practices that are more in line with the goals of participatory approaches to scientific dissemination. These are practices that bring citizens closer to situations where the knowledge generated by research is useful and can help them gain political power.

Finally, we must not forget that the distribution of our scientific findings will rely on various forms of mass communication, such as social media and the mainstream press. However, it can be quite challenging to secure speaking opportunities on reputable and trusted platforms that have a strong public following. However, it is important to note that social media, despite its potential for increased access and participation, has unfortunately become a breeding ground for conflicts over narratives, the spread of disinformation, and the manipulation of ideas through fake news and distorted information. Thus, each channel presents unique challenges based on its characteristics and languages, and it is our responsibility to understand and leverage their potential in support of our commitment to dialogue.

Acknowledgements

The author expresses gratitude to the National Council for Scientific and Technological Development (CNPq) and to the Carlos Chagas Foundation of Rio de Janeiro (Faperj) for their funding and support of research projects, which made it possible to complete this work. The author also extends their appreciation to PhD Professor Rosária Justi for their valuable feedback on the initial draft of this manuscript.

References

ADICHIE, C. N. *O perigo da história única*. São Paulo: Companhia das Letras, 2019.

AIKENHEAD, G. What is STS science teaching? *In*: SOLOMON, J.; AIKENHEAD, G. (ed.). *STS education*: international perspectives on reform. New York: Teachers College Press, 2000. p. 47-59.

ARANTES, D. T. Revista Brazileira, Jornal de Sciencias, Letras e Artes (1895-1899): indexação e análise da quarta fase do periódico. *Língua, Literatura e Ensino*, Campinas, v. 5, p. 83-93, 2010. Disponível em: https://revistas.iel.unicamp.br/index.php/lle/article/view/1181. Acesso em: 1 jul. 2024.

BAKHTIN, M. M. *Marxismo e filosofia da linguagem*. Rio de Janeiro: Hucitec, 2014.

BALL, S. J. *Global education inc.*: new policy networks and the neo-liberal imaginary. London: Routledge, 2012.

BENSAUDE-VINCENT, B. A historical perspective on science and its "others". *Isis*, Chicago, v. 100, n. 2, p. 359-368, 2009. DOI: https://doi.org/10.1086/599547.

BOURDIEU, P. *Questões de sociologia*. Lisboa: Fim de Século, 2003.

CHARLOT, B. A pesquisa educacional entre conhecimentos, políticas e práticas: especificidades e desafios de uma área de saber. *Revista Brasileira de Educação*, Rio de Janeiro, v. 11 n. 31, p. 7-18, 2006.

CHEVALLARD, Y. *La transposition didactique*: du savoir savant au savoir enseignée. Grenoble: La Pensée Sauvage, 1985.

CONRADO, D. M.; NUNES-NETO, N. (org.). *Questões sociocientíficas*: fundamentos, propostas de ensino e perspectivas para ações sociopolíticas. Salvador: EDUFBA, 2018. DOI: https://doi.org/10.7476/9788523220174.

FENSHAM, P. J. Connoisseurs of science: a next goal for science education? *In*: CORRIGAN, D. *et al*. (ed.). *The future in learning science*: what's in it for the learner? Cham: Springer, 2015. p. 35-59.

GILBERT, J. K.; WATTS, M. Concepts, misconceptions and alternative conceptions: changing perspectives in science education. *Studies in Science Education*, Abingdon, UK, v. 10, n. 1, p. 61-98, 1983. DOI: https://doi.org/10.1080/03057268308559905.

HETLAND, P. Models in science communication policy formatting public engagement and expertise. *Nordic Journal of Science and Technological Studies*, Trondheim, Norway, v. 2, n. 2, p. 5-15, 2014.

LARSSON, S. A pluralist view of generalization in qualitative research. *International Journal of Research & Method in Education*, Abingdon, UK, v. 32, n. 1, p. 25-38, 2009.

LEWENSTEIN, B. V. The meaning of "public understanding of science" in the United States after World War II. *Public Understanding of Science*, London, v.1, n. 1, p. 45-68, 2001.

LEWENSTEIN, B. V. *Models of public communication of science & technology*. [Ithaca]: Cornell University, 2003. Disponível em: https://hdl.handle.net/1813/58743. Acesso em: 15 abr. 2024.

MARTINS, I. Literacy as metaphor and perspective in science education. *In*: LINDER, C.; OSTMAN, L.; ROBERTS, D. A.; WICKMAN, P.-O.; ERICKSON, G.; MACKINNON, A. (ed.). *Exploring the landscape of scientific literacy*. New York: Routledge, 2011. p. 90-105.

MOREIRA, I. C.; MASSARANI, L. A divulgação científica no Rio de Janeiro: algumas reflexões sobre a década de 1920. *História, Ciências, Saúde – Manguinhos*, Rio de Janeiro, v. 7, n. 3, p. 627-65, 2001. Short DOI: https://doi.org/dkkw28.

MORTIMER, E. F.; EL-HANI (ed.). *Conceptual profiles*: a theory of teaching and learning scientific concepts. Dordrecht: Springer, 2014.

PERRAULT S. T. A brief history of science popularization. *In*: PERRAULT, S. T. *Communicating popular science: from deficit to democracy*. London: Palgrave Macmillan, 2013. P. 37-47. DOI: https://doi.org/10.1057/9781137017581_3.

SANTOS, W. L. P. Significados da educação científica com enfoque CTS. *In*: SANTOS, W. L. P.; AULER, D. (org.). *CTS e educação científica*: desafios, tendências e resultados de pesquisas. Brasília: Editora UnB, 2011. p. 21-48.

SILVA, E. M. *Educação científica e cultura política democrática*: um estudo sobre o processo de recontextualização de elementos de formação política na prática do ensino de ciências nas séries iniciais. Tese (Doutorado em Educação em Ciências e Saúde) – Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2019.