

THE NATURAL SCIENCES CURRICULUM OF PUBLIC NETWORK OF SÃO PAULO: CONCEPTIONS OF TEACHERS WHO TEACH NATURAL SCIENCES IN THE EARLY YEARS OF PRIMARY SCHOOL

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Abstract

Science education objectives in Brazil have evolved over time. Initially, the focus was on creating scientifically literate citizens who could relate scientific concepts to their daily lives. In 2017, the São Paulo City Curriculum for Natural Sciences was introduced to teach students scientific literacy through inquiry-based teaching methods. This study focused on the perceptions of teachers from an primary school in São Paulo who participated by filling out a Google Forms questionnaire. The findings revealed that the majority of participating teachers had undergone curriculum implementation training. While they considered the organization of disciplinary content to be similar to their previous teaching methods, they struggled with implementing inquiry-based teaching strategies and linking scientific content to the United Nation Foundation 2030 sustainable development goals.

Keywords: *qualitative research, primary school, science curriculum, scientific literacy, teachers' conceptions*

Introduction

The curriculum is a dynamic and complex process that encompasses the selection, organization, and articulation of information, skills, and values that are taught and learned in school and in life rather than merely a set of content or subjects (Sacristán, 2013). The curriculum is not a neutral and objective reality but a social and cultural construction reflecting the power relations and dominant worldviews in society. Furthermore, Sacristán (2013) has emphasized the importance of a critical and reflective approach to the curriculum, which considers the needs and interests of students, the demands and challenges of contemporary society, and the democratic and humanistic values that should guide education. He has argued that the curriculum should not be an instrument for reproducing social inequalities, but rather a means of transformation and emancipation for individuals and society as a whole.

Specifically in the field of Natural Sciences Education, in the Brazilian context, there have been different curricula over the years, mainly based on the policies of the current government of the time (Krasilchik, 2000). At the beginning of the twentieth century, the teaching of science aimed primarily at the transmission of information about



scientific facts, theories, and laws. The emphasis was on the memorization of concepts and the understanding of the fundamental principles of natural sciences. From the 1930s onwards, the teaching of science focused on preparing students for technical work and practical life in general. The objectives included the development of observation, analysis, and problem-solving skills. Official documents on the teaching of science only became concerned with the formation of a scientifically literate and critical citizens, capable of linking science to their daily life to position themselves regarding socio-scientific issues, from the 1990s onwards (Machado & Meirelles, 2020).

The Natural Sciences curriculum of the city of São Paulo (São Paulo, 2017) has been a document published in 2017, structured to meet the objectives of basic education, which include the formation of critical and conscious citizens of their role in society. The teaching of Natural Sciences in the city of São Paulo focuses on understanding natural phenomena, and promoting the development of scientific skills and competencies such as observation, critical analysis, and experimentation.

The document is organized around three major themes: a) cosmos, space, and time; b) life, health, and the environment; c) matter, energy, and their transformations. Each theme is approached in an interdisciplinary way, connecting natural sciences with other areas of knowledge, such as mathematics, history, and geography. Additionally, the curriculum seeks to promote environmental education, encouraging students to reflect on their relationship with the environment and to adopt sustainable practices.

According to the curriculum guidelines, Natural Sciences classes should be developed using active methodologies that value the active participation of students in the learning process. In this way, students are encouraged to construct their knowledge based on their own experiences, making observations, investigating problems, and proposing solutions. Therefore, the curriculum indicates that teaching science by inquiry is a coherent approach to these principles.

The promotion of scientific literacy has also been proposed as an ideal formation for students, as it "enables the construction of meaning about the world and allows for the development of critical sense for evaluating and making conscious decisions about situations in their surroundings, whether they are local or global" (São Paulo, 2017, p. 64). The promotion of scientific literacy is indicated as essential for all citizens in modern society, as it enables a critical stance based on scientific knowledge (Özdem et al., 2010). Thus, this is a key concept in the document, explored at various points throughout its writing.

The Natural Science curriculum of the city of São Paulo also provides for the implementation of extracurricular activities such as science fairs, visits to museums and research centers, and scientific research projects. These activities aim to broaden students' repertoire and encourage interest in Natural Sciences.

Thus, the Natural Science curriculum of the city of São Paulo seeks to educate students capable of understanding science as an ever-evolving process that contributes to understanding and transforming reality. Students are encouraged to adopt a critical stance toward scientific knowledge.

To ensure the quality of Natural Science education in the city of São Paulo, teachers undergo continuous training, including courses and qualifications in various areas such as active methodologies, the use of digital technologies, and formative assessment. In addition, the curriculum is constantly reviewed and updated, considering changes and advances in the field of Natural Sciences.

The year after its publication, a course was held to implement the Curriculum of the City of São Paulo for Natural Sciences (and other curriculum components) to align teachers' practices with the theoretical and methodological assumptions proposed in the document. This training was promoted by teachers who worked on the development and writing of the curriculum. In this way, is relevant to know what these teachers think about this new idea of curriculum and how its relation to educational science practices in primary classrooms.

Based on the above, this work has aimed to identify "what are the conceptions of primary school teachers in the municipal network of São Paulo who teach Natural Sciences about the Curriculum of the City?"

Research Methodology

The research is of a qualitative nature. It is characterized as a research method that seeks to understand complex and multifaceted phenomena, often of a subjective nature, by exploring the participants' perspectives in the study. It aims to understand how people experience, interpret, and make sense of the world around them. Thus, it is an approach especially useful for investigating social, cultural, and behavioral phenomena (Creswell, 2010).

One of the main advantages of qualitative research is its flexibility and adaptability. Unlike quantitative research, which relies on standardized methods of data collection and analysis, qualitative research allows researchers to adjust their techniques and strategies according to the specific needs of each project. Additionally, qualitative research is capable of capturing nuances and complexities that are often lost in the quantitative approach. This is especially important when studying subjects such as subjectivity, cultural diversity, and interpersonal relationships (Crotty, 1998).

The general context of the data was part of a continuous formation course applied in a municipal school of São Paulo city as a part of doctoral research. In this way, the selection of the participants was based on the school level they have classes (primary school level) and the participation in this course. For this reason, being limited to teachers working in one school, there was a methodological limitation of having few participants. The school was researched present very experienced teacher, which majority of this professionals have more than fifteen years of experience in primary classes.

The data collection analyzed in this work involved the response to an online questionnaire (Google Forms) by primary school teachers from the municipal network of São Paulo who work at a school on the outskirts of the city, as shown in Table 1.

Table 1*Questions to Research Participants about Teachers' Conceptions of the São Paulo City Natural Sciences Curriculum*

Questions
1. How many years of experience do you have as a teacher?
2. Did you participate in the implementation course for the São Paulo City Natural Sciences Curriculum?
3. If you participated, did the course help your teaching practice?
4. Do you find a discrepancy between the organization of content you used before the City Curriculum and the way it proposes now?
5. What difficulties do you face when teaching Natural Sciences?
6. Can you relate the content of Natural Sciences to the Sustainable Development Goals proposed by the Agenda 2030?
7. Had you heard of the term "Scientific Literacy" before meeting the São Paulo City Natural Sciences Curriculum?
8. If you answered yes to question 7, where did you first come across this term?
9. What are the main difficulties you face in your teaching practice to promote scientific literacy?

Due to the relatively recent idea of the São Paulo city Natural Sciences curriculum, the literature does not yet have a reported and validated instrument for analyzing and understanding teachers' conceptions of this document. Therefore, it was decided to develop this questionnaire based on a survey of curriculum conceptions from teachers used in other scientific studies with already validated instruments (Ring, 2017).

The data analysis was carried out according to Bardin's content analysis approach (Bardin, 1977), in which the analysis categories emerge from the floating reading of the data, seeking to group them according to their similarities and differences.

Research Results

The participation of these teachers in the courses for implementing the Curriculum of the City of São Paulo, which took place throughout the year 2018, the year following the publication of the Curriculum of the City of São Paulo, most respondents (62.5%) indicated having participated in this implementation course. Most of the teachers who participated in this implementation (5 out of 8 respondents) indicated that, to some extent, this training helped them in their work in the classroom and to better understand the assumptions of the Curriculum of the City of Natural Sciences.

The organization of disciplinary content before and after the Curriculum of the City was indicated by only 1 of the 8 teachers as being very different from what was practiced before the publication of this document. Therefore, most teachers noted that the organization of content still follows a similar logic to what they did throughout their careers.

The main difficulties indicated by the participating teachers during the teaching of Natural Sciences were highlighted as material difficulties (books, instruments, laboratory) and the possibility of organizing experimental classes.

Regarding the correlation between the UN's Agenda 2030 and the possible connections with Natural Science content, the majority of participating teachers (5 out of 8) indicated that it was not satisfactory in relation to the 17 Social Development Goals outlined by the Agenda 2030. Thus, these teachers indicate facing difficulties in observing these relationships during their lessons.

Regarding their knowledge of "Scientific Literacy" prior to encountering the Curriculum of the City of São Paulo, most teachers (5 out of 8) indicated that they were unfamiliar with the term before coming across the document. Two teachers stated that they became familiar with the term through continuing education courses offered by the municipal education network, and one teacher indicated that they learned about the term while taking a course in a postgraduate education program offered by a state public university.

The last question asked the teachers to indicate the main daily difficulties in promoting Scientific Literacy during their Natural Science classes. Once again, 6 out of 8 teachers indicated material difficulties related to not having a laboratory to conduct experimentation activities with their students. Two other teachers cited learning gaps resulting from the pandemic and remote classes that occurred in the years 2020 and 2021.

Discussion

The group of teachers mostly have more than 15 years of experience in basic education. The results also indicate that more than 60% of the participants in this research completed the curriculum implementation course provided by the education network itself. According to the typology of moments in the teaching career proposed by Huberman (2009), these professionals are in the stage of emotional distancing from their teaching practice, disconnecting, to some extent, from engagement with their professionalization process. Therefore, having a lot of classroom experience, they have some crystallized conceptions and are more resistant to changes and interventions in their teaching practice.

The organization of the content was considered similar to the structure they followed before the publication of the document. Only one participant indicated that the changes were significant. Material difficulties were the most indicated obstacles to good teaching in natural sciences, followed by difficulties in planning experimental classes. This data confirms the conception that part of the teaching staff may have, that experimental activities are fundamental to the teaching of science (Munford & Lima, 2007). This data may also bring the hypothesis of a distorted view of science and scientific work brought by these teachers (Cachapuz et al., 2005) regarding an empirical-inductivist and atheoretical science, where concepts emerge from students' experimental work or strictly experimental, with the experiment having the role of confirming the theory.

Most of the group of teachers also recognizes difficulties in relating the disciplinary content of natural sciences to the sustainable development goals proposed by the UN's Agenda 2030. This result is in line with that found by Singhal and Wadhwa (2020),

who explored in-service science teachers and found that these professionals still have a lot of difficulties understanding sustainable development goals and applying them in their teaching practices. Agirreazkuenaga (2020) stated that basic education curricula are increasingly in demand to meet the sustainable development goals proposed by the Agenda 2030. Since an education based on ethical and moral values for social improvement has been shown to be an educational trend.

It is also noteworthy that most participants were unaware of the term "scientific literacy" before encountering the Natural Sciences curriculum of the city of São Paulo. Paz et al. (2019) investigated a group of teachers working in basic education and found very similar results. In addition to the lack of knowledge of the term, the researchers also obtained data levels of scientific literacy that were not very developed in this investigated group.

The absence of higher levels of scientific literacy among teachers may suggest that these professionals may also have greater difficulty in promoting scientific literacy in their basic education classes with their students (Listiani et al., 2022). This data also reinforces the importance of continuous training courses that assist basic education teachers, as it has been shown to be the main disseminator of the concept of scientific literacy (Paz et al., 2019).

The difficulties in promoting scientific literacy were pointed out by the participating teachers as related to learning gaps due to the pandemic and remote classes in the years 2020 and 2021, as well as difficulty in conducting experimental classes. This data brings to light a major problem: the learning gaps due to remote teaching during the pandemic (Engzell et al., 2021). Considering the socioeconomic reality of most students in the public education system, these difficulties in accessing education were even greater due to the lack of devices that could connect them and even internet services in their homes.

Conclusions and Implications

Based on the research results, it's possible to reflect that the conceptions of teachers in the early years who teach science are closely related to rigorously experimental science, where object manipulation is an essential part of sufficient science learning. Despite most participating teachers in this research being highly experienced, with over half having more than 15 years of classroom experience, they still have difficulties in promoting science lessons that can meet the assumption of promoting scientific literacy desired by the Curriculum of the City of São Paulo for Natural Sciences.

The results of this study indicate that greater initiatives are needed for primary school teachers focusing on science teaching, with a particular emphasis on promoting teaching that values students' scientific literacy. The formative gaps obtained because of this work are in line with those found in other studies conducted in different countries, highlighting the need to investigate with basic education teachers their conceptions and difficulties regarding the practice of curricula that focus on the development of skills rather than just the more traditional development of content.

In this sense, future studies with a larger number of participants are suggested to be conducted as quantitative studies, which evaluate the conceptions of public-school teachers about the curriculum and scientific literacy, since this theoretical framework is relevant not only in the Brazilian scenario but also on a global scale when related to science programs in basic education.

Declaration of Interest

The authors declare no competing interest.

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