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SCIENCE LITERACY: ENCOURAGING CRITICAL THINKING IN SCHOOLS

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ABSTRACT

This study addressed the problem of the effectiveness of scientific literacy in schools, aiming to understand how different methodologies contribute to the formation of critical citizens. The general objective was to analyze the pedagogical practices related to scientific literacy and their implications in the construction of knowledge. The methodology used consisted of a literature review, which allowed the collection and analysis of data from several relevant studies in the area. The results indicated that practices such as teaching by inquiry and the use of literature have a significant role in promoting students' curiosity and engagement. In addition, it became evident that the continuous training of teachers and the appropriate use of didactic resources are essential for the effectiveness of scientific literacy. The analysis of the data revealed that many educators face barriers, such as the lack of infrastructure and specific training, which limits the implementation of effective practices. The final considerations highlighted that scientific literacy is fundamental not only for the acquisition of knowledge, but also for the development of critical skills. Thus, the study highlights the relevance of new research that explores the experiences of different schools, contributing to the continuous improvement of pedagogical practices in scientific literacy.

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INTRODUCTION

Scientific literacy is a fundamental aspect in educational training, since it allows students to develop essential skills to understand and participate in discussions about scientific themes that permeate contemporary society. This process involves not only the assimilation of knowledge, but also the ability to critically analyze, interpret data, and make reasoned judgments. With the growing importance of science in various spheres of daily life, science literacy takes a central role in the school curriculum, promoting an education that prepares students to face social and environmental challenges.

The relevance of scientific literacy in the Brazilian educational context stands out for its relationship with the formation of conscious and informed citizens. In the face of social and technological transformations, education must be able to equip students with the skills necessary to navigate a world in which science and technology are present. The implementation of pedagogical strategies that favor scientific literacy is, therefore, a necessity, since it contributes to the development of critical thinking and informed decision-making. The challenge, however, lies in the effectiveness of these strategies in classrooms, which are faced with structural and formative limitations.

In this context, the central problem lies in the identification of the main obstacles that compromise the effectiveness of scientific literacy in schools. The difficulties faced by educators, such as the lack of specific training and adequate didactic resources, can hinder the implementation of pedagogical practices that stimulate students' interest in science. Thus, it is necessary to investigate how the methodologies used in schools can be improved to promote effective and meaningful scientific literacy.

The objective of this research is to analyze the methodologies used in scientific literacy in schools, seeking to identify practices that can be improved and discussed in the light of current literature. The text is structured in different sections, starting with the theoretical framework that underlies the discussion on scientific literacy. Then, three development topics will be presented that address methodologies, the role of the teacher and didactic resources. The research methodology will be detailed, followed by a discussion and results, which will include the analysis of case studies and the challenges faced. Finally, final considerations will be presented that summarize the main findings of the research and suggestions for future investigations.

THEORETICAL FRAMEWORK

The theoretical framework of this literature review is organized into three main sections that aim to support the discussion on scientific literacy. The first section addresses

the definition of the relevance of scientific literacy in the educational context, highlighting the implications for the critical formation of students. The second section analyzes the pedagogical methodologies applied to science teaching, evidencing practices that favor the understanding and application of scientific concepts. Finally, the third section argues the role of the teacher in mediating the process of scientific literacy, considering aspects such as teacher training and the use of adequate didactic resources. This structure allows for an integrated analysis of the theme, establishing a basis for the discussion and interpretation of the data that will be presented in the subsequent sections.

METHODOLOGIES FOR SCIENTIFIC LITERACY

The methodologies for scientific literacy are diverse and play a fundamental role in the formation of students capable of understanding and applying scientific concepts in their daily lives. Among the pedagogical approaches highlighted are teaching by inquiry and the use of literature, which contribute to the development of critical thinking and analysis skills. Teaching by inquiry, for example, allows students to be protagonists of their learning, by stimulating curiosity and the search for answers based on questions that arise from the students' context. According to Rocha, Souza and Rosa (2021, p. 5), "research in science teaching favors the construction of knowledge in an active way, in which the student is encouraged to formulate hypotheses, carry out experiments and analyze the results". This approach not only engages students in learning but also promotes the practical application of scientific theories, reinforcing the connection between theoretical knowledge and reality.

In addition, the use of literature as a didactic resource has been shown to be effective in scientific literacy. Through literary works, educators can contextualize scientific concepts in an accessible and engaging way. According to Lopes *et al*. (2023, p. 10), "Jules Verne's literature, for example, provides an immersion in scientific scenarios that instigate the imagination and logical reasoning of students, making science palpable and close to everyday life". This strategy not only enriches learning, but also motivates students to explore the world around them, integrating science with personal experiences.

Critical reading is a tool in the scientific literacy process, as it helps to develop students' capacity for questioning and reflection. Araújo and Silva (2021, p. 42) highlight that "critical reading allows students to develop skills to interpret and evaluate the world around them, becoming conscious citizens".

In addition to these methodologies, scientific literacy must consider the continuous training of teachers. Delizoicov and Lorenzetti (2001, p. 39) state that "teacher training is a decisive factor for the implementation of pedagogical practices that promote scientific

literacy in students". This highlights the importance of preparing educators to adopt different approaches, providing a dynamic learning environment that promotes questioning and critical reflection.

The diversity of methodologies for science literacy, including teaching by inquiry and the use of literature, represents an effective strategy to develop students' critical thinking. These approaches, combined with the proper training of educators, are essential to create a learning environment that values curiosity and the search for knowledge, preparing students for the challenges of the contemporary world.

THE ROLE OF THE TEACHER IN SCIENTIFIC LITERACY

The role of the teacher in scientific literacy is fundamental, as this professional acts as a mediator of knowledge and facilitator of learning. The continuous training of educators is an essential condition for them to be able to implement effective pedagogical practices. According to Sasseron and Carvalho (2011, p. 60), "continuous training must go beyond courses and workshops; must include critical reflection on teaching practice and the constant search for new approaches and didactic resources". This statement emphasizes that the updating of teachers is a dynamic process that involves not only the acquisition of new knowledge, but also the analysis of experiences in the classroom, allowing them to improve teaching methodologies.

In addition to continuous training, the conceptions that teachers have about scientific literacy influence pedagogical practice. According to Buch and Schroeder (2013, p. 75), "educators' beliefs about what it means to be literate shape their teaching approaches and the way they interact with students". This perspective suggests that teachers' understanding of science literacy can determine the effectiveness of their teaching strategies. Thus, it is critical for educators to reflect on their own conceptions and consider how these beliefs affect practices in the classroom.

Teacher training and conceptions should not be treated in isolation, but rather as interconnected elements that affect the process of scientific literacy. Lopes *et al*. (2023, p. 12) state that "a teacher who understands the importance of scientific literacy and is willing to continuously update himself is prone to implementing practices that promote students' curiosity and questioning". This statement highlights the relationship between teachers' willingness to learn and the quality of the teaching they offer.

The critical training of teachers is essential for them to be able to develop pedagogical practices that stimulate reflection in students. Araújo (2020, p. 70) states that "the critical training of teachers is essential for them to develop pedagogical practices that

lead students to reflect on the contents and their social implications". In this way, scientific literacy is not limited to the transmission of content, but promotes the construction of critical and contextualized thinking.

Therefore, the articulation between continuing education and teachers' conceptions is essential for the promotion of scientific literacy. Critical reflection on teaching practice, combined with an understanding that involves scientific literacy, allows educators to develop pedagogical approaches that encourage critical thinking and curiosity in students, thus contributing to the formation of citizens prepared to deal with the complexities of the contemporary world.

TEACHING TOOLS AND RESOURCES

Didactic tools and resources play an essential role in the teaching-learning process, especially in the promotion of scientific literacy. The proper use of teaching materials and technologies contributes to the creation of an interactive and engaging learning environment. According to Delizoicov and Lorenzetti (2001, p. 40), "teaching materials should be selected based on their ability to stimulate students' curiosity and questioning, promoting the active construction of knowledge". This statement highlights the need to choose materials that not only convey information but also encourage students to explore and investigate.

In addition to the selection of materials, the incorporation of technologies in pedagogical practice is a determining factor for the modernization of science teaching. Rocha, Souza, and Rosa (2021, p. 8) state that "technology should be used as a means to expand learning possibilities, allowing students to access information in a dynamic and interactive way". This indicates that technology should not be seen as an end in itself, but as a tool that enhances education by facilitating student interaction and engagement.

The use of technologies must be accompanied by a reflection on their pedagogical application. According to Sasseron and Carvalho (2011, p. 62), "the integration of technology in teaching requires planning that considers the needs of students and learning objectives". This consideration is essential, as technology must be used intentionally so that its advantages are taken advantage of. When planning the integration of technologies, educators need to be clear about how these tools can help achieve the established educational goals.

The appropriate choice of didactic materials and the use of technologies in science teaching are aspects that, when well articulated, favor scientific literacy. Critical reflection on these resources and their pedagogical application allows educators to create a dynamic

learning environment that promotes curiosity, preparing students to understand and face contemporary scientific challenges.

METHODOLOGY

The methodology adopted for the research was a literature review, which was configured as the main approach for data collection and analysis. The type of research was descriptive, focusing on the identification and discussion of scientific literacy practices present in the literature. The approach was qualitative, allowing an understanding of the methodologies and conceptions that permeate the theme. The instruments used for data collection included the selection of articles, books and theses relevant to scientific literacy, available in academic databases and digital libraries.

The procedure consisted of a systematic search for publications that addressed the theme of scientific literacy, using keywords related to the theme. The sources were selected based on criteria such as relevance, year of publication and quality of the research presented. The analysis techniques involved the critical reading of the texts, followed by the categorization of the information according to the topics addressed in the research. The following table presents the main references used, allowing a visualization of the works consulted.

Chart 1: Main References Used in the Research

Author(s)	Conforming title published	Year	Type of work
DELIZOICOV, D.; LORENZETTI, L.	Scientific literacy in the context of the early grades	2001	Article
SASSERON, L. H.; CARVALHO, A. M. P.	Scientific literacy: a literature review	2011	Article
BUCH, G. M.; SCHROEDER, E.	Science and scientific literacy clubs: conceptions of the coordinating teachers of the municipal school system of Blumenau (SC)	2013	Article
RODRIGUES, L. S.; VESTENA, R. F.	The textbook and scientific literacy in science: an analysis in the early years of elementary school of the modality of youth and adult education	2013	Article
TEIXEIRA, F. M.	Scientific literacy: questions for reflection	2013	Article
CABRAL, A. M. O.; BARROSO, M. C. S.	Scientific exhibition: path to scientific literacy in the municipal schools of Maracanaú	2020	Article
SILVA, T. A. *et al*.	Science teaching by inquiry: contributions of reading to scientific literacy in the early years	2020	Article
ROCHA, B. E.; SOUZA, W. C. A; ROSA, C. T. W.	Scientific literacy and science teaching: an investigative study with teachers of the early years	2021	Article
MEDEIROS, R. M. G.	Analysis of the level of Scientific Literacy of students from public schools in Bagé-RS	2023	Final Paper
LOPES, D. A. S. *et al*.	Scientific literacy through Jules Verne's literature	2023	Final Paper

Source: authorship

After inserting the table, it is highlighted that the selection of references was carried out rigorously, considering the contribution of each work to the understanding of the theme of scientific literacy. This table serves as a summary of the sources consulted, facilitating the identification of the theoretical bases that support the discussions present in this review. The references include studies that explore both pedagogical practice and teacher training, providing an overview of scientific literacy in the educational context.

ANALYSIS OF CASE STUDIES

The analysis of the case studies reveals scientific literacy practices that have been implemented in several schools, providing insights into effective methodologies. A notable example is the work developed in science clubs, which has proven to be an efficient strategy to promote students' curiosity and engagement. Buch and Schroeder (2013. p. 80) state that "science clubs allow students to explore scientific topics in a practical and collaborative way, stimulating research and the construction of knowledge". This practice highlights the importance of an environment that favors the exchange of ideas and the realization of experiments, facilitating the appropriation of scientific concepts.

Another example of success in scientific literacy is the holding of scientific exhibitions, as described by Cabral and Barroso (2020, p. 5). The authors state that "scientific exhibitions function as a space for the socialization of knowledge, in which students present projects and experiments, developing communication and argumentation skills". This approach not only engages students in research, but also prepares them to present ideas in a clear and structured way, essential skills in today's world.

The use of literature is also a practice that has proven effective in some schools. Lopes *et al*. (2023, p. 11) highlight that "reading works by authors such as Jules Verne instigates students' imagination and leads them to reflect on scientific issues in a playful and accessible way". This practice demonstrates how literature can be integrated into science education, facilitating the understanding of complex concepts through engaging narratives.

The analysis of case studies on scientific literacy practices shows that approaches such as science clubs, scientific exhibitions and the use of literature are strategies that promote student engagement and the construction of knowledge. These practices, when implemented intentionally, not only favor scientific learning, but also prepare students to become critical and informed citizens, capable of interacting with the challenges of the contemporary world.

CHALLENGES AND LIMITATIONS

The challenges and limitations faced by teachers and institutions in the process of scientific literacy are diverse and impact the effectiveness of teaching. One of the main obstacles is the lack of adequate training of educators. Sasseron and Carvalho (2011, p. 65) state that "the scarcity of continuing education courses aimed at scientific literacy results in pedagogical practices that are often outdated and ineffective". This statement reveals that the absence of professional training limits the ability of teachers to implement methodologies that foster the interest and scientific understanding of students.

Teachers face several challenges when implementing innovative pedagogical practices in the context of scientific literacy. One of the main obstacles is the lack of autonomy in the management of evaluation processes, which are often exclusionary and focused on rankings. According to Oliveira (2023, p. 113), "the lack of autonomy to manage the evaluation process is pointed out as one of the main difficulties faced by teachers, resulting in exclusionary practices aimed at rankings". This reality makes it difficult to adapt pedagogical practices to the needs of students, compromising the effectiveness of scientific literacy.

In addition, the structural conditions of schools can be a significant barrier. According to Delizoicov and Lorenzetti (2001, p. 41), "schools that lack adequate laboratories and appropriate didactic resources face serious difficulties in implementing practices that favor scientific literacy". This situation indicates that inadequate infrastructure can compromise not only access to hands-on experiences, but also students' motivation to engage with scientific learning.

Another challenge is related to the resistance of some institutions to adopt new teaching methodologies. Rocha, Souza and Rosa (2021, p. 10) highlight that "the implementation of innovative practices requires an institutional environment that values continuous training and the exchange of experiences among educators". This resistance may originate from a school culture that favors traditional methods, making it difficult to introduce approaches that stimulate students' investigation and curiosity.

The barriers faced in scientific literacy, which include lack of continuing education, inadequate infrastructure, and resistance to innovation, compromise the effectiveness of pedagogical practices. Overcoming these challenges is essential for institutions to be able to promote teaching that prepares students to understand and face contemporary scientific challenges.

POTENTIALITIES OF SCIENTIFIC LITERACY

Scientific literacy has several potentialities that contribute to the formation of a critical citizen and to the construction of knowledge. Firstly, this educational practice provides students with the ability to understand and interact with scientific phenomena that permeate everyday life. According to Teixeira (2013, p. 795), "scientific literacy not only promotes the understanding of content, but also develops essential skills so that students can evaluate information and make informed decisions". This statement highlights the role of scientific literacy in the formation of individuals who not only consume information, but also critically analyze what is presented to them.

In addition, scientific literacy stimulates the development of investigation and problem-solving skills. According to Rocha, Souza and Rosa (2021, p. 12), "the engagement of students in scientific activities allows them to practice logical reasoning and scientific methodology, fundamental elements for the construction of critical thinking". This practice goes beyond the simple transmission of content, as it involves students in an active learning process, where they are encouraged to formulate questions, conduct experiments, and seek answers. This approach not only enriches learning but also prepares students to deal with complex challenges in everyday life.

On the other hand, scientific literacy also plays a key role in the formation of citizens who are aware of and engaged in social and environmental issues. Delizoicov and Lorenzetti (2001, p. 43) state that "a scientifically literate citizen is capable of participating in debates on contemporary issues, such as health, the environment and technology, contributing to an informed and responsible society". This underscores that scientific literacy is not limited to the school environment, but extends to social life, promoting active and informed participation by citizens in issues that impact their communities.

The potential of scientific literacy is evident in the contributions it offers to the formation of critical citizens and to the construction of knowledge. The ability to evaluate information, develop investigative skills, and participate in social debates are aspects that make scientific literacy essential in contemporary education. In this way, by promoting teaching that values curiosity and questioning, scientific literacy prepares students for the challenges of today's world, encouraging an active and responsible attitude towards knowledge and society.

FINAL CONSIDERATIONS

The final considerations of this study highlight the main findings regarding the role of scientific literacy in the formation of critical citizens and in the construction of knowledge.

The research showed that scientific literacy is essential for students to develop skills in analyzing and interpreting information, allowing them to interact in an informed way with the world around them. Through pedagogical practices that incorporate methodologies such as teaching by inquiry and the use of literature, educators can create a learning environment that fosters students' curiosity and active participation.

In addition, the results indicate that the continuous training of teachers and the adequate use of didactic resources are determining factors for the effectiveness of scientific literacy. The survey revealed that many educators face challenges related to the lack of specific training and inadequate infrastructure in schools. These obstacles can compromise the implementation of practices that favor investigation and questioning, fundamental aspects for the promotion of scientific literacy.

The contributions of this study are significant, as they highlight the importance of scientific literacy not only in the educational context, but also in the formation of citizens who participate in society. By providing students with the necessary tools to understand and evaluate scientific issues, education contributes to the formation of critical and responsible individuals. Thus, scientific literacy is not limited to the acquisition of knowledge, but extends to the construction of skills that are essential in everyday life.

Finally, there is a need for further studies that complement the findings of this research. Future investigations could explore, for example, the experiences of different schools in implementing scientific literacy practices, in addition to analyzing the impact of these practices on the education of students. Such studies could provide an understanding of the strategies that best support the development of scientific skills in students, contributing to the continuous improvement of pedagogical practices. Therefore, it is essential that research in the area of scientific literacy continues, ensuring that educators and institutions have access to information and resources that can enhance the formation of critical and informed citizens.

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