Educação em Análise

Article

Science literacy in the initial education of Science and Biology teachers and its contribution to social justice[1]

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Abstract

The research presented here stems from questions and investigations that we have been developing regarding the role of Scientific Literacy (SL) in Science and Biology Education, as a contribution to the construction of a socially just school. The study is configured as a theoretical essay, in which we seek to present and discuss the following aspects: SL and Science Education; SL and the domains of scientific knowledge; the socially just school; and SL and its implications for the education of Science and Biology teachers. To deepen the discussion, we draw upon authors such as: Lorenzetti; Lorenzetti and Delizoicov; Chassot; Krasilchik and Marandino; Sasseron and Carvalho; Silva and Sasseron; Mendes and Machado; Sasseron and Orofino; Libâneo; Silva Maria; Moraes; D'ávila and Epaminondas; Smania-Marques; Garcia Da Silva. The reflections from the analysis highlighted the need to create more spaces within the curriculum for the discussion, problematization, and practice of Scientific Literacy in the initial education of Science and Biology teachers. Teachers need to understand SL not only as a sporadic formative movement, but as a permanent pedagogical objective that seeks to provide students with skills, behaviors, and attitudes supported by science and aligned with moral values and social justice.

Keywords: Scientific literacy; social justice; teacher education; Science education; Biology education.

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A alfabetização científica na formação inicial de professores de Ciências e Biologia e sua contribuição para a justiça social

Resumo

A pesquisa apresentada é oriunda de indagações e investigações que estão sendo desenvolvidas por nós, sobre a aposta da Alfabetização Científica (AC), no Ensino de Ciências e Biologia, como contribuição para construção de uma escola socialmente justa. O estudo configura-se como um ensaio teórico, no qual procuramos expor e discutir os seguintes aspectos: AC e o Ensino de Ciências; AC e os domínios do conhecimento científico; Escola socialmente justa; AC e suas implicações na formação de professores de Ciências e Biologia. Para aprofundar a exposição, elencamos autores como: Lorenzetti; Lorenzetti e Delizoicov; Chassot; Krasilchik e Marandino; Sasseron e Carvalho; Silva e Sasseron; Mendes e Machado; Sasseron e Orofino; Libâneo; Silva Maria; Moraes; D'ávila; Epaminondas; Smania-Marques; Garcia Da Silva. As reflexões da análise evidenciaram a necessidade de criar mais espaços no currículo para discussão, problematização e prática da AC na formação inicial de professores de Ciências e Biologia. Os docentes precisam entender AC não apenas como um movimento formativo esporádico, mas como um objetivo pedagógico permanente que busca propiciar aos estudantes habilidades, comportamentos e atitudes subsidiados pela Ciência e aliados a valores morais e de justiça social.

Palavras-chave: Alfabetização científica; justiça social; formação de professores; ensino de Ciências; ensino de Biologia.

La alfabetización científica en la formación inicial de profesores de Ciencias y Biología y su contribución a la justicia social

Resumen

La investigación presentada surge de las preguntas e investigaciones que estamos desarrollando sobre la apuesta por la Alfabetización Científica (AC) en la Enseñanza de las Ciencias y la Biología, como una contribución para la construcción de una escuela socialmente justa. El estudio se configura como un ensayo teórico, en el cual buscamos exponer y discutir los siguientes aspectos: la AC y la Enseñanza de las Ciencias; la AC y los dominios del conocimiento científico; la escuela socialmente justa; y la AC y sus implicaciones en la formación de profesores de Ciencias y Biología. Para profundizar en la exposición, seleccionamos autores como: Lorenzetti; Lorenzetti y Delizoicov; Chassot; Krasilchik y Marandino; Sasseron y Carvalho; Silva y Sasseron; Mendes y Machado; Sasseron y Orofino; Libâneo; Silva Maria; Moraes; D'ávila y Epaminondas; Smania-Marques; Garcia Da Silva. Las reflexiones del análisis evidenciaron la necesidad de crear más espacios en el currículo para la discusión, problematización y práctica de la Alfabetización Científica en la formación inicial de profesores de Ciencias y Biología. Los docentes necesitan comprender la AC no solo como un movimiento formativo esporádico, sino como un objetivo pedagógico permanente que busca proporcionar a los estudiantes habilidades, comportamientos y actitudes fundamentados en la ciencia y articulados con valores morales y de justicia social.

Palabras clave: Alfabetización científica; justicia social; formación de profesores; enseñanza de las Ciencias; enseñanza de la Biología.

Introduction

In a world plagued by climate change, pseudoscience, fake news, pandemics, increased migration, and a massive influx of news originating from social media, we are experiencing various forms of human rights violations within a global context (Silva; Sasseron, 2021). Never have we been so vulnerable to a constant flow of information, which is not always correct or truthful. Knowing how to properly utilize new information and communication technologies, as well as knowing how to address the environmental challenges resulting from global warming, becomes imperative. In this sense, Science and Biology Teaching carries a major task and responsibility, given that it is of paramount importance for students to acquire tools that can be useful in their daily lives to identify, analyze, and take a critical and questioning stance toward the challenges of the 21st century.

In this context, we understand that it is important for future Science and Biology teachers to reflect on how they can introduce scientific concepts to students in order to "immunize" them against this barrage of information and constant innovation. We conceive that it is necessary to develop didactic strategies within Science Teaching that promote student reflection, as well as the appropriate appropriation of concepts and the scientific method—which, if well comprehended in daily life, can be of great help in resolving the constant challenges of modern life.

According to Silva and Sasseron (2021), we are currently experiencing a moment of environmental crisis and social injustice, in which the attribution of who broadcasts information is not limited to specific agents and is not analyzed by evaluation and monitoring mechanisms established in traditional media outlets. Viewpoints and proposals of knowledge are displayed and presented to the public in a comprehensive and unrestricted manner, without commitment to facts, and are immediately viewed and shared (Silva; Sasseron, 2021).

Science Teaching aims to educate individuals to enable them to solve everyday problems, taking into consideration the knowledge produced by Science and the methodologies of knowledge construction proper to the scientific realm (Sasseron; Machado, 2017). The authors further elucidate that when proposing disciplines considered "Scientific," these must be connected to the student's reality, such that scientific theories and laws can explain natural phenomena, contrasting theoretical concepts with environmental facts in our daily lives. In this sense, Scientific Literacy can be considered decisive for a critical, high-quality science education that promotes the student's social participation.

We understand Scientific Literacy as a powerful perspective for transformation and for critical, active social participation in contemporary society, wherein individuals—grounded in scientific knowledge—can choose, decide, and reflect upon their future and the future of society with responsibility, critical thinking, and a foundation in scientific principles, respecting the environment and life. Thus, this theme has motivated us in recent years and prompts us to present this theoretical essay, which gathers the following points of discussion: Scientific Literacy and Science Teaching; Scientific Literacy and the domains of scientific knowledge; A socially just school; and Scientific Literacy and its implications for the education of Science and Biology teachers.

This study is configured as a theoretical essay because it consists of a "logical and reflective exposition and rigorous argumentation with a high level of interpretation and personal judgment" (Severino, 2007, p. 206). For this exposition, we selected the following authors for dialogue: Lorenzetti (2000), Lorenzetti; Delizoicov (2001), Chassot (2003; 2008), Krasilchik; Marandino (2007), Sasseron; Carvalho (2011), Silva; Sasseron (2021), Mendes; Machado (2024), Sasseron; Orofino (2025), Libâneo (2025), Silva Maria; Moraes; D'ávila (2025), and Epaminondas; Smania-Marques; Garcia Da Silva (2025).

Scientific Literacy and Science Teaching

Scientific Literacy can be understood as a formative process about Science, encompassing the appropriation of scientific knowledge, practices, and values by individuals, so that they are prepared to understand and analyze situations, solve problems, make decisions, and fully exercise their citizenship in a society increasingly permeated by Science and technology (Laugksch, 2000).

For Chassot (2008), Scientific Literacy is a body of knowledge that helps society to make sense of the world in which it is situated. From this perspective, Ceolin, Chassot, and Nogaro (2015) elucidate that students need not only to understand Science, but also to know how to use this knowledge to be critical actors, mediators, and agents working toward collective well-being. For teachers, it is essential to recognize and visualize the multiple applications and benefits of Science in improving quality of life, as well as its limitations and harmful consequences when it is not utilized in an ethical and appropriate manner.

Chassot (2003) defends the conception of Science as a language constructed by humans to explain the natural world, thereby conceptualizing Scientific Literacy as providing the reading of this language in which nature is written. He further highlights the aspect of social inclusion, as beyond understanding Science, it enables people to integrate into the world in which we live; the scientifically literate individual understands Science, its utility, and its limitations, and comprehends that world transformation is necessary, thus being prepared to make decisions.

According to Lorenzetti (2000), Scientific Literacy can be considered the process by which the language of Natural Sciences acquires new meanings, constituting a means for the subject to expand their universe of knowledge and culture as a citizen embedded in society. This acquired knowledge will be of paramount importance for their participation in society, assisting them in decision-making involving scientific knowledge.

Norris and Phillips (2003) state that the sense of Scientific Literacy encompasses a multiplicity of skills and knowledge regarding Science, so as

to include: the ability to distinguish what is Science from what is not Science according to the scientific method; the ability to use scientific knowledge for problem-solving; an understanding of Science and its applications, taking into account the Nature of Science and its connection to culture; the evaluation of the benefits and risks of Science; and the use of necessary concepts to engage in socioscientific issues.

Currently, there is also the concept of Biological Scientific Literacy. According to Angelo, Silva, and Motokane (2025), biologically literate subjects understand the essential principles and concepts of Biology across its distinct disciplines, comprehend the characteristics of the knowledge and methods of this Science, the Nature of Biology, as well as the historical, social, cultural, economic, philosophical, ethical, and environmental processes involved in the preparation and legitimation of its scope of knowledge and its repercussion on society; furthermore, they are expected to develop attentional control, critical thinking, decision-making, creativity, expertise, inhibitory control, cognitive flexibility, and working memory, among others.

According to Ward et al. (2009), there is a gap in the understanding of Science among different groups of individuals. According to Sessa and collaborators (2019), it is fundamental to relate science education in schools not only to the understanding of Science, but to associate it with social, technological, political, and economic issues; this mobilization transforms Science Teaching into a tool for understanding scientific knowledge and how it is embedded in society.

Hodson (2010) understands that socioscientific issues must be approached from local, regional/national, and ultimately global contexts, while also addressing the specific interests of students, focusing on seven different areas: human health; water, land, and mineral resources; food and agriculture; energy resources and consumption; industry; information sharing and dissemination; and ethics and responsibility in scientific research and its

products and applications. The author further informs us that this issue-based approach includes four (4) levels of complexity (Chart 1):

Chart 1 – The four (4) levels of complexity of the issue-based approach.

Level	Characteristics
1	Aimed at understanding the social impact of changes in Science and technology and recognizing that both are, in their vast majority, culturally determined.
2	Related to recognizing that decisions regarding research and scientific/technological development are made in defense of self-interest, that benefits for some may occur to the detriment of others, and identifying that scientific/technological advancement is intrinsically linked to the distribution of wealth and power.
3	Involves constructing one's own opinions and establishing one's own principles and values that guide decision-making, recognizing what is truly important to the student behind their actions.
4	Addresses preparation for and action on socioscientific and environmental issues.

Source: Organized by the authors based on Hodson (2010).

In this social context, the action of teachers is paramount for the development of students' scientific thinking; spaces for teacher education can be considered privileged and essential for the analysis, reflection, and discussion of practices for knowledge construction (Sessa et al., 2019). Teacher education is a privileged locus for debate on Science Teaching and on how this can guide/influence the practices of future teachers (Delizoicov; Angotti; Pernambuco, 2011). Sarti (2021) tells us that educators are required to possess competencies associated with critical thinking, which are frequently not developed during initial and continuing education—which are commonly theoretical and technical in nature, or insufficiently analytical.

According to Oliveira and Garcia (2024), to promote Scientific Literacy in Science Teaching, teachers must reevaluate the curriculum, build autonomy, and design teaching projects that address meaningful themes of student interest; by reconsidering their pedagogical conceptions and practices, teachers enable students to engage autonomously, critically, and actively in the construction of scientific knowledge and to develop learning that promotes the transformation of society and the world they inhabit.

Although there are various conceptualizations of Scientific Literacy, in the understanding of Freitas and Dias (2026), its main objective "is not limited to the memorization of content, but must promote a critical and contextualized understanding of Science. It is about educating citizens capable of interpreting and intervening in reality based on scientific knowledge" (Freitas; Dias, 2026, p. 10). Thus, we comprehend that the importance of Scientific Literacy in Science Teaching lies in the understanding that Science learned in school can assist in making minor or major decisions, such as: having an awareness of the prescribed and proper use of antibiotics; and engaging in decisions that influence and impact the environment, particularly in this era of climate change.

It is important to understand that Science is not confined to the school, embedded solely in theoretical content, or in scientific research in university laboratories. Students need to visualize that Science is present in their daily lives, as seen in applied Science: electric lighting; vaccines; Wi-Fi; the refrigerator, which preserves food temperature; heaters or air conditioners; motor vehicles, such as cars and motorcycles; medications; and the cell phone itself, to which we are constantly connected. By visualizing Science in everyday life, students can perceive that this scientific knowledge did not arise from nowhere, but was constructed and reformulated over several centuries of the history of Science.

It is essential to conceive Science as a human endeavor, intrinsically linked to the social, political, economic, and environmental context in which it is situated at any given historical moment, with its setbacks, errors, and occasionally protocols far removed from the research ethics utilized today. Despite various setbacks over time, a scientific method has been established that is highly secure and efficient, responsible for discovering cures and treatments for various diseases, aiding in the conservation of endangered species, and increasing human life expectancy. Science serves a purpose: to increase the population's quality of life—not just for elites, but for everyone who needs it. Thus, we conceive that knowledge and technology are not a privilege of the few, but a right of all, culminating in greater social equity.

Scientific Literacy and the Domains of Scientific Knowledge

Scientific Literacy is configured in various research works in the field of Science Education as bound to educational purposes designed for pedagogical actions aimed at training students to understand elements of scientific practice and utilize them for evaluating situations and making decisions (Lorenzetti; Delizoicov, 2001; Krasilchik; Marandino, 2007; Sasseron; Carvalho, 2011; Sasseron; Silva, 2021).

For Sasseron and Silva (2021, p. 5), Scientific Literacy as an educational approach enables students to be introduced to elements of scientific culture, "allowing them to incorporate the social norms and practices of this field for use in evaluation and decision-making." For Sasseron and Orofino (2025), the concept of Scientific Literacy is linked to a formative perspective in which students come to know the fundamental components of the scientific universe through Science Teaching—learning and understanding the norms, values, and techniques of Science, as well as the circumstances and conditions bound to scientific practice. Thus, it is expected that they can comprehend and critique Science, being able to decide whether or not to utilize scientific knowledge to act upon current societal problems in favor of social justice. Furthermore, the researchers explicitly state that the promotion of Scientific Literacy does not aim to train scientists, but rather to educate citizens who, living in a society where the methods and products of Science are present in daily life, can comprehend related information, evaluating and validating this knowledge based on concepts or on the search for elements that demonstrate the criteria involved in the construction of information—especially regarding the area of knowledge and the existence of social and epistemological perspectives underpinning its hypothesis and investigation.

Silva and Sasseron (2021) discuss in their work the ideas of Roberts (2011) and Valladares (2021) regarding different conceptions of Scientific Literacy. According to Valladares (2021), there are Visions I and II of Scientific Literacy

advocated by Roberts (2011), the former (I) considering scientific activity as an intellectual enterprise aimed at understanding currently valid scientific explanations and mobilizing skills linked to scientific inquiry procedures. Vision II derives from research in Science, Technology, and Society (STS) that deepens the debate on the consequences of scientific and technological activities in society, as well as responsible decision-making regarding individual and collective problems, which rendered conceptions of Scientific Literacy more complex. The author introduces a third (III) vision of Scientific Literacy, characterized by the importance of active participation in discussions about Science and engagement in socioscientific challenges involved with principles such as equality and social justice, aiming for the common good at local and global levels.

Sasseron and Orofino (2025), grounded in the ideas of Duschl (2008) and Stroupe (2014), propose the development of Scientific Literacy linked to the conceptions of Scientific Domains—namely: Conceptual Domain, Epistemic Domain, Social Domain, and Material Domain (Chart 2)—which must be worked with in an integrated manner. The authors understand that the domains express parts of an interconnected whole for the construction and evaluation of knowledge in the field of Sciences; they also understand that scientifically literacy-building is associated with contact with cultural elements of scientific practice and suggest an approach to these domains with coherence and logical sequence, enabling processes in which Science is recognized as a social action for the development of knowledge about natural phenomena and situations linked to them.

Chart 2 – Domains of scientific knowledge and their characteristics.

Scientific Domain	Characteristics
Conceptual Domain (CD)	• Related to concepts, laws, theories, and mechanisms for scientific thinking; • Content is historically valued and can be said to be the domain that manifests most prominently in Science teaching; • In Vision III of Scientific Literacy, the conceptual domain cannot be worked with in isolation, but must be developed in an interconnected manner with the other domains—material, epistemic, and social.
Epistemic Domain (ED)	• Associated with the processes of constructing and analyzing knowledge about natural phenomena; • Can be linked to investigative procedures to understand something, which is not limited to the use of experiments, but mainly to mechanisms and activities that enable the formulation, critical analysis, and validation of scientific knowledge—such activities are social practices of Science, thereby requiring the Social Domain (SD); • The Material Domain (MD) is also necessary, given that resources are essential for the formulation and validation of knowledge in the Sciences.
Social Domain (SD)	• Expresses the understanding of how scientific knowledge is produced and the criteria used to analyze and validate it; • Whenever shared practices within the scientific community are brought into debate and addressed in school, it is likely that the SD of scientific knowledge is being constructed; • There is the possibility of this perspective occurring in a traditional manner—that is, merely illustrating the norms and methods shared by scientists during knowledge construction activities—just as it is feasible that, in the classroom, students engage with the SD of scientific knowledge in contexts where, for example, there is debate on adapting a way to investigate a situation or on the legitimacy of a data point regarding the analyzed problem.
Material Domain (MD)	• Addresses the development, use, and adaptation of research instruments, as well as intellectually conceived methods to structure and substantiate work; • Produced knowledge is closely linked to such resources and cognitive strategies; for example, understanding the microscopic world occurs through optical tools, and interpreting slides and magnified objects also involves a level of visual world interpretation; • Graphic representations, illustrations, drawings, and figures also represent typical components of the MD of scientific knowledge.

Source: Organized by the authors based on Sasseron and Orofino (2025).

Silva and Sasseron (2021) clarify that, in the teaching and learning context, the development of Scientific Literacy for social transformation requires the articulated mobilization of the four domains of scientific knowledge in order to execute scientific practices in didactic situations as a means toward consolidating educational objectives.

Socially Just School

In alignment with Scientific Literacy and the domains of scientific knowledge, Libâneo (2025) discusses social justice within the school context, asserting that two opposing conceptions of the purposes and functions of schools exist: the neoliberal and the sociopolitical or progressive. The neoliberal approach—the dominant perspective in the Brazilian educational system—is characterized by a technicist results-driven curriculum and a culture of performance, aiming at the development of productive skills through training for the labor market according to market interests. In contrast, the progressive approach, grounded in education for individual emancipation, seeks the enhancement of students' human potential through the concepts of Science, Art, the encouragement of critical thinking, the development of collective moral values, and innovative ways of engaging in social, professional, and cultural life.

Furthermore, the author informs us that, within the sociopolitical view of the school, teaching practice lies in acting upon the formation and development of students to collaborate in honing their talents, providing each student with the opportunity to fully develop their cognitive skills through concepts while in direct contact with cultural, social, and material diversity. Thus, among the various purposes and functions of the sociopolitical school, one can highlight that of assisting students to grow and refine themselves as individuals, promoting the assimilation of essential competencies—including those of a cognitive nature, such as self-knowledge, self-sufficiency, and social integration (Libâneo, 2025).

For Libâneo (2025), school education consists of unique processes of internalization, by students, of socially and historically developed culture and Science—such as cultural signs and "psychological instruments"—which assist in systematizing their behavior and activities through the process of interiorization. In this manner, educational institutions fulfill their social function when they stimulate and expand students' cognitive capabilities through concepts, thereby working toward their intellectual, emotional, and moral development (Libâneo, 2025).

According to Libâneo (2025), this pedagogical process through which students incorporate human competencies and aptitudes present in educational contents develops through the actions of concrete individuals with their own demands, interests, and motives, embedded in social, cultural, and material contexts. According to the researcher, this means that the assimilation of curricular content by students is mediated by personal and social reasons for studying, which are interconnected with their social, cultural, and material conditions. Furthermore, according to the author, this represents the first requirement for a socially just school, as it seeks to make these conditions available to all regardless of social class, ethnicity, gender, etc.—that is, a curriculum of cultural and scientific education pedagogically aligned with the social, cultural, and material conditions of students' daily lives, and thus closely associated with sociocultural diversity and social inequalities.

In short, social justice in the school environment refers to ensuring the means to provide students—especially those most in need—with the necessary scientific and cultural education, interconnected with sociocultural plurality, to develop purposes and skills to engage in community activities in a critical and transformative manner (Libâneo, 2025). For the author, a socially just school includes the incorporation of methodological actions that compensate for background social inequalities and school inequalities through a plural curriculum, appropriate didactic strategies, and continuous support for academic obstacles that arise throughout the teaching-learning process. In

addition, the researcher clarifies that it is fundamental to understand which curriculum and which methodologies respond most meaningfully to students' daily lives within their social, cultural, and material conditions—wherein sociocultural plurality, individual and social differences, and coexistence among people of diverse cultural identities are expressed. Addressing the sociocultural and material diversity of students within the curriculum requires solid teaching practices that guarantee their inclusion in the very curricular, pedagogical, and management structures of the school environment (Libâneo, 2025).

In synthesis, Libâneo (2025) states that it is not enough to merely recognize differences and inequalities, nor are socio-educational activities within the school scope sufficient for valuing social and cultural plurality—that is, it is not enough to draw upon students' daily lives and culture solely to engage them in studying. It is necessary to refine their conceptual perception and its connection to students' personal development—that is, to the role of knowledge in life outside the school environment (Libâneo, 2025).

Scientific Literacy, bound to the work of Science and Biology teachers in Basic Education schools, can contribute to the education of youth through the analysis and appropriation of scientific and artistic knowledge, for example. We believe that Scientific Literacy provides a foundation for a more reflective outlook on the web of issues permeating the collective sphere. Moreover, it contributes to the development of critical thinking through its questioning, skeptical, and curious character when facing the problems and (mis)information to which students are exposed—given that these traits are inherent to scientists and can be fostered through teaching grounded in Scientific Literacy. This set of skills aims at individual emancipation to make conscious decisions, alongside greater social activism grounded in values such as social justice and the pursuit of equity for all.

Scientific Literacy and Its Implications for the Education of Science and Biology Teachers

Castro and Santos Junior (2025) inform us that it is fundamental for discussions on Scientific Literacy to manifest with greater frequency in initial and continuing teacher education, as its presence promotes pedagogical practices that are more lucid and coherent with the problems of contemporary society, enhancing the transformative capacity of science education in Brazilian schools.

According to Mendes and Machado (2024), promoting Scientific Literacy is essential in the current school context, considering that its objective is to prepare students to understand and critically engage with scientific and technological processes. Through Scientific Literacy, subjects have the opportunity to refine behaviors and fundamental principles for analyzing and understanding the reality in which they live, as well as for making responsible choices to act actively in society. Furthermore, according to the authors, considering the significant impact that teacher education has on improving the quality of teaching, it is of paramount importance to research and utilize teaching approaches that seek to foster Scientific Literacy (Mendes; Machado, 2024).

Silva Maria, Moraes, and D'ávila (2025) elucidate that the preparation of instructional planning enables the development of essential teaching skills, such as cooperation, active listening, and pedagogical rhetoric skills, and that this experience consolidates the understanding that teaching is a continuous practice of learning in which educators must reflect upon their praxis and remain flexible according to the situation. In addition, the authors explain that planning aids in the construction of four valuable learning outcomes: understanding the essential need to relate concepts in a meaningful manner; sharpening sensitivity toward the actual student scenario; developing an interdisciplinary perspective for Biology teaching; and consolidating teacher autonomy and creativity (Silva Maria; Moraes; D'ávila, 2025).

In this sense, planning is paramount to achieving the educational objectives proposed by teachers; therefore, the lesson plan is a tool that can assist educators in better understanding their intentionality regarding the proposed lesson, its pedagogical purpose, where to begin, and where they aim to arrive, using lesson planning as a resource. A lesson plan can be conceptualized as a pedagogical tool that defines the content and activities of one or several lessons comprising a course (Goés et al., 2015). According to Libâneo (1993), a lesson plan can be understood as the methodical description of the sequence of activities to be carried out by the teacher across one or more instructional days, considering what is sought as objectives with the students.

From this perspective, a lesson plan may consist of a pedagogical sequence (*sequência didática*), within which various elements and instructional strategies are included to constitute one or several lessons with a well-established and determined instructional purpose, possessing a specific pedagogical aim regarding what, why, for whom, and with what objective to teach. Thus, the utilization of different methodologies and instructional strategies presents itself as an effective resource with great potential, taking into account individual learning differences and how each student comprehends the concepts developed in the classroom (Taxini et al., 2012). For Zabala (1998), a pedagogical sequence is a set of systematized, structured, and linked activities designed to achieve specific learning objectives, featuring a defined beginning and end known to both the teacher and the students.

For Epaminondas, Smania-Marques, and Garcia Da Silva (2025), the search for innovative instructional approaches that provide meaningful learning connected to students' contexts is recurrent in Biology Teaching; pedagogical sequences (PS) are included in this scenario as a resource enabling systematic activity planning capable—through teacher mediation—of facilitating a productive encounter between students and the scientific knowledge to be learned. For the authors, to guarantee its efficacy, this instructional plan

cannot be arbitrary, but must be grounded in theoretical and methodological frameworks that ensure a systematized and coherent design construction.

The experience of designing pedagogical sequences demonstrated to researchers the relevance of collaboration between Basic Education teachers and Science Education researchers, ensuring that PS plans are both theoretically grounded and feasible for classroom application; they understood that despite possessing knowledge in similar fields, these professionals present differences—one of a theoretical-methodological nature and the other more practical—both forms of knowledge being equally significant for the development of pedagogical sequences (Epaminondas; Smania-Marques; Garcia Da Silva, 2025).

Research indicates that many teachers face difficulties in implementing teaching and learning strategies that promote Scientific Literacy; among the listed elements, initial teacher education focused on the transmission of concepts is highlighted, with little to no emphasis on active methodologies, interdisciplinary approaches that account for students' daily lives, or debates regarding the structure of Science and STS (Science, Technology, and Society) relationships (Heinrichs et al., 2025). The authors further clarify that Scientific Literacy requires teachers to understand more efficient ways to structure instruction, select appropriate teaching and learning strategies, contextualize content with students' daily life situations, and foster interdisciplinarity; in this light, teacher pedagogical knowledge is crucial for planning interventions that stimulate student interest, encourage critical thinking, and promote the construction of meaning for scientific content (Heinrichs et al., 2025). For Sasseron and Orofino (2025), understanding the role of the Sciences and the role that information about Science plays for and brings to the collective body become essential factors in planning actions aimed at developing Scientific Literacy.

Final Considerations

The theoretical exposition presented herein enabled us to highlight the potential that teaching and learning strategies that promote Scientific Literacy possess for Science and Biology Education. Conceiving an education grounded in Scientific Literacy allows us to advance toward the development of social justice within the school—characterized by a progressive nature and underpinned by education for individual emancipation. However, for this to become possible, initial teacher education in Science and Biology degree programs must provide dedicated spaces within the curriculum for the discussion, problematization, and practice of Scientific Literacy. Thus, by equipping future Science and Biology teachers with the necessary resources for implementing Scientific Literacy in their classrooms, we will achieve not merely a sporadic and fragmented formative moment, but a clear, well-defined educational objective. We believe that teacher pedagogical intentionality is essential to promoting contextualized Science and Biology teaching—one allied with contemporary issues, meaningful to students, fostering greater social engagement, and driving structural transformations in the pursuit of a more just society.

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