

Scientific literacy in perspective: intersections between scientific denialism and science teaching¹

Tereza Santos Farias²

Myrna Friederichs Landim de Souza³

Leonardo Ferreira de Almeida⁴

ABSTRACT

This work constitutes a systematic literature review (RSL) on research that takes into account the relationship between scientific literacy, scientific denialism and science teaching, based on the analysis of a corpus of 09 journals and 26 articles, published between 2013 and 2023. Despite the multidimensionality of the term scientific denialism, we are interested in understanding the scope of its effects on Science teaching, supported by literature. The results allowed us to observe that Science teaching can be Enhanced with the perspective of scientific literacy, and the approaches of scientific literacy with critical thinking and an investigative approach emerge as clear notes to be incorporated into teaching procedures and practices, however, it is up to reflection on what paths are necessary so that curricular guidelines and guidelines find appropriate conditions for their effective implementation in the heart of educational policies, which are schools.

KEYWORDS: Scientific literacy; Scientific denialism; Science teaching.

¹ English version by Lilian Therezinha Degaut Santos de Souza. *E-mail:* liliandegaut96@gmail.com.

² MSc. in Educação e Contemporaneidade. Universidade Federal de Sergipe, São Cristóvão, Brasil. Orcid: <https://orcid.org/0000-0001-7417-4693>. *E-mail:* terezasf@academico.ufs.br.

³ PhD in Recursos Naturais. Universidade Federal de Sergipe, São Cristóvão, Brasil. Orcid: <https://orcid.org/0000-0002-0263-9532>. *E-mail:* myrna@academico.ufs.br.

⁴ MSc. in Ensino de Ciências e Matemática. Universidade Federal de Sergipe, São Cristóvão, Brasil. Orcid: <https://orcid.org/0000-0002-6663-6840>. *E-mail:* leobioufs08@academico.ufs.br.

A literacia científica em perspectiva: interseções entre o negacionismo científico e o ensino de ciências

RESUMO

Este trabalho se constitui como uma revisão sistemática de literatura (RSL) sobre pesquisas que levam em consideração a relação entre a literacia científica, o negacionismo científico e o ensino de ciências, a partir da análise de um corpus de 09 periódicos e 26 artigos, publicados entre 2013 e 2023. No que pese a multidimensionalidade do termo negacionismo científico, nos interessa compreender o alcance dos seus efeitos no ensino de ciências, apoiadas na literatura. Os resultados permitiram observar que o ensino de ciências pode ser potencializado com a perspectiva da literacia científica, e as aproximações da literacia científica com pensamento crítico e abordagem investigativa surgem como claros apontamentos a serem incorporados nos procedimentos e práticas de ensino. No entanto, cabe a reflexão sobre quais os caminhos necessários para que as orientações e diretrizes curriculares, encontrem condições apropriadas para a sua efetiva implementação no coração das políticas educacionais, que são as escolas.

PALAVRAS-CHAVE: Literacia científica; Negacionismo científico; Ensino de ciências.

La alfabetización científica en perspectiva: intersecciones entre el negacionismo científico y la enseñanza de las ciencias

RESUMEN

Este trabajo constituye una revisión sistemática de la literatura (RSL) sobre investigaciones que tienen en cuenta la relación entre alfabetización científica, negacionismo científico y enseñanza de las ciencias, a partir del análisis de un corpus de 09 revistas y 26 artículos, publicados entre 2013 y 2023. A pesar de la multidimensionalidad de la término negacionismo científico, nos interesa comprender el alcance de sus efectos en la enseñanza de las ciencias, sustentado en la literatura. Los resultados permitieron observar que la enseñanza de las ciencias puede potenciarse con la perspectiva de la alfabetización científica, y los enfoques de la alfabetización científica con pensamiento crítico y enfoque

investigativo emergen como notas claras para ser incorporadas a los procedimientos y prácticas docentes, sin embargo, corresponde a la reflexión sobre qué caminos son necesarios para que las directrices y lineamientos curriculares encuentren condiciones apropiadas para su efectiva implementación en el corazón de las políticas educativas, que son las escuelas.

PALABRAS CLAVE: Alfabetización científica; Negacionismo científico; Enseñanza de las ciencias.

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Introduction

The COVID-19 pandemic has deepened existing problems, whose multiple consequences, of a socio-economic, humanitarian and, in the particular case of Brazil, even civilizational nature, have added new contours to some of the problems that Brazil had not faced head-on. It is no exxageration to point out that we are going through a trial of civilizational barbarism, and this perception also demarcates a deep hatred for education (Charlot, 2020), presented by the new barbarians, where we are invited to a necessary immersion in the anthropological foundantion of education, in order to achieve a photograph of the time in wich we are inscribed, having as a filter the contemporany configurations of the pedagogical processs. Although the term scientific denialism encompasses a complex multidimensionality, we are particularly interested in understanding the scope of its effects on education, more precisely on science teaching, as well as investigating the perspective of scientific literacy and the possible relationships that are established between these three fields. This was the effort made in the construction of this work, which investigaded the academic productions published in the scope of the journals selected from stratum

A1 to B1, of the journals in the areas of teaching education, indexed in the WebQualis list.

This work was guided by the following question: what does research say about the relationship between scientific literacy, scientific denialism and science teaching? In view of the above, this systematic literature review takes into account works in Portuguese, English and Spanish, focused on science teaching, with 26 articles published in the last ten years as the corpus of analysis.

Scientific denialism and scientific literacy

The context of crisis in which we are immersed calls on us to re-signify our civilizational trajectory, also starting with education, a fundamental element for the socialization of man and his humanization, in a perennial process that involves ruptures, where culture is renewed and man makes history (Aranha, 1990). The scenario of a serious health crisis was exacerbated by the strengthening of scientific denialism, which not only contributed to delaying the effective control of the health crisis, but also produced perverse effects in other sectors of society, notably education and, in a particular way, considering the specific context of schools and the curriculum, science teaching. More broadly, looking at the global picture, we find elements of a post-truth scenario⁵, where a fictional ethics of reality is drawn up, anchored in disinformation and even in the denial of factual reality. Cristóvão (2017, p.23), in presenting us with a narrative that presents the contours of fiction and poetry, also seems to deliver a photograph of our time, where “it is not only the sharpness that is blurred, it is also the nature of the reference, its concentrated status of reality, the reference as if losing its specific contour in the concrete world”.

⁵The concept of post-truth used here refers to the neologism that has gained momentum since 2016, where objective reality has become less important in shaping public opinion than proven, scientifically-backed theses, especially since the use of social networks has increased.

There is growing concern about the implications that the post-truth era can have on the objective reality of subjects, especially since 2016, when the “Trump era” helped make this term the word of the year (Keyes, 2018), amplifying the capillarity of fake news, from social circles to public policies. In Seixas (2019, p.125), we find an important reflection on overcoming the desire for truth, present in our temporal reality, with “a certain lack of interest on the part of subjects in establishing a heuristic movement to verify facts and truths, since it is better to maintain convictions and identities than to verify them at all costs”.

Leaving this broader canvas, it is possible to see some points of contact between post-truth and scientific denialism, where the harmful effects become material, including in the concrete context of science teaching. It is important both to keep the proper proportions between post-truth and scientific denialism, and to try to understand some of the intertwining of this plot, and in this regard Vilela and Selles (2020, p. 1731) make an important contribution: While scientific denialism is limited to concepts and explanations developed by the scientific community, post-truth takes on a broader and more generic character, as it concerns the production and dissemination of false information on the most varied topics, always with the intention of distorting it and serving a certain group whose ideology is assumed to be conservative. Information is fabricated or distorted and ends up reinforcing prejudice and intolerance towards those groups that threaten conservative values. So we can understand that scientific denialism is a more sophisticated process of producing disinformation, which is structured around conspiracy narratives and is dressed up as science.

Placing this work proposal in the historical time in which we are immersed is of fundamental importance in order to reclaim the place of education, school and teaching, as a space for building knowledge, marked by inquiry, by questioning, by investigation (Bachelard, 1996), in a continuous search for answers for answers and new questions, even

if there is no pretension of establishing absolute truths, but where the permanent exercise is kept alive, in the hope that “subjectivism is adapted to reality” (Armentia, 2005, p.93). The potential that scientific literacy can harbor in confronting the nuances of barbarism and sustainable values (Auler, 2011), in a double way constituting elements for the development of the sciences while also enabling a more accurate apprehension of society, from the perspective of a critical position based on scientific evidence.

One of the possible understandings of scientific literacy is demarcated by the Organization for Economic Cooperation and Development (OECD), in the triennial comparative study of the Programme for International Student Assessment (PISA), conceived as “the ability to use scientific knowledge, identify questions and draw conclusions based on evidence in order to understand and help make decisions about the natural world and the changes caused by human activity” (OECD, 2003). According to PISA, scientific literacy relates to knowledge about science and the application of this knowledge in everyday life contexts, where it is important to understand scientific ideas and place oneself in the world as a reflective citizen, based on the knowledge, skills and contexts that organize the field of science. The transition from a logic of merely transmitting finished content to an investigation and opening up of evidence (Nardi, 2009) outlines the invitation that needs to be made to students for continuous reflection, towards the development of a global subject, connected to the idea of cosmopolitan citizenship (Cortina, 1997), and the perspective of scientific literacy in science teaching, is a possibility that is closely linked to argumentation and that contributes to the development of epistemic practices (Sasseron, 2020) by integrating the various dimensions of science and being able to move in the direction of teaching that is full of meaning and that makes sense in the concrete context of the historical subject that is the student.

Science teaching and the school curriculum

Science teaching (Hodson, 2014), from the perspective of the new national curricular references, is demarcated from the perspective of investigation as a guiding option, and the National Common Curricular Base (BNCC) “expressly defends scientific literacy, which can be related to the idea of scientific culture for all” (Silva, 2021, p.14). The introductory text for the natural sciences area of the BNCC highlights the emphasis on process and practices with an investigative dimension, an approach connected to student protagonism, the presence of open and contextualized challenges and problems, as well as the search for solutions of a theoretical and/or experimental nature with a critical bias (Brasil, 2018).

The BNCC approach to the area of natural sciences is spiral, and points to the progression of learning and the gradual development of the area’s fundamental concepts, through an intimate interface between scientific knowledge and everyday life. In the BNCC we find the theoretical demarcation of the space for critical and divergent thinking, as well as the delimitation of the investigative approach and student protagonism as central elements in the learning process. There is express reference to pedagogical work with problematization, and references to scientific curiosity, intervention in reality, social, historical and cultural contextualization of science and technology are also central, as well as an important focus on the relationship between science, technology, society and the environment (Brasil, 2018).

The investigative dimension of the natural sciences is very important, and in the set of specific competences of the area, as well as the skills, it is possible to recognize the importance of working with problematization, problem situations and problem solving, be they individual, social or environmental. Among the numerous research procedures, such as:

identifying problems, formulating questions, identifying relevant information or variables, proposing and testing hypotheses, developing arguments and explanations, choosing and using measuring instruments, planning and carrying out experimental activities and field research, reporting, evaluating and communicating conclusions and developing themes of the area; we note that the BNCC offers a stimulus to the student's role in the learning process, and this perspective is closely associated with the search for problem solving.

The critical appropriation of standardized curricular references and their overcoming as prescriptions are echoed in the reflection on the teacher as an epistemic subject, brought up by Adúriz-Bravo (2000, p. 50), where it is necessary to understand that “the teacher is understood in this context as a real (non-formal) epistemic subject, with a previous history of theoretical and practical knowledge”. The study proposed in this paper will look at the possibility, based on this systematic literature review, of understanding the relationship between scientific literacy, scientific denialism and science teaching.

Methodological Procedures

The effort made to construct this Systematic Literature Review (SRL) investigated the academic productions published in the journals selected from stratum A1 to B1, in the areas of teaching and education, on the WebQualis list, as well as on the SciELO database. Papers published in Portuguese and focused on science teaching in the last ten years were taken into account.

The RSL was chosen because of its systemic nature of investigation, which offers greater quality in obtaining information according to the defined protocol, which included defining the research question, data items, keywords, search string, publication sources and inclusion and exclusion criteria for the papers (Kitchenham, 2007).

During the selection process, all the papers found in the WebQualis and SciELO databases were exported to the computer and then imported into Mendeley, a free reference manager, where they were checked for duplicates. After the first filter, the papers were partially read, analyzing the title, abstract and keywords sections. The last filter allowed us to arrive at the corpus of analysis which is the object of this work, where a complete reading of the papers, applying the inclusion and exclusion criteria, defined the universe of articles analyzed here. We highlight the search expressions selected described below:

TABLE 1: Lists of expressions used to search for articles

Language	Search expressions
Portuguese	scientific literacy, scientific denialism, science teaching

Source: Prepared by the authors (2024).

The main research question, which aims to address the proposed study, is as follows: What is the relationship between scientific literacy, scientific denialism and science teaching?

After identifying the journals, a search was carried out to select the articles, and the string chosen (Table 2) for this research returned a total of 62 papers in the initial search through WebQualis. In the SciELO database, the first application of the search string returned 465 findings. The search brought together the keywords, using terms and their synonyms in Portuguese, making up the following string: (“scientific literacy” and “scientific denialism” or “science teaching”).

TABLE 2: Automatic search string used in the databases

Databases	<i>String</i> used	Portal
CAPES Webqualis Portal	“scientific literacy” AND “scientific denialism” OR “science teaching”	http://novo.periodicos.capes.gov.br/
SciELO Portal	“scientific literacy” AND “scientific denialism” OR “science teaching”	https://www.scielo.br/

Source: Prepared by the authors (2024).

After this initial return, the papers found were selected again, taking into account their alignment with the research question and their relevance for use in this study. The search process was instituted, taking into account the alignment with the scope of answers to the main research question (RQ1), considering the time frame from 2013 to 2023, from studies published in portuguese. All the articles were analyzed by reading the title, abstract and keywords.

We excluded journals that only have sections or special issues dedicated to teaching and education, but which do not have a central focus on research in these areas, with the regularity and expressiveness desired for researchers interested in science teaching. In each of the RSL stages, inclusion and exclusion criteria were adopted, and, in the end, the works that met all the criteria required in this study were included as the knowledge base for extracting information and discussing the results.

From the articles located, and after reading the title and abstract, the analysis was carried out in order to verify the approximation with the main research question, and the inclusion and exclusion criteria were applied, refining the preliminary analysis to a total of 26 articles. The inclusion and exclusion criteria enable researchers to find studies that respond more reliably to the research objectives (Kitchenham, 2007), and here we excluded studies that were not peer-reviewed, published in congresses and

conferences and/or articles and books and/or secondary studies such as surveys and summarized articles and studies associated with the research questions and objectives.

Results and discussion

Once the papers had been selected, data was read and extracted from the 26 articles, which were selected and organized by full title, unique identification code, author's names, year of publication and database:

CHART 1: Selected articles

Id	Título	Autores	Ano	Bases
1	Wich science is denied on social networks? Reflections from ethnographic research in a denialist virtual community	Pivaro, G. F. Junior. G. G.	2022	WebQualis
2	Some high school students perceptions of science, pseudoscience and anti-science movements	Miguel, M. L. Santos, L. J. dos; Souza, L. A. M. de	2022	WebQualis
3	Inquiry-based teaching and argumentation to promote scientific literacy in science teaching	Ramos, R. A. Parisotto, C.	2022	WebQualis
4	The cartography method and science education: interlocutions	Ribeiro, E. S. Costa, F. A. G. da	2022	WebQualis
5	Teaching science through inquiry in times of pandemic: promoting scientific literacy through a fake news approach to cancer	Monteiro, M. M. Marcelino, V. de S.	2022	WebQualis
6	Influence of social media on the perception of high school students in the tocantina region of Maranhao about the covid-19 pandemic	Lima, R. C. Silva, V. R. da	2020	WebQualis
7	Science education in the post-truth era: the weakening of biological knowledge	Feitosa, A. A. M. Medeiros, F. V. G. de. Cavalcante, A. M.	2021	WebQualis

8	Dynamic biology text workshops: tools for scientific literacy in times of fake news	Gravina, M. das G. P. Munk, M.	2020	WebQualis
9	Using a science text on vaccinations: a proposal for elementary school	Soares, V. P. Ribeiro, R.	2019	WebQualis
10	The impact of the national common curriculum (BNCC) on the work of science teachers in the final years of elementary school	Krützmann, F. L. Alves, D.K.C Silva, C. C. da	2023	SciELO
11	What ideas does fake news convey about covid-19 vaccines? Challenges for science education and science communication	Veneu, F. Rocha, M. B. Zago, J. P. Malacarne, J. A. D, Melo, A. H.	2023	SciELO
12	Fake news and science teaching: insights and discussions for teaching and research	Delgado, K. P. Milaré, T.	2022	SciELO
13	Research in science teaching and science education in times of pandemic: reflections on the nature of science and interdisciplinarity	Catarino, G. F. de C. Reis, J. C. de O.	2021	SciELO
14	Curricular autonomy as a fator associated with science performance in PISA	Gualberto, L. Rodrigues, A. M.	2021	SciELO
15	Scientific literacy and domains of scientific knowledge: proposals for a formative perspective committed to social transformation	Silva, M. B. Sasseron, L H.	2021	SciELO
16	Professional teacher development and formation of the creative investigatiuve subject according to the common national curriculum for science teaching	Rocha, C. J. T. da	2021	SciELO
17	The relationship between the teaching of natural sciences and the formation of world conceptions in the light of cultural-historical psychology	Zocoler, J. C. Sforni, M S. de F.	2020	SciELO
18	In favor of scientific realism in teaching	Arthury, L.H. M. Garcia, J. O.	2020	SciELO
19	Narrative fiction and the teaching of social sciences	Schweig, G. R.	2020	SciELO
20	The natural sciences in the 1 st and	Marcondes, M.	2018	SciELO

	2 nd versions of the common national curriculum	E. R.		
21	What does literacy mean to science education researchers and what impact do these concepts have on science teaching?	Cunha, R. B.	2018	SciELO
22	Scientific literacy or scientific literacy?: interests involved in the interpretations of the notion of scientific literacy	Cunha, R. B.	2017	SciELO
23	Teaching science through investigation: a pedagogical strategy to promote scientific literacy in the early years of elementary school	Brito, L. O. de. Fireman, E. C.	2016	SciELO
24	Relations between reading, writing and literacy/scientific literacy: a bibliographical survey of national journals in the field of science teaching	Suisso, C. Galieta, T.	2015	SciELO
25	Scientific literacy, inquiry teaching and argumentation: the relationship between the natural sciences and schools	Sasseron, L. H.	2015	SciELO
26	Scientific literacy: questions for reflection	Teixeira, F. M.	2013	SciELO

Source: Prepared by the authors (2024).

In the universe of papers selected, there was a greater prominence of publications in the SciELO database, most of which focused research into science teaching for basic education. With regard to the distribution of the papers over time, a significant majority of the findings revealed that production has intensified in the last four years.

Scientific literacy is a term that is rarely used in the universe of studies researched, with the term scientific literacy being used more frequently, which points to the potential field for exploring and deepening research into scientific literacy in the context of publications in the area of science teaching.

The study by Pivaro and Giroto (2022) shows that there is a discontinuity between the knowledge seen at school and what happens

outside it, as if school knowledge had to remain confined to its limits, with little impact on people's daily lives. The authors present some of the difficulties in developing scientific literacy, highlighting the exponential increase in access to communication on online networks and the consequent flood of information, where the absence of a solid base of scientific knowledge compromises proper understanding and favors the behavior of attacking science, highlighting the importance of emphasizing the non-neutrality of science and breaking down the image of scientists who are alien to society.

The multiple reasons for the proliferation of scientific misinformation call for reflection on the lack of understanding among network users about the nature of science and the construction of scientific knowledge, as a fertile ground for the propagation of distorted views, which gradually grow and feed the discourse attacking the credibility of science, underpinning the denialist discourse in public opinion. The studies analyzed, which associate scientific denialism with science teaching, demonstrate the need to improve investigative processes in science teaching, in order to broaden the perception of the production and validation of scientific knowledge and the development of a critical sense. The work by Miguel, Santos e Souza (2022) draws attention to denialist attitudes that collide head-on with the consensus of the scientific community, distorting studies or presenting results that are at odds with the scientific method, as well as bringing to light ideas that are averse to science, such as: terraplanism, climate change denialism, vaccine hesitation and the nature of science in science teaching. In these questions, where the mimetic characteristics of pseudoscience are presented, not only science is mimicked, but also a dogmatic view of science, based on precepts related to religion, which make individuals face two conflicting perspectives on the same phenomenon, coming from religion and science.

Ramos and Parisotto (2022) make an important contribution to the impact of inquiry-based science teaching in this scenario, highlighting the

importance of approaches that favor didactic situations where scientific work comes closer to school culture, by avoiding the mere transmission of knowledge and strengthening the perspective of “building knowledge”, based on conceptual, procedural and attitudinal work.

Ribeiro and Costa (2022), by investigating cognition and displacing the understanding of knowledge as a representation of reality or truth, produced a cartography that shed light on the emancipatory perspective of science, and the defense of knowing in access to experience, in addition to questioning the normativity of a neutral and supposedly universal science, reflecting on the current ways of thinking and doing science with the scenario of rising negationism. The scientific literacy approach, in the research conducted by Gravina and Munk (2020), highlights the potential of problematizing and critically reading science communication content to promote scientific literacy. Lima and Silva (2020), when analyzing students perceptions, highlight the influence of social media as a vehicle for the dissemination of fake news, especially in scenarios of uncertainty and high demand for public information on issues such as crises and health. The research proposal developed by Soares and Ribeiro (2021), based on the discussion of a science text with elementary school students, reflected on didactic strategies with the potential to promote the development of reading, interpretation and critical thinking, with a view to contributing to the non-dissemination of fake news.

Monteiro and Marcelino (2022) point to the contribution of the investigative approach in changing students perceptions and in positioning and making decisions based on criticality, in the face of everyday information. Augusto, Valkiria and Maia (2021) analyzed the phenomenon of post-truth and its implications in the context of scientific denialism, and pointed to the contribution of scientific literacy in confronting the inconsistent knowledge that questions science at the same time. Krützmann, Alves and Silva (2023), by focusing their analysis on science teachers in the final years of elementary school,

bring us the impacts of the BNCC on the science curriculum, highlighting the lack of interface with social issues and with students daily lives. The researchers point to the rupture that the latest of the BNCC has promoted in relation to content linked to science, technology, society and the environment (STSE), indicating a weakness in the latest version of this curriculum document, which guided the construction of curricula with education networks and schools, in the relationship between science and society, which could compromise the construction of knowledge with this important bias.

Veneu *et al.* (2023) highlight the need to build different strategies to combat fake news, and situate the place of science teaching and science communication, as well as the detailed analysis of discursive strategies, drawing attention to the relationship between the profusion of false information disseminated on various platforms and the emergence of public doubts about the safety of vaccines. The authors highlight the importance of the anti-vaccine movement in tackling the pandemic, weakening the ways in which the virus is controlled and spread throughout society, and call for the threat posed by such movements to be considered on the global agenda in future immunization programmes. The relevance of health education and communication programs in the context of scientific literacy is well highlighted by the authors, who also highlight the need to pay attention to individuals who have less basic knowledge about public health and their potential to adhere to anti-vaccination behaviors. For the authors, the place of science teaching, as a space for problematization and critical analysis of the consequences of anti-vaccine fake news, must find resonance in teaching and learning classes and procedures, going beyond simply checking the source of the news received.

Delgado and Milare (2022) offer an important contribution to combating fake news in the context of science teaching, highlighting the commitment to critical education, and the strategies of science

communication, science teaching with a STS approach, scientific literacy, media and information literacy, and scientific literacy. Decision-making in everyday life based on a critical analysis of information is one of the contributions of critical science teaching, and the authors point to the potential that fake news holds for the possibilities of contextualized science teaching, aimed at minimizing both a research gap and producing effects on people's daily lives. The fragilities exposed by the pandemic, both on an individual level and with regard to the project of humanity, also point to the relevance of the conception of science and scientific work, according to Catarino and Reis (2021), reinforce the importance of science teaching committed to the struggle for a more just and democratic society, through new ways of understanding the world and intervening in it.

Gualberto and Rodrigues (2021) highlight the importance of the decision-making process of teachers in developing the curriculum, and argue that curricular autonomy provides an opportunity to materialize the curriculum in line with the particularities of communities, as well as increasing accountability for decisions within the curriculum. The work dialogues with the current context of science teaching, especially in view of the developments in schools as a result of the establishment of a national curriculum base, and advocates the potential for changing teachers practices, always mediated by the real possibilities of schools.

Among the works dealing with scientific literacy, Silva and Sasseron (2021) perspective on the social nature of the appropriation and use of scientific knowledge deserves to be highlighted, where literacy can offer important support for understanding and analyzing phenomena, under the strong influence of the relationship between science and society, a formative perspective that enables students to come into contact with elements of scientific culture.

Rocha (2021) study sheds light on teacher training, and highlights the professional development of the creative, investigative subject, set in motion to know, learn and understand the real world.

For the author, the construction of scientific knowledge is the result of the development of creativity, concepts and theories, which cannot be given up when teaching science. Zocoler and Sforzi (2020) make an important contribution to science teaching in the final years of elementary school, by enriching the view of the adolescent subject, who enters this transition phase markedly in the second stage of elementary school. The authors bring the vision of cultural-historical psychology, with the contributions of Davidov and Vygotski, where adolescence is marked by very rich formative possibilities, with the development of higher, theoretical thought, formed by concepts, and where the formation of higher syntheses occurs, which are the personality and conception of the world. The importance of intentionality in organizing study situations where scientific concepts can be better understood by students is highlighted.

In the work of Arthury and Garcia (2020), we find an indication of the commitment of science teaching to the context of the production of scientific knowledge, from the perspective of humanizing the development of science and the fallibility of the view of the scientist, enabling students to see how, generally speaking, the intellectual constructions of scientific activity, even with all the human vicissitudes of the scientist, are sincerely committed to very compelling material evidence. Schweig (2020) perspective points to the need to go beyond merely opposing fake news and fighting lies, proposing the use of fiction as a resource for approaching knowledge. In Marcondes work (2018) the author provokes a reflection on the impact of the Brazilian curriculum framework on schools pedagogical policy projects, whose appropriation must consider local realities and needs, valuing cultural aspects of the territories. She also draws attention to the perspective of scientific literacy expressed in the BNCC, whose teaching and learning procedures and practices can take into account the principles of scientific investigation in a TS approach.

Cunha (2018) recalls the historical perspective of the emergence of the term literacy, with the knowledge produced in the area of science from 1958 onwards. He recalls the historical importance of Paul Hurd work, and the need for public knowledge of science, given the launch of sputnik, which also aroused concern in the American scientific community about developing scientific literacy in children, in a society that was gradually becoming more sophisticated from a scientific and technological point of view. The study reveals the scarcity of works that take into account the literacy perspective, and sheds light on the analysis of the proximities and distances between literacy and scientific literacy, as well as addressing the three levels of literacy in science, in the practical, civic and cultural fields.

Cunha (2017) in another work, recovers the conceptual vision of scientific literacy, and justifies the recurrence in associating the term literacy with literacy skills, derived from the usual interpretation as reading and writing, adding the categories associated with a literate individual: educated, competent; or capable of acting minimally as a consumer and citizen. The emphasis on the day-to-day work that must be undertaken by scientific literacy is present in the text, in favor of reading, writing and understanding science.

By proposing the application of a didactic sequence involving scientific investigation, Brito and Fireman (2016) defend the adoption of science teaching by investigation as a pedagogical practice that promotes scientific literacy, while promoting the development of conceptual content in a context rich in meaning and understanding of the world.

When investigating the relationships between reading, writing and scientific literacy and/or scientific literacy. Suisso and Galieta (2015) point to a common assumption about the ability to read and write in the context of scientific topics: the ability to read/write when the content is scientific differs from the ability to read/write other topics, which would be related to certain textual genres that are privileged in the context of science teaching,

such as: scripts and reports of practical-experimental activities and scientific articles.

The reflection in Sasseron (2015) work on whether schools teach subjects or teach about ways of perceiving the world helps us to think about the links between the practices established in schools and the construction of scientific knowledge, and how we can encourage the development of practices that allow students to develop critical, analytical and propositional attitudes towards scientific issues of relevance to society.

Teixeira (2013) begins by situating literacy and literacy within aspects of written language, as objects of study for linguists and where language is the object of investigation, and offers valuable contributions to broadening views on the subject. The thesis is that, by linking science, reading and writing on the same level of indispensability, as cultural assets that enable inclusion in graphocentric societies, we assume the perspective that this domain of knowledge is relevant to all individuals.

Conclusion

In this work, which sought to identify what research says that takes into account the relationship between scientific literacy, scientific denialism and science teaching, by investigating the relevance of this field for science teaching researches, investigating publications in journals in this area, the approximations and distances were presented, based on the selected units of analysis.

Analysis of the research corpus revealed the main objectives, research questions, data collection methods and results of these studies. The term scientific literacy was an infrequent finding in the search string, and the fragile relationship established with scientific denialism showed that there is a potential field of research to be explored in the context of science teaching. Despite the 10-year time span, the most significant studies were from the last 4 years. The investigations that did

not focus on theoretical studies were aimed at basic education students. It was possible to observe the recurrence of the pandemic scenario in the studies that investigated scientific denialism, making it possible to identify the context of defending investigation, argumentation and problematization in the development of scientific literacy, and its potential collaboration in the construction of a critical sense.

The results show that science teaching can be enhanced by including the perspective of scientific literacy, in order to stimulate a critical and protagonist stance in students learning paths, and that the links between the field of scientific literacy and critical thinking and the investigative approach are clear points to be incorporated into teaching procedures and practices. However, it is worth reflecting on the paths needed for the guidelines and curricular directives to find appropriate conditions for their effective implementation in the heart of educational policies, which are schools.

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