

Vaccines and Science Teaching: A Literature Review as an Antidote to Fake News

ABSTRACT

During the COVID-19 pandemic, science faced repeated discredit, mainly due to attacks from so-called fake news, with vaccines being one of the main targets. It is understood that science education, in promoting scientific literacy as outlined in the BNCC (Brazilian National Common Core Curriculum), can contribute to combating fake news, as well as attacks and discredit towards science. Thus, this study aims to present a literature review in the form of documentary research on the current state of the relationship between vaccines, science education, and basic education, along with other contextual issues. It presents a survey of articles from the CAPES Portal of Periodicals database (2005 to 2024) to map and analyze how and if vaccines are related to science education. The findings involve reflections on interdisciplinarity, misinformation or fake news, low vaccination coverage, and the absence of the vaccination topic directly related to education or found false information. Thus, based on the results obtained, it is understood that it is necessary to bring the content about vaccines as a central theme in basic education, as the school is the only access many students have to scientific content, and science needs to address the current issues permeating society.

KEYWORDS: Scientific Denialism. Teaching and Learning in Natural Sciences. Basic Education.

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INTRODUCTION

Since the onset of the COVID-19 pandemic in 2019, the world has been grappling with the circulation of this virus. The recorded deaths will be etched in history, and the scientific community's race to research and produce vaccines was crucial in combating and mitigating the consequences of this virus. Research on COVID-19 and its variants continues to this day. On May 5, 2023, the World Health Organization (WHO) declared in Geneva, Switzerland, the end of the Public Health Emergency of International Concern (PHEIC) related to COVID-19 (Pan American Health Organization [PAHO], 2023), as it is no longer considered an unknown event. However, the pandemic persists, necessitating ongoing precautions and, most importantly, continued vaccination.

Vaccines and the practice of vaccination hold historical significance, offering the greatest benefits to human health beyond any other cultural, social, or scientific advancements (Fernandes *et al.*, 2021). The COVID-19 vaccines are already showing efficacy results, as demonstrated by Araújo *et al.* (2022) in their study conducted in Londrina, Paraná, which revealed that vaccinated populations have lower mortality rates from COVID-19 compared to the unvaccinated.

However, the recent years, due to the COVID-19 pandemic, have highlighted the issue of denialism not only for this pandemic but also for various other vaccines (measles, polio, etc.). This moment can be compared to other historical health emergencies, as detailed in a recent study by Losekann (2023):

[...] termed the Vaccine Revolt, which was the response to the government's handling of the smallpox outbreak in 1904. Subsequently, the Spanish Flu of 1918, which shares many similarities with the coronavirus and occurred amidst scientific controversies (Silveira, 2005), opening the door for various alternative treatments (Schwarcz; Starling, 2020); the HIV/AIDS epidemic, a stigmatizing disease targeted by denialist government actions in South Africa, although the Brazilian government's response was considered exemplary by scholars and other countries; the Zika virus and its association with congenital microcephaly and Guillain-Barré Syndrome (GBS), characterized as a PHEIC, where Brazil played a strategic role in mobilizing resources and scientific efforts. Previous health emergencies share similarities with the COVID-19 pandemic, and governmental and social responses indicate possible pathways (LOSEKANN, 2023, p. 57, our emphasis).

In times of general discredit towards science, society accesses information at the speed of a click (or even less), via Internet navigation, social networks, or digital media. Fake News—false news—is validated and propagated, which can be explained as:

Generally, there are two types of false news: the first is related to the dissemination of information by malicious individuals for their own interests; the second pertains to those innocently shared, albeit incorrect, among people within the same social circle (ALBUQUERQUE *et al.*, 2021, p. 3).

In this context, Fake News has become an obstacle for society, prompting initiatives to combat it, including in the political sphere, such as Bill No. 2.630/2020, the Fake News Law or the Brazilian Law of Freedom, Responsibility, and Transparency on the Internet (BRASIL, 2020), which has been the subject of much contention due to differing opinions across various sectors of society. Discussions on actions against Fake News are urgent, as there remains a segment

of society, known as denialists, who rely on Fake News and Post-truth discourses to challenge reality and scientific thought. Consequently, gaps exist between scientific evidence and public opinion (FREYESLEBEN, 2020). It is necessary to be cautious about opinions without scientific validation: "Science, both by necessity of completion and as a principle, is absolutely opposed to opinion. If, on a particular issue, it legitimizes opinion, it is for reasons other than those that give rise to opinion" (BACHELARD, 1996, p. 18).

Obscurantism and relativism attempt to confuse public opinion, also highlighting the failure of educational systems—from schools to universities—in providing humanistic and scientific education, as evidenced by the increasing number of people who do not understand the importance of scientific knowledge (SILVA; VIDEIRA, 2020). However, it is important to emphasize that it is not fair to generalize and attribute ignorance or the failure of the educational system as the sole culprits to these denialist groups, as there are those with vested interests and a political agenda, as Silva and Videira (2020) warn.

Vaccines, especially but not only those seen in recent years against COVID-19, have suffered (and still suffer) from the spread of fake news, whether due to malicious intent or innocent misinformation. Nonetheless, vaccines have proven to be extremely important in combating numerous communicable diseases (e.g., Poliomyelitis, Tetanus, Whooping Cough, Measles, Rubella, Mumps, Yellow Fever, Diphtheria, Hepatitis B, etc.). Thus, they protect not only individuals but entire communities and beyond.

Vaccines are products of scientific studies, applications, and tests on populations. They are technologies aimed at combating contagious diseases in public health. Despite this, misinformation and attacks on vaccines have been gaining ground, especially on social media, which may influence the low vaccination coverage, as pointed out by the study by Frugoli *et al.* (2021). This study analyzes fake news and vaccine hesitancy within the 3CS model (confidence, complacency, and convenience) and demonstrates that false news has the potential to produce vaccine hesitancy.

Science education, with the aim of problematizing through investigation and the active roles of students, also promotes, based on scientific evidence, critical awareness of various aspects of society. Reflecting on science education, Carvalho (2004) discusses scientific acculturation (as opposed to the accumulation of scientific content):

Teaching that aims at scientific acculturation should be such that it leads students to construct their conceptual content by participating in the construction process and providing opportunities to learn to argue and exercise reason, rather than giving them definitive answers or imposing their own views by transmitting a closed vision of Science (CARVALHO, 2004, p. 3).

Science education needs to consider the student and the role they play in the learning process, with the goal of knowledge construction. According to Moreira (2004), the objective of science education is to make students share meanings within the context of science, that is, to interpret the world from a scientific perspective.

A escola é o espaço mais propício para a discussão de problemáticas que envoSchools are the most suitable spaces for discussing issues that involve society

and consequently for fostering a scientific spirit. However, there is another obstacle to problematizing scientific knowledge versus common knowledge: the pedagogical obstacle, often unknown to science teachers (BACHELARD, 1977). Therefore, it is important to raise questions about the teacher's role. According to Freire (1996), the teacher mediates knowledge through curiosity, instigating students in their knowledge construction. Their methodological and scientific training is relevant in educational practice and the promotion of science.

In this context, some studies contribute to the discussion of science education in this era of post-truths, science discredit, and fake news. The study by Feitosa, Medeiros, and Cavalcante (2022) indicates that "ignorance about how science works can lead people to try to deny well-established scientific facts, supported by fallacious arguments despite evidence" (p. 452). In response, these authors propose the term Biological Literacy, a fusion of literacy and scientific literacy, capable of equipping people to identify real-world biological phenomena and their implications for life, enabling the balanced management of such phenomena.

Similarly, in a recent study, Britto and Mello (2022) analyze fake news discourses related to the origin of the SARS-CoV-2 virus and treatments for COVID-19. They advocate for bringing the debate about fake news concerning scientific matters into classrooms so that students can identify the lack of evidence, coherence, and science in these news items.

In discussing the Nature of Science (NoS), Pereira and Gurgel (2020) highlight the need to update metaphysical content to address new political, social, and educational challenges. They reflect:

[...] we might think that if the priority of metaphysical discourses in teaching was previously to combat views that underestimated the capabilities and potential of science, today it is urgently necessary to critically recognize its epistemic virtues (PEREIRA; GURGEL; 2020, p. 1281).

In a context where information and misinformation are easily accessible, schools become uninteresting places for learning, especially when they are stuck with methods that do not yield learning outcomes. Therefore, formal education needs to seek new theoretical foundations and methodologies to reach students. The study by Pinto and Saavedra (2022) presents the use of Digital Information and Communication Technologies (DICT) in mediating the teaching of physics content, along with the collaborative production of animated videos, promoting different approaches to scientific concepts.

The National Common Curricular Base (BNCC) for the Natural Sciences area in Elementary Education highlights the importance of scientific and technological development, as well as advocates for the discussion of socially significant topics, encompassing ethical, political, cultural, and scientific knowledge. It thus guides scientific literacy, which "involves the ability to understand and interpret the world (natural, social, and technological), but also to transform it based on the theoretical and procedural contributions of sciences" (BRASIL, 2017, p. 321).

The BNCC (BRASIL, 2017) suggests the promotion of situations based on the following axes: (1) Problem definition; (2) Survey, analysis, and representation; (3) Communication; and (4) Intervention. Therefore, its principles align with the perspective of teaching Natural Sciences through investigation and information evaluation. Among the eight specific competencies proposed, the fifth stands out:

Construct arguments based on data, evidence, and reliable information and negotiate and defend ideas and viewpoints that promote socio-environmental awareness and respect for oneself and others, embracing and valuing the diversity of individuals and social groups, without prejudice of any kind" (BRASIL, 2017, p. 324).

Thus, the BNCC (BRASIL, 2017) outlines a path that strengthens the fight against misinformation and fake news within the content taught in Natural Sciences. However, the specific content about vaccines is not included in Early Childhood Education and the early years (1st to 5th grade) of Elementary Education, appearing only in the second stage (6th to 9th grade) and in High School.

The BNCC (BRASIL, 2017) for Early Childhood Education presents the rights to learning and development, structured around five fields of experiences (the self, the other, and the us; body, gestures, and movements; traces, sounds, colors, and shapes; listening, speaking, thinking, and imagining; and spaces, times, quantities, relations, and transformations). Hence, there is no specific science education, nor is there any mention of vaccines.

For the first stage of Elementary Education (1st to 5th grade), the BNCC (BRASIL, 2017) in the area of Natural Sciences is divided into three thematic units (matter and energy; life and evolution; and earth and universe). The knowledge objects and skills do not include the study of vaccines. It is only in the second stage of Elementary Education, in the 7th grade, under the axis of Life and Evolution, that vaccines are mentioned in the skill:

(EF07CI10) Argue about the importance of vaccination for public health, based on information about how the vaccine works in the body and the historical role of vaccination in maintaining individual and collective health and eradicating diseases (BRASIL, 2017, p. 347).

For High School, in the area of Natural Sciences and their Technologies, specific competence 3 mentions vaccines and revisits them in the skill:

(EM13CNT310) Investigate and analyze the effects of infrastructure programs and other basic services (sanitation, electricity, transportation, telecommunications, vaccination coverage, primary health care, food production, among others) and identify local and/or regional needs regarding these services, in order to evaluate and/or promote actions that contribute to improving the quality of life and health conditions of the population (BRASIL, 2017, p. 545).

Thus, the BNCC (BRASIL, 2017) provides limited depth in its coverage of the teaching of Natural Sciences on a highly relevant topic such as vaccines and the action of vaccination in the education of children, adolescents, and young adults. It is understood that this content could be integrated across all stages and modalities of Basic Education, especially given the current context, making it more than necessary, including in an interdisciplinary manner.

It becomes important not only to explore the content of vaccines from a rational perspective through scientific education but also to approach it as artifacts resulting from scientific intervention. This emphasizes the importance of their intentionality and understanding of spatial-temporal dimensions (AULER; DELIZOICOV, 2011). Therefore, vaccines need to be problematized as technological

products that embody and materialize the interests and desires of societies and hegemonic social groups (AULER; DELIZOICOV, 2006).

In this way, the teaching of Sciences aims to promote scientific acculturation and literacy, ensuring that there is no ignorance about Science itself while fostering a critical view of it. This approach allows the challenges of today to be addressed through education. Thus, the topic of vaccines needs to be critically and scientifically addressed to combat the strengthening and spread of fake news. This study will seek to present how and if vaccines appear in research on science education in Basic Education in Brazil.

It should be noted that vaccines, as an object/content of study in Basic Education, are not exclusive to science education, although they are expected to be included in this area due to their proximity to scientific knowledge. Therefore, interdisciplinarity is also present in this research.

It is also emphasized that vaccines, as technological artifacts, particularly those affected by recent denialism—such as the case of attacks on the COVID-19 vaccine—are featured in some of the works reviewed. Other works bring new problematizations related to these artifacts, especially concerning teaching and learning, the school environment, and practices that aim to foster critical thinking among Basic Education students regarding fake news and misinformation. In this way, these works seek to establish a dialogue with the guidelines of the BNCC (BRASIL, 2017).

METHODS

This study is a documentary research and literature review related to the theme of vaccines and science education. It also encompasses the context of Basic Education and pertinent problematizations, aiming to bring a critical discussion of the current state of the issue (Gil, 2002). Thus, mapping and analysis of the results were carried out.

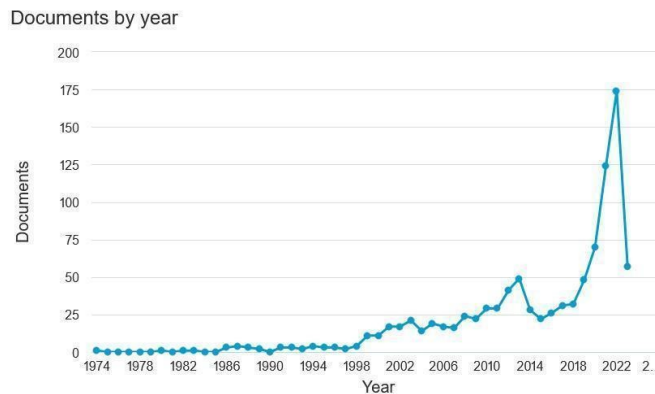
The survey was conducted using the Portal Periódicos CAPES database. Since its inception, the portal's purpose has been to support scientific research conducted in Brazilian postgraduate programs, incorporating databases such as SciELO and Scopus. Therefore, a search using appropriate descriptors on the Portal Periódicos CAPES makes another search on Scopus redundant, as a search result on the Portal provides direct access to the text via redirection to Scopus. Additionally, its collection includes a vast, distinct, and excellent range of scientific productions of various types, such as articles in conference proceedings, scientific journals, and scientific books. This is particularly relevant because of its extensive representation in fields of knowledge that align with the purpose of this study, such as the Human Sciences, including Education, and Health Sciences (BRASIL, 2015).

The research was conducted in February 2024, using CAFE access, with the keywords: *Vacinas AND ensino de ciências (boolean AND operator)*. The keywords were entered into a single search field combined with the *boolean* operator, using only Portuguese terms, and applying the following filters: time period (between the years 2005 and 2024); availability (peer-reviewed journals); and language (Portuguese). The language selection is based on the premise that this study aims

to observe the impacts of denialism on Brazilian basic education and how this issue, through relationships with the BNCC (BRASIL, 2017), can suggest solutions.

The 17-year interval is justified by the search in the Scopus database with the terms *vaccine AND science education*, as it shows an increasing interest from the community starting in the 2000s, notably from the year 2005, used as a reference point, as illustrated in the following chart:

Chart 1 – Search in the Scopus database with the filters described in the text



Source: Research data.

The results found were exclusively from articles in scientific journals. A total of 25 results were obtained, and after reading the abstracts, the works that align with the proposal of this research were selected—those that presented direct relationships with Vaccines, Basic Education and/or Teaching, Denialism, and Fake News. Therefore, after selecting and excluding works that did not fit, as well as duplicates, the result was 10 selected scientific articles. Following this mapping, data organization was assisted by the following software: Endnote, which helped in the bibliographic organization of the research found; Mendeley version 2 for browser-based highlights and annotations; and a spreadsheet for organizing extracted data. The selected works and discussion will be presented next.

RESULTS AND DISCUSSION

As previously mentioned, the analyzed works are all scientific articles. The following Table 1 shows the selected documents:

Table 1 – Works found from 2005-2024

Authorship/Year	Title	Keywords
Veneu <i>et al.</i> (2023)	What ideas do fake news convey about Covid-19 vaccines? Challenges for Science Teaching and scientific dissemination	Chemistry teaching; Decolonization; Teacher training; Polyrationality.
Vittorazzi, Silva e Silva (2023)	The social representations of vaccines in the context of Science and Health Education in Elementary School	Vaccine; Elementary education; Social representation; Socio-scientific aspects;

		Sociology and education.
Melo e Oliveira (2023)	The concept of conspiracy theories in controversies about flat Earth theory	Conspiracy theories; Flat Earth theory; Science education; Controversy mapping.
Gomes <i>et al.</i> (2022)	An educational project in interdisciplinary (mis)encounters: redefining the meanings of being, thinking, and acting with students in social isolation	Interdisciplinarity; Science; Philosophy; Psychology; Social isolation.
Scholz (2022)	"Is history science, professor?": pandemic reflections on history and teaching	Covid-19; History teaching; Scientific method; Historical consciousness.
Araujo e Eichler (2022)	Epistemic disregard in the face of the COVID-19 pandemic in Brazil	Epistemic disregard; COVID-19; Misinformation.
Bicudo e Teixeira (2022)	Scientific Education and Science Denial	Scientific education; History of science; Scientific dissemination; Antiscience; Knowledge democratization.
Teixeira e Bicudo (2021)	Use of videos in educational activities for scientific dissemination on science denial movements	Knowledge democratization; Scientific dissemination; Audiovisual resources; Scientific culture.
VIEGAS <i>et al.</i> (2019)	Vaccination and adolescent knowledge: health education and actions for immunoprevention	Public health; School health; Vaccination; Vaccination coverage; Health education.
Monteiro, Paula e Nascimento Júnior (2019)	An experience report in initial teacher training: a game for teaching vaccines from a historical perspective	Teacher training; Game; Vaccine.

Source: Authors (2024).

The selected and analyzed articles add reflections on whether and how vaccines are related to science education and basic education in Brazil, as well as expand this discussion. Some research problematizes the scenario of denialism, obscurantism, and fake news, as well as the media through which they spread, such as social networks and media outlets. These studies also explore the influences and foundations of these phenomena, including political aspects, making it possible to dialogue with the theory of this work, especially in relation to education and the objectives of the BNCC (BRASIL, 2017) in the area of Natural Sciences.

The research by Veneu *et al.* (2023) analyzes the ideas contained in fake news about vaccines, using a collection of a fact-checking service. Through content analysis, they created 13 categories: 1. Conspiracy theories; 2. Death; 3. Diseases and symptoms caused by the vaccine; 4. Public figures and the vaccine; 5. False

information about vaccination; 6. Changes in the body's functioning; 7. Vaccination in children and adolescents; 8. Vaccine composition; 9. Vaccine inefficacy; 10. Forced vaccination; 11. Vaccines and the three branches of government; 12. Post-vaccine/vaccinated restrictions; and 13. Replacement of vaccines by ineffective treatments.

Denialism and obscurantism appear throughout the work, especially in Conspiracy Theories, which the study defines as a belief in behind-the-scenes, powerful, and malicious forces. This contributes to the reflection that fake news also strengthens these beliefs, fostering a general distrust of all news. This is consistent with the idea that fake news spreads misinformation by malicious individuals, as pointed out by Albuquerque (2021) in the theoretical basis of this research. Therefore, it is crucial to understand and identify fake news as a central topic in discussions about denialism, especially in relation to vaccines. Education and schools, through critical teaching and scientific acculturation, play a crucial role in building arguments based on data, evidence, and reliable information (BRASIL, 2017).

Various categories indicated how false news uses social media through texts, videos, and images that distort or fabricate information about vaccination, such as pathological speeches, loss of civil rights, vaccine composition, etc. In this sense, Veneu *et al.* (2023) advocate for media literacy among students and teachers. This research understands the dialogue with the goal of scientific literacy, which encompasses ethical, political, cultural, and scientific knowledge (BRASIL, 2017).

Research by Vittorazzi, Silva, and Silva (2023) presents a cognitive-structural study of the social representations of vaccines by 7th-grade students, using word evocation from the Central Core Theory. Therefore, this study aligns with the findings of this research regarding the mandatory content on vaccines, which appears only in the second stage of elementary education, in the 7th grade, under Natural Sciences, in the Life and Evolution axis (BRASIL, 2017). The central representations of the students included terms such as: health, protection, cure, pain, and prevention. According to Vittorazzi, Silva, and Silva (2023), students perceive vaccines as contributing to people's health maintenance but also associate them with fear and pain.

In this sense, the study by Viegas *et al.* (2019) also emphasizes the role of students. The research, interfacing with extension activities, aimed to survey the vaccination status of 9th-grade elementary school adolescents, aged 13 to 18, from a public school in Divinópolis, Minas Gerais. It identified low vaccination coverage, particularly for the yellow fever vaccine, with some students citing "fear of injection" as a reason for not getting vaccinated.

The works of Vittorazzi, Silva, and Silva (2023) and Viegas *et al.* (2019) raise the issue that personal feelings and experiences impact opinions and vaccination coverage among students in the second stage of elementary school. This highlights the need for scientific literacy regarding vaccines, beyond common sense, especially critical recognition through epistemic virtues (PEREIRA; GURGEL, 2020), as well as problematization of scientific knowledge *versus* common knowledge (BACHELARD, 1977) and the ability to interpret the world based on the theoretical and procedural contributions of science (BRASIL, 2017).

In their work, Melo and Oliveira (2023) mapped the mobilizations of the concept of conspiracy theories in controversies about flat Earth theory on Facebook. Although this work does not directly address education, it encompasses discussions with broad implications, such as media and political contexts, relevant to the discussion of this research. Some controversies were directly connected to Brazilian political disputes, such as the engagement in vaccine-related distrusts, highlighting the importance of debate and scientific literacy promoted by schools, as advocated in this research.

Araujo and Eicheler (2022) propose contextualizing the epistemic disregard during the Covid-19 pandemic and suggest combating this scenario by advocating for teaching strategies that develop public policies aligned with increasingly advanced science education in Brazil. They argue that this is crucial to avoid repeating mistakes made during the pandemic in the future (ARAUJO; EICHELER, 2022, p. 185). Thus, this work defends the responsibility of science education and the educational system in combating obscurantism.

The research by Bicudo and Teixeira (2022), an essay-based work, investigates science denial movements, the spread of false news, conspiracy theories, and their consequences for education. They advocate for comprehensive scientific education and "science teaching committed to the notions of reality" (BICUDO; TEIXEIRA, 2022, p. 5).

Thus, the works of Araujo and Eicheler (2022) and Bicudo and Teixeira (2022) corroborate the orientation of this research. Although they do not focus directly on a specific stage of education or Basic Education, they align with promoting teaching that constructs arguments based on data, evidence, and reliable information (BRASIL, 2017).

In the second research by the same previous authors, Teixeira and Bicudo (2021), they analyze audiovisual teaching resources available on the Internet concerning topics like science denial. They describe several short videos and provide suggestions for using these videos in scientific dissemination activities in educational spaces to provoke reflection on science denial, post-truths, and Fake News. Although the research has this didactic proposal, it does not specify age classification, the stage of education for which they suggest these videos, or the teaching area. Thus, it is implied that the selection of these resources before the educational practice should be carried out by the educator. Nonetheless, this research contributes to reflecting on the practice of using audiovisual teaching resources aimed at promoting scientific literacy (BRASIL, 2017).

Interdisciplinarity emerges as a means of combating and reflecting on the context of misinformation in the article by Gomes *et al.* (2022), which reports an experience with high school students from the project "Life at risk during the pandemic: the relevance of science and ethical-philosophical reflection intersect in the global village" during 2020, with virtual meetings. The topic of Covid-19 vaccines was explored in one of the project meetings, with a biological focus. It is worth noting that in high school, in the area of Natural Sciences and their Technologies, vaccines are mentioned in skill EM13CNT310 of the BNCC (BRASIL, 2017), as previously indicated in this research. In the experience of Gomes *et al.* (2022), the integration of the field of Philosophy with other areas, allowing ethical reflections on the production of knowledge in the history of Science and "[...] Physics as a field of idea production and calculation and Biological Sciences as a

field of research and natural studies, foundational for learning areas like epidemiology and pharmacology” (GOMES *et al.*, 2022, p. 218), is highlighted. This pedagogical report aims to promote reflection among students, which is considered necessary for evaluating the topic and misinformation and Fake News, allowing for reflection beyond the field of Science education, with the intention of permeating more knowledge or fields (BRASIL, 2017).

In Scholz (2022), the Covid-19 pandemic scenario highlights the prominence of Natural Sciences in dialogue with the area of Applied Human and Social Sciences. It emphasizes teaching history as an antidote to denialism, with critiques of public education policies. It also advocates applying the historical method to the pandemic as “an act that transcends pedagogical objectives” (SCHOLZ, 2022, p. 256). This article emphasizes interdisciplinarity, which challenges the discussions of this research not only in the field of Natural Sciences.

Melo and Oliveira (2023), there is a presentation of the actions of different actors, including those linked to scientific dissemination, who associated flat earthism and conspiracy theories as threats. One mode of association was “due to actions that disparage flat earthism and other social dynamics, categorizing them as illogical conspiracy theories” (MELO; OLIVEIRA, 2023, p. 410). The analyses in Melo and Oliveira’s (2023) work corroborate the importance of scientific dissemination for the general population (BRASIL, 2017). This ensures that more actors, not just those linked to scientific dissemination, have knowledge about science. As pointed out in this research, ignorance can lead to the denial of scientific facts, supported by fallacious arguments (FEITOSA; MEDEIROS; CAVALCANTE, 2022). Similarly, some people do not understand why scientific knowledge is important (SILVA; VIDEIRA, 2020), which emphasizes the need for scientific literacy.

The initial teacher training and didactic experiences aimed at knowledge construction are presented in the article by Monteiro, Paula, and Nascimento Júnior (2019). This research shows its relevance by discussing future science teachers and their training, which is part of the objective of this article. Thus, the work presents an experience report on initial training with undergraduate students in Biological Sciences, in the discipline “Biology Teaching Methodology,” focused on vaccine education. They used a game to teach how vaccines work and their historical context. Interestingly, the study occurred just before the Covid-19 pandemic but already highlighted the following consideration:

Teaching about vaccines is important for understanding reality, as understanding the historical context of their creation enables students to overcome possible alienation by comprehensively understanding the economic, political, social, cultural, and environmental issues that permeate the relationship between health and disease. (MONTEIRO; PAULA; NASCIMENTO JÚNIOR, 2019, p. 114).

Monteiro, Paula, and Nascimento Júnior (2019) highlight the role of teachers in the teaching and learning process and the need to break away from the traditional teaching model. They used a pedagogical game as an alternative to knowledge construction. The BNCC (BRASIL, 2017) is the guiding text for national education. However, it is necessary to have both initial and continuous training to concretize scientific literacy in pedagogical practice with Basic Education students.

Few works directly cited experiences in Basic Education and/or the area of Natural Sciences teaching related to vaccines. However, the works brought reflective contributions to this research, such as misinformation and Fake News, directly or indirectly, denialism and obscurantism (SCHOLZ, 2022; VENEU *et al.*, 2023), the spread and influence of social networks and politics (VENEU *et al.*, 2023; MELO; OLIVEIRA, 2023; ARAUJO; EICHELER, 2022; TEIXEIRA; BICUDO, 2021), the epistemological crisis and loss of trust in fundamental institutions of society, discrediting science, and the need for scientific literacy (TEIXEIRA; BICUDO, 2021; VENEU *et al.*, 2023; VITORAZZI; SILVA; SILVA, 2023; VIEGAS *et al.*, 2019; MELO; OLIVEIRA, 2023; ARAUJO; EICHELER, 2022), and initial teacher training, didactic experiences, and interdisciplinarity (MONTEIRO; PAULA; NASCIMENTO JÚNIOR, 2019; GOMES *et al.*, 2022; SCHOLZ, 2022). Therefore, in general, these works align with the assumptions and objectives of the BNCC (BRASIL, 2017) in Natural Sciences, as well as touch on discussions about vaccines in the teaching and learning process, encompassing different stages and areas of teaching.

FINAL CONSIDERATIONS

In the historical moment of the pandemic, the discrediting of science, distrust in technologies such as vaccines, the spread and validation of falsehoods through denialism, conspiracy theories, and/or obscurantism—primarily disseminated on the Internet and digital social networks without critical formation and scientific literacy—where personal opinions outweigh scientific procedures and validation, the fields of education and science teaching become the most urgent means to combat this crisis. Through problematization, investigation, knowledge construction, scientific literacy, and cultural acclimatization promoted in teaching actions, students can be equipped with evaluative and critical capacities regarding their reality. Thus, interdisciplinary dialogue in different areas of knowledge and teaching is essential for strengthening this teaching and learning proposal.

As identified in the analyzed works, fake news presents real challenges in teaching and learning. Distrust in science results from societal occurrences, where opinions and denialism negatively influence a topic as crucial to education and health as vaccines.

Therefore, it is important to highlight in this study that scientific content about vaccines needs to be prominently featured in the teaching of natural sciences. Currently, they are not central and recurring themes in the BNCC (BRASIL, 2017), the document that guides the national basic education curricula. The absence of such topics in primary education, particularly in its early stages, as well as in early childhood education, contributes to a flawed scientific understanding of vaccines.

Thus, it becomes necessary for students and teachers to deepen epistemological questions about vaccines, as scientific ignorance and misunderstanding can lead to the glorification of common sense and the credence given to false information. In this context, the training of teachers, especially in the area of natural sciences, is emphasized for scientific and critical appropriation, starting from initial training and continuing through professional development.

It is considered that school might be the only access to scientific education for many students. Likewise, students take the knowledge constructed in the school

environment to their homes, their family interactions, and other spaces, serving as a bridge between scientific education and society.

It is understood that vaccination, not just against COVID-19, contributes to collective health. Therefore, educational actions about vaccination are crucial in various societal spheres, especially in education. Thus, it is necessary to consider the reflection that the absence of emphasis on this content in curricula may contribute to false news becoming unquestionable truths. Therefore, the reflections presented in this article apply not only to COVID-19 but also serve as an alert to the necessity of including these contents in curricular frameworks and school practices, as they are subjects under attack from misinformation. Ignorance and lack of critical thinking contribute to the crisis and discrediting of science, becoming obstacles for society.

VACINAS E O ENSINO DE CIÊNCIAS: UMA REVISÃO DE LITERATURA COMO ANTÍDOTO PARA AS FAKE NEWS

RESUMO

No cenário pandêmico da Covid - 19 a Ciência passou por reiterado descrédito, principalmente pelos ataques das chamadas Fake News, cujo um dos alvos foram as vacinas. Entende-se que o ensino de Ciências na promoção do letramento científico, como aparece na BNCC, pode contribuir no enfrentamento das notícias falsas, bem como nos ataques e no descrédito à Ciência. Desse modo, este estudo tem como objetivo trazer uma revisão de literatura na forma de pesquisa documental sobre o atual estado da questão da relação entre as vacinas, o ensino de Ciências e a Educação Básica, como demais problematizações do contexto. Mostra-se o levantamento de artigos no banco de dados do Portal Periódicos CAPES (2005 a 2024) para o mapeamento e análise de como e se as vacinas aparecem relacionadas ao ensino de Ciências. Os aportes encontrados envolvem as reflexões sobre a interdisciplinaridade, desinformação ou Fake News, a baixa cobertura vacinal e a ausência do tema vacinação diretamente relacionada ao ensino ou informações falsas encontradas. Desse modo, com base nos resultados obtidos, entende-se que é necessário trazer como tema central o conteúdo sobre vacinas na Educação Básica, pois a escola é o único acesso de muitos estudantes ao conteúdo científico e a Ciência precisa debater as questões atuais que permeiam a sociedade.

PALAVRAS-CHAVE: Negacionismo Científico. Ensino e Aprendizagem em Ciências da Natureza. Educação Básica.

NOTES

1. Este estudo é fruto da apresentação de trabalho no Simpósio Nacional de Ensino de Ciências e Tecnologia (SINECT, 2022).

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