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SCIENTIFIC LITERACY IN HUMAN SCIENCES: TOWARDS A DIALOGUE

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Abstract

The present study aims to discuss and problematize how close is the relationship between the notion of scientific literacy and school teaching of human sciences by presenting the results of the analysis of 32 articles, focusing on their main contributions, principles, challenges and suggestions that may potentially foster the dialogue between scientific literacy and human sciences. The construction of the analysis was based on a heuristic methodology whose results gave visibility to four general aspects: scientific literacy as a way to qualify human sciences teaching, the strengthening of a vision about school education based on scientific values, the valorization of practices as a place of formative experience and the viability of scientific literacy to be thought of as a social practice.

SCIENTIFIC LITERACY • HUMAN SCIENCES • BASIC EDUCATION

ALFABETIZAÇÃO CIENTÍFICA NAS CIÊNCIAS HUMANAS: O INÍCIO DE UM DIÁLOGO

Resumo

Esta pesquisa propõe discutir e problematizar a aproximação entre a noção de alfabetização científica e o ensino escolar das ciências humanas. Enunciamos os resultados da análise de 32 artigos com o objetivo de extrair as suas principais contribuições, princípios, desafios e sugestões com potencial para fomentar esse diálogo. O método aplicado para a construção da análise foi uma heurística cujos resultados deram visibilidade a quatro aspectos gerais: a alfabetização científica como forma de qualificar o ensino escolar das humanidades, o fortalecimento de uma visão sobre a educação escolar baseada em valores científicos, a valorização das práticas como lugar da experiência formativa e a viabilidade de a alfabetização científica ser pensada como uma prática social.

ALFABETIZAÇÃO CIENTÍFICA • CIÊNCIAS HUMANAS • EDUCAÇÃO BÁSICA

ALFABETIZACIÓN CIENTÍFICA EN LAS CIENCIAS HUMANAS: HACIA UN DIÁLOGO

Resumen

El articulo busca discutir y problematizar el acercamiento entre la noción de alfabetización científica y la enseñanza escolar de las ciencias humanas. Enunciamos los resultados del análisis de 32 artículos con el objetivo de extraer sus principales aportaciones, principios, retos y sugerencias con potencial para fomentar este diálogo. El método aplicado para la construcción del análisis fue una heurística cuyos resultados dieron visibilidad a cuatro aspectos generales: la alfabetización científica como forma de cualificar la educación escolar en humanidades, el fortalecimiento de una visión sobre la educación escolar basada en valores científicos, la valorización de las prácticas como lugar de experiencia formativa y la viabilidad de la alfabetización científica para ser pensada como una práctica social.

ALFABETIZACIÓN CIENTIFICA • CIENCIAS HUMANAS • ENSEÑANZA BÁSICA

CULTURE SCIENTIFIQUE EN SCIENCES HUMAINES: VERS A DIALOGUE

Résumé

L'article vise à discuter et à problématiser la proximité entre la notion de culture scientifique et l'enseignement scolaire des sciences humaines. Il présente les résultats de l'analyse de 32 articles afin d'en extraire les principales contributions, principes, défis et suggestions susceptibles de favoriser le dialogue entre la culture scientifique et les sciences humaines. La méthode appliquée pour la construction de l'analyse a été une méthode heuristique dont les résultats ont donné une visibilité à quatre aspects généraux: la culture scientifique comme moyen de qualifier l'éducation scolaire en Sciences Humaines, le renforcement d'une vision de l'éducation scolaire basée sur des valeurs scientifiques, la valorisation des pratiques comme lieu d'expérience formative et la viabilité de la culture scientifique à être pensée comme une pratique sociale.

CULTURE SCIENTIFIQUE • SCIENCES HUMANINES • ÉDUCATION DE BASE

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THE PRESENT STUDY ADDRESSES THE NOTION OF SCIENTIFIC LITERACY[1] AND ITS APPLICATION to the practices and formative goals of school teaching in human sciences. Despite not being unprecedented, such dialogue has had its interest renewed in the different epistemic communities that constitute the great area of knowledge in question. More recently, this debate has gained new contours based on the contributions of knowledge produced on the subject in different subfields of research and by the expectation expressed by the curriculum base that high school students develop quite diversified skills in the human sciences. Among other aspects, these skills involve reading texts with a critical eye for their sources, proposing and questioning hypotheses, identifying positions and contradictions, producing written materials based on arguments, expressing opinions that articulate information and knowledge, and observing and abstracting concrete and symbolic events.

In current terms, when talking about scientific literacy, one should be careful not to confuse it with scientific education (Santos, 2007), as these are domains that refer to different processes. The intentionality of scientific literacy lies in the development of practices that favor the conversion of school knowledge into good and cultural capital. More than a reference of proficiency or school success, it corresponds to a vision about the schooling process that aims to build the interface between theories, methods, and practices, always aiming at the engagement of learners with their own concrete experience. Being most often used in academic research linked to science didactics, such a notion has varied in meaning over time. Diáz (2018, pp. 20-21) emphasizes that, at first, the perspective of scientific literacy was very much identified with the description and mastery of scientific content, and its evaluation was based on comparisons measured by benchmarks.

According to Sasseron and Carvalho (2011), it was no sooner than the 1990s that debates on the theme began to consider scientific literacy as a set of actions capable of enhancing the analysis, understanding, and explanation of what happens in nature, in the individual, in society, in cultural practices, in politics, etc. From then on, studies have presented a variety of competencies and skills that have become part of the reflection on scientific literacy and its execution and measurement. For some, it is the ability to read, listen and speak, for others to think critically and engage.

Even if the purposes vary depending on the context of application of the research, the literature brings the message that scientific literacy qualifies basic schooling, not only by preparing for further steps, but also by establishing the necessary dialogue between the sciences that are in the curriculum and society, stimulating the use of scientific languages in everyday situations in a critical and socially responsible way. It is a joint operation between the acts of reading, writing, analyzing, problematizing, arguing, debating, and taking a stand. In this sense, Duschl (2008, p. 286) states that the decision about "what counts" as scientific literacy is more important than the simple expression of generic proficiency indicators.

In our understanding, there is an inevitable approximation between the notion of scientific literacy and the teaching of human sciences in school, given a certain current consensus that this teaching – disciplinary or not – can be more than a simple description of different categories, concepts, themes and worldviews, if, beyond a certain dogmatism, it hybridizes scientific content and activist knowledge, with a view to helping recompose a fragmented world, stimulating an expanded conception of citizenship. And this must be found in the very basis of education and, notably, in its strategies, methods and practices.

1 The term "scientific literacy", according to Vizzoto and Pino (2020, p. 5), as cited in Laugksch (2000), appeared for the first time in the international educational context in the article "Scientific literacy: Its meaning for American schools", by Paul D. Hurd (1958), published in Educational Leadership journal.

The scope of our study is to debate potential ways to consolidate this expectation. For this, we conducted a bibliographic analysis focused on international research about the theme, trying to find scientific literacy practices and experiences regarding human sciences teaching and investigate its premises, methodological details and results, identifying the principles associated with the nature, the content and the impact of this science on society.

Methodology

Data collection was performed through the electronic scientific library Education Resources Information Center (Eric), where we found studies published in international journals between 2015 and 2020 on scientific literacy in humanities in school education corresponding to the last four years of elementary school and high school. We proceeded to rationalize the semantic search based on queries that adopted command lines composed of keywords chosen to find the desired results. The search was carried out in three stages, the first of which focused on the following terms: *scientific literacy*; *disciplinary literacy*; *indicators of scientific literacy*; *literacy skills*. The second search was refined by combining the previous terms with others: *human and social sciences*; *social studies*; *humanities*. Finally, we proceeded to a more specific search using the subject names, adding to the main keywords terms such as: *history*; *geography*; *sociology*; *philosophy*.

Overall, the combinations between the keywords produced 28 command lines, which gave us 58 results. We then clipped this sample based on the criteria "relevance" and "peer review" to select what would enter the final analytical base, a process that resulted in a sample of 32 publications in 23 international scientific journals. We emphasize that these two criteria were measured by Eric library's own search engine metrics. The method applied to construct the analysis and the conclusions presented was a heuristic based on a descriptive exercise that sought both to extract from the findings their main contributions, correlations and domains, and to perceive the general principles for scientific literacy in human sciences, concerned with helping the learning process from the integration of aspects of the scientific "method" into teaching. The results were discussed considering the contributions by Duschl (2008), Berland and Hammer (2012), Ford (2015), Stroupe (2015), Jiménez-Aleixandre and Crujeiras (2017), and Kind and Osborne (2017).

Results

Regarding the transmission of knowledge, Spires et al. (2018) argue that deep reading comprehension must go through a movement related to identifying sources, understanding visual representations, and using figurative languages, rhetoric, and deconstructing narratives. For scientific literacy in human sciences, there is a shared understanding that the skills associated with working with sources – such as seeking information, contextualizing it, and producing arguments – encourage students to ground the ideas they launch in their textual productions and encourage them to check and confront various pieces of evidence on the same subject. In this sense, knowing how to work with sources is the cornerstone of the reading practices, seeking a dialectic that involves readers with the authorship and the sources of the materials, inquiring about positions and interests.

Wineburg and Reisman (2015) argue that students need strategies to decode the texts they read, emphasizing that this would be insufficient if we consider that the focus of elementary schooling is preparation for citizenship. The authors discuss how guided reading practices can help restore students' agency. Regarding History, Wineburg and Reisman (2015, p. 636) consider that the movement of scientific literacy is, par excellence, knowing how to work with sources and references, and suggest that this work provides a broader worldview, which they call *Weltanschauung*, i.e.,

a radical way of learning to read the world. In this direction, Duhaylongsod et al. (2015, p. 591) suggest the use of an original theory, entitled theory of change, whose approach is centered on qualifying the discussions held in the classroom to promote three skills similar to those used by historians: considering the social perspective, always thinking of the other, understanding academic language, and developing complex reasoning, following and formulating logical arguments, making analyses, syntheses, and evaluations.

Despite being complex, such skills can contribute to purposeful reading practices and expository writing, and, according to De La Paz et al. (2017), to expand students' cultural capital when they are taught about human sciences. Mainly focused on metacognition, this study analyzed literacy practices that used instructional strategies to enhance the construction of historical arguments in students' written productions. During instruction, each phase was provided with controlled and conditioned references with reading and writing indicators that allowed the observation that part of the difficulties in substantiating arguments lies in the understanding of cause and effect of events in the past. In this sense, the authors suggest practices that consider establishing goals for reading, analyzing and planning the text produced based on contextualizing the primary sources, identifying the components and structure of the arguments, considering the evidence and claims, planning the style of the text, and discussing and evaluating such evidence.

Swanson et al. (2016) draw attention to reading comprehension strategies used before, during, and after the process, considering that, although many strategies can be used, usually teachers ask students to read and summarize read sections and then give some explanation. Park (2016, p. 36) argues that critical historical thinking literacy allows students to learn to interpret and evaluate the world in which they live, as it can help them see through texts, that is, how they are socially and ideologically constructed. To this end, the author suggests that the following indicators should be observed: understanding the differences and contradictions between texts, understanding who wrote and where the sources come from, identifying the social, political, and cultural contexts of the sources, and identifying the agents historically involved in the situations studied. Park (2016) suggests some aspects for working on scientific literacy, including: expanding what counts as historical text and choosing sources that have identifiable authorship, developing language to talk about the differences between what the event is and what the stories told about the event are, exploring with students the differences between historical literary genres, asking questions about the origin of sources, encouraging research in other sources such as newspapers and social media, and considering argumentation in assessment.

Learned (2018) argues that scientific literacy practices can provide elements for students to think critically about the texts they are subjected to, comparing perspectives across socio-historical periods and thinking about their place in history and society. To see how students made sense of texts, reading through sources to answer historical questions, the author used general literacy strategies regarding scientific literacy as a guide, elaborating the following questions: What question are you trying to answer? What information is provided by the document? What are your inferences or conclusions? What evidence supports your argument? How did this event impact the story? What is your opinion about the reading?

Meloche et al. (2020) discuss the critical evaluation of reading sources used in social studies classes. The study analyzes the strategies mobilized by students from an elite school to find out how they deal with this demand. After applying some tests to understand how students evaluate their sources, the authors concluded that, in general, there is a reluctance to question the legitimacy of what is read, reinforcing the concern of teachers regarding the excess of information accessed in an uncritical way. The tests aimed to reveal what was timeless regarding the information, the importance of the information, the source, the reliability, truthfulness and accuracy of the

content, and the reason why that information exists. The study demonstrated three relevant points: persistence of uncritical evaluation of sources, recurrence of unreliable sources, and absence of critical conversations about race and racism. On the latter, Meloche et al. (2020, p. 191) point out that "critical literacy provides an excellent perspective for discussing how voices are privileged – or underprivileged – in textual sources".

As for writing, Newman and Rosas (2016, p. 54) suggest that it is essential to measure the students' involvement with interdisciplinarity in human sciences, allowing them to take on the role of performers and creators of productions, practices and communications that express relevant characteristics of the area of knowledge being addressed. The authors emphasize that, being a doer means to evoke the commitment to overcome the superficiality of the facts and the skills required. Moreover, the researchers point out that vocabulary acquisition is a very useful component in thinking about ways to improve writing and reading comprehension. Regarding vocabulary use, Swanson et al. (2016, p. 215) draw attention to the quality of contextualization and morphology.

Jaeger (2016) discusses how to cultivate the sociological imagination in the context of evidence-based argumentation. The author argues that curricula generally include critical reading and argumentative writing as learning goals, however, in practice, this does not always happen. The researcher suggests that cultivating the sociological imagination as a form of understanding can help students perceive the social structures that shape their lives. Jaeger (2016, p. 105) instructed learners sociological imagination, administered tests, and then interviewed high school students to see how they develop writing and evidence-based argumentation. The results showed that students who participated in the research demonstrated insight into the sociological imagination, and 8 out of 10 were able to write productions with solid arguments, with emphasis on opinions regarding otherness and citizenship.

Maddox and Saye (2017) investigated writing in human sciences under the perspective of hybrid assignments and how they support students in demonstrating historical thinking skills and focus on decision making regarding social issues. The authors argue that authentic tasks, i.e., those requiring students to construct knowledge using more elaborate processes to answer a problem would be the answer. The idea is that, through this type of task, students perceive and incorporate real issues are challenged to demonstrate their knowledge, eventually sharing their thoughts through writing. The authors claim that these hybrid tasks demonstrate how historical narratives are constructed while also developing analytical and reasoning skills applied to citizenship issues, and recommend that literacy practices use guides, with hints and suggestions about what to incorporate into each part of the text, to serve as scaffolding to help students achieve the complexity involved.

Discussing how geography curriculum can enhance scientific literacy, Xuan et al. (2019) define it based on four aspects: disciplinary knowledge, which refers to facts, concepts, principles, laws, hypotheses, theory, and models, inquiry, which refers to the skills of analyzing and evaluating information to project conclusions, application and connection, which refer to the personal use of science as a way of knowing, and values and attitudes, which refer to worldview, emotions, personal motivations, and engagement in moral and ethical issues.

Lawrence et al (2019) discuss how to design scientific literacy practices that are engaging and contribute to historical research, emphasizing the role of primary sources and the incorporation of inquiry-based teaching and problem solving. They argue that inquiry-centered learning situations ensure greater student interaction with authentic resources and materials, rather than traditional textbooks and handouts. Cowgill and Waring (2017) assessed the ability of students and teachers in an American high school to analyze primary historical sources. For this, the authors adapted the historical problem-solving method developed by Sam Wineburg (1991), aimed at measuring analytical ability from reading historical images and documents.

Cowgill and Waring (2017) analyze how individuals select and construct meaning from sources and the extent to which they can contextualize, corroborate, and read sources carefully. The authors critique the training of teachers by identifying in them the difficulty of engaging in in-depth analysis of historical sources, which may explain some of the students' difficulties. They reinforce that literacy should be concerned with developing and deepening ways of analyzing images and aspects, improving engagement with written documents, and stimulating content, assessments, and procedures.

In a complementary direction, Meydan (2017) discusses the importance of skills and abilities developed in science projects for students to learn under a scientific geography perspective. Although human science projects are not common in science fairs, they represent great mediators of interdisciplinary issues, especially if the goal is to think about issues involving the relationship between nature and society. Anyanwu and Le Grande (2017), in studying geography teachers in Cape Town, South Africa, reinforce that knowledge of processes, causality, and possible responses to the problem are pillars of scientific literacy in human sciences.

This corroborates Middaugh (2019), who analyzed the role of media in the dissemination of fake news, the capacity for discernment, and the impact of misinformation on young people's engagement in social and citizenship issues. The author presents a critical approach towards the dissemination of inaccurate or unbiased information and how this has fueled what she called the language of indignation, that is, the apprehension that, when faced with civic situations, young people have given more emotional responses than evoked scientific knowledge. Middaugh (2019) presents a broad definition of youth civic engagement as something to be developed by acquiring social engagements and relationship skills that allow one to balance attention to emotional elements when debating social issues in the digital world.

Horn and Veermans (2019) discuss, under the perspective of social sciences and education, how critical thinking can be converted into skills to avoid belief in fake news on Facebook. Taking high school students from a Finnish international school as subjects of the study, the authors applied a test developed at Stanford, which is based on five aspects: analysis of the strength of arguments in a Facebook news story, presentation of other similar sources, determination of the strongest argument, evaluation of evidence, and comparison with other sources. The overall conclusion is that the use of critical thinking in Finnish students is worrisome, because the ability to reason about information collected on the internet is not verified.

Gleason (2018) investigated how young people think and communicate on social media. His research is interesting for thinking about literacy indicators in human sciences and social sciences, because it reveals some clues about how young people socialize in activities carried out in the digital context, especially on Twitter. The author reinforces that thinking from hashtags can help young people to re-signify some skills, such as recognizing cultural practices, knowing how to deal with different cultural productions, establish interpersonal relationships, learn to relate in emerging contexts, develop public practices and increase metacognitive awareness.

In the same direction, Cataldo et al. (2019) question what happens when students evaluate science news resulting from their Google searches. The current debate about the integrity and credibility of news creates the need to pay attention to how young people evaluate the results of their research. The authors analyzed the different processes involved in the search for resources and information, using a methodology that involved 116 students in simulations and tasks about scientific news. The study sought to understand what the search behavior would be, how the students considered the resources and sources (useful, quotable, and reliable), and whether it was reliable news. The results demonstrated that, in most cases, high school students were likely to find reliable news sources. The problem lies in the lack of citation of the resources and in the evaluation of their credibility.

Additionally, Hintermann et al. (2020) suggest that geography education can play an important role in providing students with some tools that aid social navigation in a highly media-driven world, where the flow of information, entertainment, and advertising offers itself as reliable knowledge. At this point, scientific literacy in the humanities and social sciences is intertwined with a media literacy, since the very media consumed by young people subvert the knowledge of geography, history, sociology, etc. Analyzing a project with Austrian students, the authors (2020, p. 124) argue for geographic literacy as an active pursuit of three basic aspects: problem solving and decision-making from the interpretation of geographic analyses, technologies, and representations, understanding that cultures and identities are deeply connected to the physical and human characteristics that define places and regions, and the notion that spatial patterns on the planet suffer from the action of humans.

Regarding this possibility, Siegner and Stapert (2019) emphasize the importance of interdisciplinarity, questioning the lack of a more holistic approach, highlighting the contribution that human sciences can make on other themes. The authors examined over the course of a year, some practices to teach climate change through the integration between human sciences and science curricula. They argue that the application of human science tools in climate change literacy is essential to humanize the discussion through stories, narratives, critical thinking, and other knowledge strategies.

Lorimer (2018) discussed the challenge of getting students with reading difficulties or reluctance to read and learn from history and social science texts. Building on the notion of engagement, the author suggests the use of critically supported simulations as a literacy strategy, as they allow for position-taking, risk-taking, communication of thoughts, and opportunities to ask questions. This active and collaborative methodology is consistent with the curricular goals of history and social science education, which prioritize experiences designed to foster critical thinking. In this sense, examining the results that emerge from simulations is fortuitous to experience that the construction of knowledge and meaning is a socially and individually active process. Moreover, knowledge construction is fostered by authentic, real-world environments and students' self-regulation, which happens in a self-mediated and self-conscious manner. The conclusion is that in order to mitigate the gap between engaged learning and textbook-based instruction in history and social sciences, teachers should consider the benefits of interactive experiences with primary source documents, such as decision-making simulations.

Emran et al. (2020) advocate for understanding the concept of "nature of science" as a common thread in developing scientific literacy among students. The study questioned some students at a school in Israel to find out their perceptions of the nature of science. Based on a questionnaire that examined seven constructs that underlie perceptions about the nature of science (theory load, creativity and imagination, experimentality, durability, coherence and objectivity, science for girls and science for boys), the results presented by Emran et al. (2020, p. 249) indicated that, despite notable differences in perceptions regarding these constructs, greater importance was given to subjective constructs – those that express the uncertain, flexible, and subject to interpretation nature that mark scientific work – than to coherence constructs, which are those that imply the stable nature of science. Two other important findings were that both boys and girls are able to engage with scientific work and that cultural capital influences perceptions about science.

Yacoubian (2018) argues that scientifically literate citizens would be better able to engage in social issues and make science-based decisions. In his study, the author discusses the importance of school curricula to reinforce this attribution, and the need for the elucidation of some fundamentals to incorporate the principles of a science education with a view to democracy. His approach moves towards the development of learning situations that promote experiences in which ideologies

and narratives are critically discussed and reflected upon without taboos or censorship, through the practice of deliberative discussions. The author (2018, pp. 321-322) adds that science-based education for decision making on social issues must consider two actions. First, it should provide ample possibilities for experimentation, based on practices that involve relevant social issues to be thought about scientifically. Second, it should encourage the development of deliberative practices, with emphasis on critical thinking, valuing equality and social justice.

Burke et al. (2016) advocate the use of critical geography to promote students' critical engagement with public spaces. From the analysis of images and maps, they problematized the students' life experiences, arguing that they would be sources of knowledge to question inequalities. Thus, the authors regard geography as an educational tool to foster critical thinking, autonomy, allowing the use skills and knowledge to think about changes in urban spaces. In this case, literacy emerges as a potential tool for thinking about and intervening in local issues. Burke et al. (2016, p. 156) asked young people to take photos, collect information, and study maps to tell the stories of their neighborhood. The results of such interventions demonstrate that the students recognize the importance of a sense of community and are aware of their own failures to foster it.

The results provided by Burke et al. (2016) relate to Vargas and Erba's (2017) analysis of a university project aimed at educating high school students, children of Latin workers, about cultural and citizenship issues. The action started from a radio station, aiming to improve social skills, civic awareness, and respect for cultural differences, and made noticeable how much the development of self-confidence, self-esteem, and emancipation was related to the permanence of the participants in the project. The different programs made for the radio were intended to develop knowledge on fundamental the human sciences issues, such as culture, ethnicity, class, immigration, oppression, prejudice, discrimination, racism, etc.

Vargas and Erba (2017, p. 209) investigated the literacy epistemology offered by the project from the development of four dimensions of cultural competence: cultural awareness, cultural knowledge, cultural skills, and cultural practice. The authors concluded that the production of radio programs allowed participants to acquire cultural skills by developing something focused on informing the community, as well as providing knowledge and experiences that helped to value diversity in society.

Kucan et al. (2018) argue that knowledge of local history is a fundamental part of successful literacy. The backdrop is engagement through research on historical issues that are culturally relevant to the subjects. Students were engaged in research with qualified resources, whose orientation was to provide an understanding of the structure of the unit, raise questions about the place, contextualize the unit, offer the opportunity for synthesis and discussion, provide information, provoke position--taking and defense of differing viewpoints, provoke critical reading of texts, learn about citizenship and participation, and think about practical uses of the knowledge and evaluate its relevance. Finally, the interconnection of such aspects was found to provide students with opportunities to present their claims, defend them, and apply knowledge in real world situations, approaching the work of historiography.

Gadsden et al. (2019) draw attention to issues associated with students' civic knowledge, especially when they require association with identity-related themes (ethnicity, race, class, and gender). The qualitative study presents four narratives of young black men from a public high school to reflect on how learning can encourage them to investigate and evaluate their personal experiences. The central question is to assess the possibility of literacy on sociopolitical and identity issues. In the same study (2019, p. 85), the authors describe that interviews with young people show that their knowledge about sociocultural issues comes from their own experiences in communities, schools, and public spaces, and that discussions held in investigative learning situations increase

their understandings of historical, social, and political dimensions, sharpening their analyses of the structures that perpetuate inequalities.

After discussing some questions about social structures and civic knowledge, the researchers concluded that these students' testimonies demonstrate that life history can foster engagement in social issues, political participation, questioning privilege, criticism of marginalization and racism, and the evaluation of one's own actions in relation to change. An (2020) moves in the same direction, the author analyzes her own daughter's school productions to question so-called white social studies, problematizing the way racism and racial issues are addressed by the discipline of history. The study addresses the development of a racial culture in school teaching, drawing attention to four important aspects to think about literacy: the sense of belonging, the perception of invisibility, the questioning of hegemonic whiteness, and the interruption of normative narratives.

This is a challenging issue for critical literacy in human sciences. With it in scope, Wilder and Msseemmaa (2019) begin their reflection by saying that all students deserve educational practices that offer texts and reflections that help them deepen their awareness of mechanisms of oppression and inequalities, and that scientific literacy is a fruitful avenue for this. The study follows a young secondary school student in Tanzania to observe the possibilities of awareness raising from practices oriented towards this. They note that in the Tanzanian context, and considering the entire neocolonial heritage, it is imperative that school education practice a responsive and humanizing pedagogy. For this, the authors suggest a synergistic approach to literacy to broaden students' experience, practice, and participation.

Freirean-inspired, this approach relies on the imbrication of two aspects, the cognitive and sociocultural, as indicators for practices that offer a critical view of power structures, with a focus on raising awareness about the injustices and false narratives that afflict them. Wilder and Msseemmaa (2019, p. 482) conclude from the case of the young student that, even in the face of an unfavorable context, surrounded by colonial vestiges and neocolonial oppression, it was possible to observe traces of critical consciousness and contemplative awareness from literacy. Bearing this overview of evoked scientific literacy in mind, as students' engagement in complex social issues linked to scientific phenomena, Kinslow et al. (2019) sought to assess gains in relation to critical thinking, formal and informal reasoning, decision making, and argumentation. The socio-scientific issue regarding water quality in a local ecosystem sought to ascertain the impact and gains that environmental scientific literacy could bring to the development of critical thinking skills in students in a rural American school. The study constructs its own typology centered on the development of the following skills: complexity, perspective taking, inquiry, and skepticism. Participants responded to two assessment scenarios, one before and one after the course, so that progression and gain could be perceived, in addition to the analysis of portfolios.

Thus, Kinslow et al. (2019, pp. 395-398) demonstrated in what ways and in what hierarchy students used the four competencies in their logs and final statements about the topic, revealing skepticism as the least transformed competency and complexity as the greatest gain. They conclude by saying that there was improvement in the competencies associated with critical thinking about the topic, as well as offering insights into how students were becoming scientifically literate and constructing meanings around the proposed question.

Discussion

The analysis of the studies showed that the nature of scientific literacy in the human sciences is built on five pillars: deep reading comprehension, writing, argumentation and claiming circumstances, relativizing information, cross-cultural awareness, and position-taking. These pillars

unfold into nine skills: extracting important details from the materials studied, synthesizing arguments coherently, understanding the points of view presented, establishing empathy, connecting information and prior knowledge, applying fairness/injustice criteria, generalizing evidence and making distinctions, using dialectical reasoning, and making connections with the real world.

Additionally, regarding the practices, we observed an outstanding concern with the transmission of specific knowledge, i.e., the presentation and discussion of concepts and contents consolidated in school teaching in human sciences, in addition to current themes considered relevant. Also remarkable is the presentation of real situations identified as complex and the encouragement of resolution mediated by the application of theories, the search for and appreciation of interdisciplinarity, the investigative work with the use of methodological resources specific to human sciences and, finally, the rupture of the dichotomy between theory and practice by valuing concrete experiences rather than the simple description of categories and phenomena.

Considering these pillars and concerns, the formation emerging from objective research regards not only mastering conceptual tools, but also requalifying the purpose of teaching and strengthen a vision of value-based school education and consolidate practices as formative experiences. This suggests the problematization of the classic opposition between subjectivism and objectivism in educational action, in the sense of creating learning situations centered on planning practices and building a dense culture of human sciences, guided by the connections between the world in which the learners live and scientific knowledge. Regarding the notion of practice used in this article, we start from the understanding that it involves problematizing activities mediated by scientific approaches and the specific knowledge necessary to foster reflections on the teaching and learning process, critical thinking and values linked to citizenship (Duschl, 2008; Jaeger, 2016).

Ford (2015, pp. 1041-1042) also reinforces the idea of practices as a guiding goal of scientific literacy. He says that in school education, "it is out of reach to think and act scientifically as scientists do", yet it is admitted that developing practices can foster "powerful ways of reasoning and acting that capture what is particular about science – ways of reasoning and acting that develop reliable knowledge statements". At this point a decisive question arises, which is to know what is being called scientific in the context of basic schooling. There are variations on this theme in the literature, but most of them deny a type of "scientific method" that intuitively directs the learner toward the truth. According to Ford (2015), this is a point of attention to avoid the naturalization of the epistemic privilege of science and its overvaluation in relation to other languages and formal and non-formal knowledge.

On this subject, Jiménez-Aleixandre and Crujeiras (2017, pp. 71-75) pose two questions that are important for reflection on the limits and possibilities of scientific literacy in basic education: How can we promote student participation in the epistemic goals of science? How are scientific practices carried out in the classroom? To answer the first, the authors state that, in addition to conceptual concerns, attention must be paid to the epistemic details and the social dimension of education. Thus, there is emphasis on the notion of practices, providing a view of science as a set of procedures mediated by a discourse of construction of scientific knowledge from its social interaction, promoting rationality and critical thinking. Regarding the second question, the authors state that school programs need to engage students through investigations, reflections, and practices.

More than a description of social phenomena or approach to common sense problems, what we saw was an arc of investigations that pose the question of acting. Still on acting, there is the understanding that we can conceive of forms of instruction that offer a kind of intellectual power and skills that allow for the recognition of social problems, the evaluation of causes and correlations, the development of positions, argumentation, the debate of ideas, and the taking of positions. And

this is what allows us to visualize the image of scientific literacy in human sciences as a practice guided by critical and ethical thinking and the possible engagement in social and citizenship issues, constituting a fruitful path for human sciences as activist knowledge.

Duschl (2008, p. 286) emphasized that scientific literacy can also be understood as a cultural practice, provided that it balances the three learning objects – conceptual, epistemic and social – and that it is possible to legitimize a teaching about "how" and "why" rather than a teaching about "what". The argument is that these different learnings must be interwoven and occur simultaneously during teaching and learning processes, a fact that requires new forms of knowledge to be brought into classroom discussions.

The idea that scientific literacy is mediated by conceptual, epistemic and social aspects is critical for our reflection about human sciences, since it brings light on how to structure the moments of the practices, always seeking the creation of interfaces between cognitive processes, resources, strategies, attitudes and evaluation, favoring the most adequate contextualization of how knowledge is communicated, represented, engaged and debated.

Considering that students can be evaluated as scientifically literate when their knowledge, skills and attitudes provide them with a certain autonomy of thought, ground their communication and favor their engagement with social, ethical, political and cultural issues, it is possible to deduce two aspects: on the one hand, we have to think about indicators that can measure the expectation *versus* the reality of the learning situation. On the other hand, we should reflect about attributes that are thought and expected for the intellectual development of students' critical thinking.

Berland and Hammer (2012, p. 90), when discussing "when" and "why" students engage in argumentative practices that demand their scientific knowledge, draw attention to the need for epistemological vigilance in the structuring of practices, given the imminence of what they categorize pseudo-argumentation, name given by the authors to the moment when the results of education are expressed more in line with teachers' expectations than as knowledge construction. On students' ability to develop and evaluate arguments, i.e., the distinction between procedural display (doing the lesson) and scientific dialogue or argumentation (doing science), Jiménez-Aleixandre et al. (2000, p. 783) analyze students' conversations about some scientific content, observing, for example, epistemic operations, use of analogies, causal relationships, and appeal to reasoning, and concluded that what is essential for argumentation "is the movement from evidence to explanation", reinforcing the concern about "what counts" as explanation.

Some of our findings revealed the difficulty of making the students' involvement less superficial, suggesting that the way of instructing and including students should provide opportunities to search for new information, always accompanied by the knowledge that evokes the learning process. To improve the understanding about the idea of scientific reasoning in school education, Kind and Osborne (2017) recover the debate about the inclusion of science disciplinary work and its prominence in contemporaneity. However, the authors remark that it is necessary to know "what we want" with it.

The study shows how the emphasis on content, problems in formative assessment, the misplaced demands of large-scale external assessments, accountability policies and the lack of more coherent learning objectives have contributed to weaken the use of science as a language in school. For the authors, the result is a substantial gap between the goals of science education and the reality of classrooms, so that both science and students suffer (Kind & Osborne, 2017, p. 1).

Kind and Osborne (2017) criticize studies that have belittled and distorted the achievements of the sciences "from" and "in" school by downplaying scientific work, creating obstacles to its achievement and possible cultural contribution. For the reasons previously presented, the authors

argue that there is no way to think of a single way of reasoning in the sciences, which suggests greater vigilance to avoid simplifications.

According to Stroupe (2015, p. 1036), it is critical to avoid memorization of information and to value individual particularities, because just exposing students to the definitions of scientific practice or observing the performance of activities aimed to reproduce the canon, "is not the same as offering opportunities for students to learn the scientific practice, engaging in the authentic disciplinary work over time". Thus, when thinking of science as a language, scientific literacy would be the moment to restore the interlocutor's agency, i.e., to go beyond a self-enclosed reading, pushing the reader to seek new sources and references, stimulating the contextualization of what is read and learned.

For this reason, Diáz (2018, p. 20) advocates a change of mentality that considers scientific literacy as a school mission to make society literate, given the consideration that "democracy needs citizens who understand scientific and technological problems to be able to choose between different projects of society presented by different political options". This argument corresponds to the perception of Sasseron and Carvalho (2011, p. 75, own translation) that, over the years, there has been a growing concern to strengthen scientific literacy in basic education, supported by the "emerging need to train students to act in today's society, largely surrounded by artifacts of scientific and technological society". This synthesizes well the discussion about the social perception of science, which simultaneously reinforces the contemporary challenge of operationalizing and validating scientific literacy in basic education.

Final considerations

The rationality pervading the contemporary educational debate in Brazil has relativized human sciences in basic education, which places a question mark over the continuity of human sciences teaching in the medium and long term. However, despite all the difficulties that this circumstance creates, the discipline still has a place as a curricular component. Moreover, it is considered to aid the development of a language that blends scientific and academic knowledge with attitudes and engagement, in order to mediate the reading of the world and the concrete public and private experiences of those who study them. That is, we talk about a way of teaching and learning with a view to the social-scientific use of school knowledge, mediating the relationship between education, science, and citizenship, and consolidating a particular notion of school success. It is in this direction that much scientific/academic research has been done.

However, to imagine a "social use of school knowledge", we must consider the meanings that school and the act of learning itself have for students. Therefore, we should not eliminate from the discussion about scientific literacy the sociological question of "how" learners relate to knowledge. This is a key point, because, besides encompassing psychological, cultural, and social factors of an individual's success or failure at school, it also allows us to question what knowledge is essential for life and who decides this. For this reason, to argue what indicates that a certain subject has appropriated a language or objects of knowledge, indicators are not enough. We must also put into perspective the meaning and competence to consider how the individual perceives his or her own learning, which may refer to life history, expectations, access and privileges, etc.

If learning is conceived as the mastery of an activity engaged in the world that cannot be separated from practice, from activity, from mastery, much less from the symbolic, the relationship to knowledge is never abstract. We could see that scientific literacy in the humanities sees the possibility of contributing to a changing world, where its notion meets citizenship and social inclusion via scientific knowledge. However, to evaluate its desired effects is extremely difficult and depends not

only on the way teaching is done and practices are performed, but also on the socioeconomic and cultural conditions of those who learn, the structure of schools and the training of teachers, among many other variables.

References

An, S. (2020). Learning racial literacy while navigating white social studies. *The Social Studies*, *111*(4), 174-181. https://doi.org/10.1080/00377996.2020.1718584

Anyanwu, R., & Le Grange, L. (2017). The influence of teacher variables on climate change science literacy of geography teachers in the Western Cape, South Africa. *International Research in Geographical and Environmental Education*, *26*(3), 193-206. http://dx.doi.org/10.1080/10382046.2017.1330039

Berland, L. K., & Hammer, D. (2012). Framing for scientific argumentation. *Journal of Research in Science Teaching*, *49*(1), 68-94. https://doi.org/10.1002/tea.20446

Burke, K. J., Greene, S., & McKenna, M. K. (2016). A critical geographic approach to youth civic engagement: Reframing educational opportunity zones and the use of public spaces. *Urban Education*, *51*(2), 143-169. https://doi.org/10.1177%2F0042085914543670

Cataldo, T. T., Langer, K., Buhler, A. G., Putnam, S. R., Elrod, R., Faniel, I. M., Connaway, L. S., Cyr, C., Brannon, B., Valenza, J. K., Hood, E. M., & Graff, R. A. (2019). Science and news: A study of students' judgments of online scientific news information. *Issues in Science and Technology Librarianship*, (93). https://doi.org/10.29173/istl25

Cowgill, D., & Waring, S. (2017). Historical thinking: An evaluation of student and teacher ability to analyze sources. *Journal of Social Studies Education Research*, *8*(1), 115-145. https://files.eric.ed.gov/fulltext/EJ1141860.pdf

De La Paz, S., Monte-Sano, C., Felton, M., Croninger, R., Jackson, C., & Piantedosi, K. W. (2017). A historical writing apprenticeship for adolescents: Integrating disciplinary learning with cognitive strategies. *Reading Research Quarterly*, *52*(1), 31-52. http://www.jstor.org/stable/26622577

Diáz, M. J. G. (Ed.). (2018). *Alfabetización científica en la escuela: Propuesta de una nueva metodologia*. Unesco. http://hdl.handle.net/10261/171151

Duschl, R. (2008). Science education in three-part harmony: Balancing conceptual, epistemic, and social learning goals. *Review of Research in Education*, *32*(1), 268-291. https://doi.org/10.3102%2F0091732X07309371

Duhaylongsod, L., Snow, C. E., Selman, R. L., & Donovan, M. S. (2015). Toward disciplinary literacy: Dilemmas and challenges in designing history curriculum to support middle school students. *Harvard Educational Review*, *85*(4), 587-608. http://dx.doi.org/10.17763/0017-8055.85.4.587

Emran, A., Spektor-Levy, O., Tal, O. P., & Assaraf, O. B. Z. (2020). Understanding students' perceptions of the nature of science in the context of their gender and their parents' occupation. *Science & Education*, *29*(2), 237-261. https://doi.org/10.1007/s11191-020-00103-z

Ford, M. J. (2015). Educational implications of choosing "practice" to describe science in the next generation science standards. *Science Education*, *99*(6), 1041-1048. https://doi.org/10.1002/sce.21188

Gadsden, V., Johnson, W. F., & Rahman, S. (2019). Civic knowledge, engagement, and participation narratives of youth of color in urban schools. *Peabody Journal of Education*, *94*(1), 78-96. https://doi.org/10.1080/0161956X.2019.1553585

Gil Pérez, D., & Vilches Peña, A. (2006). Educación ciudadana y alfabetización científica: Mitos y realidades. *Revista Iberoamericana de Educación*, *42*(1), 31-53. https://doi.org/10.35362/rie420760

Gleason, B. (2018). Thinking in hashtags: Exploring teenagers' new literacies practices on twitter. *Learning, Media and Technology*, *43*(2), 165-180. https://doi.org/10.1080/17439884.2018.1462207

Hintermann, C., Bergmeister, F. M., & Kessel, V. A. (2020). Critical geographic media literacy in geography education: Findings from the MiDENTITY Project in Austria. *Journal of Geography*, *119*(4), 115-126. https://doi.org/10.1080/00221341.2020.1761430

Horn, S., & Veermans, K. (2019). Critical thinking efficacy and transfer skills defend against 'fake news' at an international school in Finland. *Journal of Research in International Education*, *18*(1), 23-41. https://doi.org/10.1177%2F1475240919830003

Hurd, P. D. (1958). Science literacy: Its meaning for American schools. *Journal of the Association and Supervision and Curriculum Development*, (13-52). http://edcipr.com/wp-content/uploads/2016/09/Hurd_1958_Science-literacy.pdf

Jaeger, E. (2016). Authors and citizens: Sociological imagination and the writing of evidence-based argument. *Literacy*, *50*(2), 100-109. https://doi.org/10.1111/lit.12078

Jiménez-Aleixandre, M. P., & Crujeiras, B. (2017). Epistemic practices and scientific practices in science education. In K. S. Taber, & B. Akpan (Eds.), *Science education: New directions in mathematics and science education* (pp. 69-80). Sense Publishers. https://doi.org/10.1007/978-94-6300-749-8_5

Jiménez-Aleixandre, M. P., Bugallo Rodríguez, A., & Duschl, R. A. (2000). "Doing the lesson" or "doing science": Argument in High School Genetics, *Science Education*, *84*(6), 757-792. https://doi.org/10.1002/1098-237X(200011)84:6<757::AID-SCE5>3.0.CO;2-F

Kind, P., & Osborne, J. (2017). Styles of scientific reasoning: A cultural rationale for science education? *Science Education*, *20*(10), 1-24. https://doi.org/10.1002/sce.21251

Kinslow, A. T., Sadler, T. D., & Nguyen, H. T. (2019). Socio-scientific reasoning and environmental literacy in a field based ecology class. *Environmental Education Research*, *25*(3), 388-410. https://doi.org/10.1080/13504622.2018.1442418

Kucan, L., Rainey, E., & Byeong-Young, C. (2018). Engaging middle school students in disciplinary literacy through culturally relevant historical inquiry. *Journal of Adolescent & Adult Literacy*, *63*(1), 15-27. https://doi.org/10.1002/jaal.940

Lawrence, S., Langan, E., & Maurer, J. (2019). Using primary sources in content areas to increase disciplinary literacy instruction. *Language and Literacy Spectrum*, *29*(1). https://digitalcommons.buffalostate.edu/lls/vol29/iss1/1

Learned, J. E. (2018). Doing history: A study of disciplinary literacy and readers labeled as struggling. *Journal of Literacy Research*, *50*(2), 190-216. https://doi.org/10.1177%2F1086296X17746446

Lorimer, M. R. (2019). Engaging adolescent struggling readers through decision-making role-play simulation: Using primary source documents. *Reading & Writing Quarterly*, *35*(3), 193-203. https://doi.org/10.1080/10573569.2018.1523029

Maddox, L., & Saye, J. (2017). Using hybrid assessments to develop civic competency in history. *Social Studies*, *108*(2), 55-71. https://doi.org/10.1080/00377996.2017.1283288

Meloche, A., Lee, V. J., Grant, A., & DeCarlo, M. J. T. (2020). Critical literacy as a lens for students' evaluation of sources in an AP World History Class. *Social Studies*, *111*(4), 189-204. https://doi.org/10.1080/00377996.2020.1727828

Meydan, A. (2017). The contribution of scientific project competitions upon high school students' acquiring a scientific viewpoint (Geography Lesson Case). *Journal of Education and Learning*, *6*(2), 294-304. http://doi.org/10.5539/jel.v6n2p294

Middaugh, E. (2019). More than just facts: Promoting civic media literacy in the Era of Outrage. *Peabody Journal of Education*, *94*(1), 17-31. https://doi.org/10.1080/0161956X.2019.1553582

Newman, B. M., & Rosas, P. (2016). Opening the door for cross-disciplinary literacy: Doing history and writing in a high school to university collaboration. *English Journal*, *106*(2), 54-61. http://www.jstor.org/stable/26450209

Park, J. Y. (2016). "He didn't add more evidence": Using historical graphic novels to develop language learners' disciplinary literacy. *Journal of Adolescent & Adult Literacy*, *60*(1), 35-43. https://doi.org/10.1002/jaal.521

Santos, W. L. P. (2007). Educação científica na perspectiva de alfabetização como prática social: Funções, princípios e desafios. *Revista Brasileira de Educação*, *12*(36), 474-492. http://dx.doi.org/10.1590/S1413-24782007000300007

Sasseron, L. H., & Carvalho, A. M. P. (2011). Alfabetização científica: uma revisão bibliográfica. *Investigações em ensino de Ciências*, *16*(1), 59-77. http://www.if.ufrgs.br/ienci/artigos/Artigo_ID254/v16_n1_a2011.pdf

Siegner, A., & Stapert, N. (2020). Climate change education in the humanities classroom: A case study of the Lowell school curriculum pilot. *Environmental Education Research*, *26*(4), 511-531. https://doi.org/10.1080/13504622.2019.1607258

Spires, H. A., Kerkhoff, S. N., Graham, A. C. K., Thompson, I., & Lee, J. K. (2018). Operationalizing and validating disciplinary literacy in secondary education. *Reading and Writing*, *31*(1), 1401-1434. https://doi.org/10.1007/s11145-018-9839-4

Stroupe, D. (2015). Describing "science practice" in learning settings. *Science Education*, *99*(6), 1033-1040. https://doi.org/10.1002/sce.21191

Swanson, E., Wanzek, J., McCulley, L., Stilman-Spisak, S., Vaughn, S., Simmons, D., Fogarty, M., & Hairrel, A. (2016). Literacy and text reading in middle and high school social studies and English language arts classrooms. *Reading & Writing Quarterly*, *32*(3), 199-222. http://dx.doi.org/10.1080/10573569.2014.910718

Vargas, L., & Erba, J. (2017). Cultural competence development, critical service learning, and Latino/a youth empowerment: A qualitative case study. *Journal of Latinos and Education*, *16*(3), 203-216. http://dx.doi.org/10.1080/15348431.2016.1229614

Vizzotto, P. A., & Pino, J. C. D. (2020). O uso do teste de alfabetização científica básica no Brasil: Uma revisão da literatura. *Ensaio Pesquisa em Educação em Ciências*, *22*(1), Artigo e15846. https://doi.org/10.1590/1983-21172020210116

Wilder, P., & Msseemmaa, D. (2019). Centering disciplinary literacies on student consciousness: A Tanzanian case study. *Journal of Adolescent & Adult Literacy*, *62*(5), 479-484. https://doi.org/10.1002/jaal.880

Wineburg, S., & Reisman, A. (2015). Disciplinary literacy in history: A toolkit for digital citizenship. *Journal of Adolescent & Adult Literacy*, *58*(8), 636-639. https://doi.org/10.1002/jaal.410

Xuan, X., Jin, Q., Jo, I., Duan, Y., & Kim, M. (2019). The potential contribution of geography curriculum to scientific literacy. *Journal of Geography*, *118*(5), 185-196. https://doi.org/10.1080/00221341.2019.1611906

Yacoubian, H. (2018). Scientific literacy for democratic decision-making. *International Journal of Science Education*, *40*(3), 308-327. https://doi.org/10.1080/09500693.2017.1420266

Note on authorship

Eduardo Carvalho Ferreira: conception and theoretical-methodological discussion of the study, production and analysis of findings. Jerusa Vilhena de Moraes: conception, orientation and theoretical-methodological discussion of the study, and analysis of the findings.

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The data underlying the research text are reported in the article.

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