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REVIEW ARTICLE OPEN ACCESS

READING IMAGES AS A POSSIBILITY FOR SCIENTIFIC AND VISUAL LITERACY: A BRIEF LITERATURE REVIEW

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ABSTRACT

This research is a systematic literature review and aimed to reflect on the relationship between scientific and visual literacy, exploring them from the reading of images. For the bibliographic survey, databases were used with the following descriptors: reading of images; scientific literacy; visual literacy and Paulo Freire. The results showed that there are few researches with the aforementioned descriptors which are presented only in Google Scholar. It was also identified that the themes of reading images and teacher training are present in the articles that composed the documentary corpus of this research, whose focus is centered on scientific and visual training, presenting its contributions to science teaching, based on reading and world interpretation.

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INTRODUCTION

The construction of knowledge requires from the subject a dialectical process between reality, experiences and knowledge. Thinking and acting dialectically requires considering the history of life, which according to Bachelard (1996, p. 20), "[...] man becomes a mutant species, or rather, a species that needs to change, that suffer if you don't change". This need arises from the search for answers to a question, called by the aforementioned author as the true scientific spirit, in order to affirm that "If there is no question, there can be no scientific knowledge" (BACHELARD, 1996, p.18). Such ideas are similar to the Patron of Brazilian Education Paulo Freire (1921-1997), when in his book "For a Pedagogy of the Question", the author state that "[...] the beginning of all knowledge, I repeat, is to ask. And it is only on the basis of questions that one should go in search of answers, and not the other way around: establishing the answers, with which all knowledge is precisely there, it is already given, it is an absolute".
The practice of literacy, as argued by Freire, stands as a relevant axis for this discussion that articulates scientific and visual literacy. While scientific literacy proves to be important to the point of being considered as an alternative that enhances a more committed education (CHASSOT, 2016), visual literacy is a complex system that can never be a system as logical and precise as language (DONDIS, 1997).

Resuming the ideas of Chassot (2016), Dondis (1997) and Freire and Faundez (1985), it is envisaged that they can support the object of study under analysis in this research, that is, the investigation of how image reading can contribute to science teaching based on scientific and visual literacy. We will use Paulo Freire's Culture Circle and the images produced for this material by Francisco Brennand (1927-2019), which consisted of a working group and debates carried out in a free and critical context of the relationships between students and the teacher. The proposal aimed for each subject to recognize himself as a creator of culture, "for this reason, images must be able to express something of themselves and, as much as possible, following their own forms of plastic expression" (FREIRE, 1967, p.7). From the reflection on the relationship between scientific and visual literacy, exploring them from the reading of images presented by Francisco Brennand and inserted in the proposal of the Culture Circle by Paulo Freire, the possibilities of developing the dialogue between Science and Art emerge, formulating the hypothesis that an interdisciplinary teaching makes it possible to establish a strategic relationship with the knowledge of Natural Sciences and Visual Arts. Therefore, this brief literature review aims to reveal how image reading can contribute to scientific and visual literacy. The descriptors used in the search for the state of the art were: *scientific literacy, visual literacy, image reading* and *Paulo Freire,* which are directly related to the doctoral research of the first author of this study, addressing the same theme.

The paper addresses world reading and literacy, presenting the different perspectives, concepts and some possibilities with a focus on scientific and visual literacy. In the second moment, we talk about *Image Reading* and its contributions to *Scientific Literacy* and *Visual Literacy*. The third moment highlights the methodological referrals, presenting how the search for the State of the Art of that research was carried out. Finally, the discussions and results found in the databases were presented, namely: *Google Scholar*, *CAPES/MEC Periodicals Portal, Online Scientific Electronic Library (SciELO)* and *Brazilian Digital of Theses and Dissertations (BDTD).*

World reading and literacy: perspectives, concepts and possibilities: Education, teaching and the formal and non-formal learning processes, in which a subject is inserted, carry with them the life trajectory, the worldview and the reading and interpretation of the surrounding reality of that subject. For Freire (1989): the social-historical condition of subjects, considering not only inherited factors but also socially acquired learning, that is, a constant search for knowledge, for humanization. The act of knowing and producing knowledge configuring the educational process is permanent, regardless of ideological conception, political positioning or economic interests, it is permanent "[...] in reason, on the one hand, the finitude of the human being, on the other, of the awareness he has of his finitude" (FREIRE, 1989). The subject needs to know that he knows and that he could know more, this is the thesis of permanent education. However, this is only possible from the understanding by the subject who has a level of literacy, a critical understanding of the act of reading beyond the decoding of the written word or language, of the relations between the text and the context. Similarly, for Soares (2020), the contemporary social's need shows that it is not enough to "know how to read and write", but that the subject knows how to use it in everyday life, mastering reading and writing. This understanding of literacy involves, in addition to encoding and decoding letters, words, phrases or texts, it is part of a range of social, historical, political, economic and cultural conditions. Therefore, to be literate is to understand written, visual, verbal expression, and a critical reading of reality can occur in the formal or non-formal space. Literacy, in turn, occurring in the formal space, consists of a political practice, mobilizing and organizing understanding of the world, in opposition to the dominant ideology. In the definition of literacy, Soares (2020) said that the term *literacy* designates the 'state' or 'condition' assumed by those who learn to read and write. (SOARES, 2020, p. 149, emphasis by the authors) and presents some perspectives for theoretical and methodological analysis, which may privilege the social or individual dimension, among which the historical, sociological, discursive and political stand out.

The historical, in turn, is the one that investigates the history of the writing system; while the anthropological one directs the studies of the processes of introduction of the writing in cultures of orality; the sociological one, on the other hand, is the one that supports reading and writing as social practices; the discursive is based on the theory of discourse and confronts the conditions of production of oral and written discourse in different discursive situations, investigating paratextual factors (format, layout, illustrations, titles, etc.) and, finally, politics, which analyzes the conditions of possibilities of literacy promotion programs, determining their objectives and goals (SOARES, 2020). It is also noteworthy that "from this incomplete enumeration, it can be concluded that the study of literacy must necessarily be multidisciplinary, and that only the contribution of different sciences can lead to a clear understanding of this phenomenon" (SOARES, 2020, p. 163). It is observed that the process of literacy is part of a much broader field. This research reports on scientific and visual literacy explored from the reading of images, delimiting itself to the term we approach "scientific literacy". Chassot (2003, p. 90) realizes that "to be scientifically literate is to know how to read the language in which nature is written". Thus, to do science is to elaborate explanations of the natural world and to be scientifically literate is to know how to read and understand nature, the world and their relationships. Visual literacy follows the same path, because by being visually literate, the subject is able to verbally express what he sees. Dondis (2003) supports this thought, bringing the idea that the childrens' first experience in contact with the world and in their learning process occurs through tactile awareness, in addition to other contributing factors, such as smell, hearing, taste and vision. The latter is considered the most relevant to meet human needs, because it is through vision that we approach the true nature of reality. For Dondis (2003, p. 86), "visual literacy has been and will always be an extension of man's exclusive ability to create messages", because in verbal literacy it is expected that the subject knows how to read and write, and can be simple or complex. Visual literacy is complex, as it is not enough to see the image, it is necessary to understand it in order to interpret it. Visual data can convey information (specific messages, expressive feelings, etc.), possessing an incomparable ability to inform the observer about himself and his own world, so this reading is only possible for the visually literate subject.

Assuming that, through the reading of images, scientific literacy and visual literacy provide necessary elements for the production of knowledge, they enable a strategic relationship with the area of Knowledge of Science and Art, so we turn our gaze to the state of the art of research that identifies with the theme. The first dissertation we found on scientific and visual literacy was written by Martins Neto (2016), entitled "Visual and scientific literacy: approaches based on astronomy themes". According to him (MARTINS NETO, 2016, p. 16), visual and scientific literacy "[...] expose the possibility of enabling the basic understanding of Science, expanding the capacity of interpretation through image analysis, providing competence to face the new challenges that our society demands. Martins Neto (2016, p.18) shows that the visual and scientific literacy of the student enables the democratization of science and art, since image reading enables the individual to relate the contents to their reality, understanding and recognizing historical facts, social and scientific studies of a given time, since "the interpretation resulting from learning to read the world will help the student to understand and constitute the world, that is, to compose and organize his social universe". Freire and Faundez's (1985) say that this process of reading the world must start from the act of asking, because when asking the student discovers the relationship between the word, action, reflection and their reality. Therefore, it is essential to overcome the dichotomy between theory and practice, since "the transformation of reality implies the union of these two types of knowledge, to achieve a superior knowledge [...] that can be transformed into action and transformation of reality" (FREIRE; FAUNDEZ, 1985, p.32). As Martins Neto (2018), Freire and Faundez (1985) defend the understanding and interpretation of the world sustained in a dialectical and significant process, it is necessary for the subject to take his reality (*practice*) as a starting point to deepen the understanding of the concepts (*theory*) and return to your reality (*practice*). In view of the above, we question: how can the reading of images contribute to the teaching of science with a training that promotes the reading and interpretation of the world and the surrounding reality? Therefore, the following session addresses the theme in order to support the reading of images.

Image reading: contributions to scientific literacy and visual literacy: The defense of literacy/literacy proposed in the previous session goes beyond reading and writing, but reading, writing, interpreting and understanding the different forms of languages: written and non-written, verbal and non-verbal. Pereira and Terrazan (2011) show that the different social practices are permeated by different semiotic modalities, which we have for the construction of texts that involve the practices. Among the non-written and non-verbal's languages we find images, which are part of the history of humanity and are widely used today in different contexts, given their communicational power. Silva *et al* (2020) present that there are several issues to be addressed when the theme is image, this is due to the large amount of images that are presented daily. The authors also call attention to the need to develop the sensitivity of the eye (the act of seeing), so that the images do not go unnoticed. Another aspect that contributes is the fact that we do not have experiences of reading images, both in the formal education space and outside it, so "it is necessary to develop this reading capacity at school, because the

image is also a form of knowledge" (SILVA et al, 2020, p.164). Campanhole (2014, p. 536) states that it is common for the term "language" to be associated with the verbal universe and the image to be classified as non-verbal language, but compares that while the "[...] morphology of verbal language has the word as a form, restricted to the language and dependent on the cultural context, the visual morphology starts at the limits of the sensorial structure, apparently delimited, but with a strong polysemic potential". Campanhole (2014, p. 539) defines that the reading of images occurs in a visual and verbal way, "[...] while the first is contemplative and indicative, the second assumes both the nominative condition of what is contained in visuality (which is more common), such as understanding and operability of visual syntax and morphology". When contextualizing the historically constructed concept of image, Silva and Neves (2016) assert that it has gone through different interpretations and it may be that each of us, in his individuality, has developed his own style of performing his image reading, so that it has its own theoretical support. This is because, as proposed by Corassa and Rebouças (2015, p. 13-14), in "[...] artistic creation, we must remember that it implies two simultaneous processes: a process of content formation and another of material formation, inseparable from and coincident", that is, "it is the form that concretizes, expresses a content. And if this content is associated with the author's theme, form and poetics, both will be inseparable, because in the artistic process the content is given in the form". In this way, for the content and form relationship to be effective in the space of formal education, coherence in educational practice is required, since there is no neutrality in education, everything emerges from an option, which is political and materializes in the process. teaching dialectic. This path allows for a conscious participation in social (re)construction, which shows that it is not enough to have access to the image, but to understand its context, a condition that is only possible for the literate subject who has appropriated all languages, verbal or non-verbal, written and unwritten (FREIRE, 1989).

Silva and Neves (2016, p.132) elucidate the steps for analyzing images and consider that "observation, based on a theoretical framework, is the first step of the research and, subsequently, follows the interpretation and presentation of the results". In other words, the authors demonstrate the importance of apprehending the concept of image, to later carry out the theoretical approach from a predetermined reference and, finally, carry out the analysis of images. To lead the discussion, it is worth mentioning that the relationship between Art and Science was built, over the centuries, with the artists of the Renaissance. Plaza (1998, p. 39), describes that "while science seeks determination in hyper-coding, art, in contrast, tends to the singular and low coding, because art is not language in the strict sense" due its artistic sensibility. Due to technological advances, new horizons have emerged for artistic and scientific development, establishing a "kind of art/science symbiosis, as an attempt to dismantle the old conception of representation of artistic forms as mimesis, that is, as an imitation of the objective world, to value the creative experience and the power of thought" (LOPES, 2012, p. 3). For Silva (2013 p. 408, emphasis by the author), knowledge cannot be constructed under a single vision, a single angle, from a false epistemological premise that it would have only one face. Far from this premise, from this cartesianism/positivism, we believe that the art-science relationship is the concrete path to a new vision, gestated in the distant Renaissance: a multidimensional vision, where plurality meets expertise so that all knowledge is built without that the riches of the contingent world that created it be lost. Thus, based on the principle that knowledge needs to be built integrally, we consider scientific and visual literacy, adding it to the proposal of interdisciplinary teaching, consisting of a possible path to a new vision, because, "to produce knowledge is to transform complex information (scientific or technological, sensitive and technical), in the results of a work process" (PLAZA, 1998. p.38). When these elements are considered, the research proposes a strategic relationship with the area of Knowledge of Science and Art based on the Images of the artist Francisco Brennand prepared for Paulo Freire's literacy proposal. Silva and Neves (2016, p. 132) state that "[...] works of art and their images are seen as documents that, together with other sources, become important sources of understanding and historical analysis". Therefore, reading images presupposes considering the historical, political, economic, cultural and ideological context in which a given image was created, thus identifying the importance of Visual and Scientific Literacy for a critical reading of the world - which presupposes the interdisciplinarity that involves the Image. By breaking with the fragmentation and limitations posed by the dominant educational format, *interdisciplinarity* is necessary in the production of knowledge. Starting from an interdisciplinary movement that overcomes the fragmented and disciplinary organization, considering a real movement in which the sciences talk to each other in the various existing dimensions, overcoming the formal space. When considering these elements, it is understood how the image can contribute to the subject's scientific literacy, from the area of Knowledge of Science and Art through the Images of the artist Francisco Brennand, to the literacy proposal of Paulo Freire.

Methodological referrals: This research, of a qualitative and documentary/bibliographic nature, involves carrying out a brief literature review, presenting the methodological synthesis and the selected sources. According to Ramos, Faria and Faria (2014, p.23), in the process of systematic literature review, it is essential that all research steps are recorded, not only so that it can be replicated by another researcher, but also to verify that the ongoing process follows a series of steps previously defined and absolutely respected. Based on the authors RAMOS; FARIA; FARIA (2014), the data collection took place on January 10, 2022 and aimed to identify how reading images can contribute to scientific and visual literacy, through training that promotes understanding and interpretation of the world and the surrounding reality, according to Paulo Freire's assumptions. The search considered scientific papers, dissertations and theses found in *Google Scholar databases, CAPES/MEC Periodicals Portal, Scientific Electronic Library Online (SciELO)* and *Brazilian Digital Library of Theses and Dissertations (BDTD).* The constitution of the thematic scope of the search was carried out with the descriptors: *scientific literacy, visual literacy, image reading* and *Paulo Freire* anywhere in the text. The results composed the documental corpus of analysis of this research, without delimitation of year, given the few existing researches on the subject. The following inclusion criteria were listed for analysis: a) to be a complete paper, dissertation or thesis available online; b) existence of all descriptors in the text; c) discuss the relevance of reading images for scientific literacy and visual literacy as a promoter of reading the world and the surrounding reality. The works resulting from the survey in the databases were submitted to analysis and discussion from authors who discuss Scientific Literacy, Visual Literacy and Image Reading with a focus on the field of Sciences, such as Freire (1967), Freire and Faundez (1989), Dondis (1997, 2003), Chassot (2003; 2016), Sasseron and Carvalho (2011), Joly (2012) and Santaella and Noth (2015), Martins Neto (2016), Silva and Neves (2016; 2021), Soares (2020); Silva et al (2020).

RESULTS AND DISCUSSION

The advanced search with the previously listed descriptors resulted in 12 works (papers, dissertations and theses) presented in Google Scholar, since in the other search engines the results for such descriptors were non-existent. The selection of works for analysis prioritized research that contemplated all descriptors in any part of it (title, abstract, keywords or texts), with emphasis on Image Reading with a focus on scientific literacy and visual literacy, their contributions to Science Teaching, with the following research selected: Martins Neto (2016); Fernandes Junior (2017); Santos (2019); Santos (2020) and Silva and Neves (2021). As it is possible to identify, the five selected researches comprise the period between 2016 and 2021. It is noteworthy, therefore, that although the researches present different research programs, the theme of reading images is common to all, in the same way that the focus is on aimed at teaching science, a condition that brings them together. The list of studies considered for this study is presented in the table below.

Table N - Identification of the researches that make up the documentary corpus of this survey.

Title	Author (year)	Data base	Local	Institution
Visual and scientific literacy: approach from the reading of images of astronomy themes	Martins Neto (2016)	Scholar Google	Dissertation presented at Programa de Pós-Graduação em Ensino de Ciência e Tecnologia.	Universidade Tecnológica Federal do Paraná (UTFPR), Campus de Ponta Grossa
Photography as an interdisciplinary tool for teaching art and science	Fernandes Junior (2017)	Scholar Google	Dissertation presented at Programa de Pós-graduação em Docência para a Educação Básica	Universidade Estadual Paulista Júlio de Mesquita Filho
The imagery discourse in physics teaching: gestures, materials and their meanings in the transposition of scientific knowledge	Santos (2019)	Scholar Google	Thesis presented at Programa de Pós-graduação em Ensino, Filosofia e História das Ciências	Universidade Federal da Bahia e Universidade Estadual de Feira de Santana
The use of drawings in the study of parasite life cycles	Santos (2020)	Scholar Google	Dissertation presented at Programa de Pós-Graduação em Ensino de Ciências Professional Master Course	Universidade de Brasília
Interdisciplinary Image Reading: Analysis of teachers in training	Silva; Neves (2021)	Scholar Google	*Journal* Tecné, Episteme e Didaxis: TED	IX Congresso Internacional sobre formación de profesores de Ciencias

The first research, already presented in this study, showed how the image reading, when inserted in the students' daily life, instrumentalizes them in the interpretation and contributes to the development of competences to solve daily problems, providing conditions for overcoming common sense (MARTINS NETO, 2016). Martins Neto (2016) problematizes his research with the fragmentation of teaching given by the organization by disciplines that do not dialogue with each other, as well as they do not relate to the student's reality. At the same time, he justifies his research with the need for teaching that prioritizes scientific and visual literacy, connecting different areas of knowledge (Science, Art, Technology and Society). While making use of cross-cutting themes, the proposal also opted for a focus on Physics-Astronomy content and Visual Arts-Image Reading content, thus promoting interdisciplinarity. As a product of qualitative and descriptive research, of a bibliographic nature, the author presented a didactic material with the purpose of supporting the development of the teaching and learning process, through theoretical-practical workshops on Scientific and Visual Literacy with interdisciplinary themes (Physics and Visual Arts) that made it possible to think about Art and Science and, consequently, to change the students' conception and thinking in the face of new knowledge.

Subsequently, in 2017, the research by Fernandes Junior (2017) was published, entitled "Photography as an interdisciplinary tool for the teaching of art and science". And as the title suggests, the study discusses artistic and scientific practices, presenting photography as an object. The research has a qualitative approach and methodologically opted for action research, with the objective of "analyzing students' conceptions about the disciplines of art and science" in order to "provide a reflection on artistic and scientific practices related to photography" (FERNANDES JUNIOR, 2017, p. 20). As a product of the research, the author prepared a book, contemplating the activities and experiments carried out with the 9th grade students during the same, aiming to contribute with teachers in the contextualization of the contents of art and science. Therefore, the author addresses the importance of visual literacy to make the student able to read images. Furthermore, he argues that this ability associated with scientific literacy can overcome the fragmentation of knowledge so latent in our country. He concludes by reinforcing that understanding the relationship between art and science makes it possible to understand that artistic production and scientific production are interconnected "[...] as if they were metabioses of the production and expression of humanity" (FERNANDES JUNIOR, 2017, p. 111). The thesis entitled *The imagery discourse in physics teaching: gestures, materials and their meanings in the transposition of scientific knowledge*, by Santos (2019) is the third research analyzed. The research proposal with a qualitative character, results from in loco observation applied in Physics classrooms, more specifically "[...] from video recordings carried out in the internship observations of trainees in Physics at UFBA, in the discipline of Methodology and Practice of Physics Teaching" (SANTOS, 2019, p. 87).

Furthermore, the author aimed to discuss the role of visual representation in teaching work, as well as to identify and classify the different modes of visual representation used by the teacher, as the author himself describes "[...] the relationship between the Physics teacher and the visual language" (SANTOS, 2019, p. 18). The main interest in the work is "[...] through the articulation of visual elements, the same ones that the teacher uses to establish communication with his students and teach Physics" (SANTOS, 2019, p. 24). The author also highlights that his object of study is imagery, understanding that Visual Literacy consists of a necessary learning in the development of science and "[...] guides us in the paths of scientific literacy" (SANTOS, 2019, p. 176). The fourth research identified as *The use of drawings in the study of the life cycle of parasites*, authored by Santos (2020), aimed to identify the contributions of the production of drawings in the understanding of the helminths and nematodes life cycles in a didactic sequence for students of the first year of high school, in order to understand the importance of the image as a methodological resource in science teaching and the appropriation of scientific knowledge. It is a qualitative research with a participant observation method, in order to contribute to the didactic sequence and with notes in the logbook, helping in data collection. Throughout the development of the steps of the didactic sequence, the author can see that the errors reported from the drawings/images were corrected, creating a second drawing/image, "in this way the activities of the didactic sequence with the elaboration of drawings as a non-verbal verbal, collaborated positively in the students' learning process" (SANTOS, 2020, p. 69), that is, for visual and scientific literacy.

The last research presented in table 1, consists of the article by Silva and Neves (2021) with the title "Interdisciplinary Image Reading: analysis of teachers in training", the authors start from a proposal of Interdisciplinary Image Reading (LI²), carried out in a discipline with students/professors of two Postgraduate Programs, which had as objectives to contribute with theoretical references for reading/analysis of images and to present the analysis of images elaborated from LI². First, the discussion has a theoretical basis relating Art and Science, problematizing from the reality of each student/teacher, and considering Paulo Freire's ideas when working with day-to-day themes and, finally, the authors carried out a comparative analysis between student responses and established criteria (SILVA; NEVES, 2021). On the merits of final considerations, the authors understood "[...] that the LI² proposal contributes to a significant expansion of the reading/analysis of the subjects, that is, for visual literacy" (SILVA; NEVES, 2021, p.3555).
From the analysis of research that represented three dissertations, a thesis and a paper contained in the documentary *corpus* of the present paper, it was identified that the theme of image reading is present in all research, worked in different disciplines in the field of Science (Physics, Biology, Astronomy), however with the same view focused on scientific and visual training and its contributions to science teaching. Another highlight involves issues related to work in the classroom, as the research works with teaching subjects and students,

both in basic education and higher education, more specifically with the training of teachers. Nevertheless, it was noticed that only the dissertation research by Martins Neto (2016) and the thesis by Santos (2019) addressed scientific and visual literacy in greater theoretical depth.

FINAL CONSIDERATIONS

The construction of knowledge does not occur spontaneously and in isolation, but stems from the relationship between the subject and the world that is inserted. Thus, their cultural, economic, political, social and educational influences, associated with the processes of thought and creation, contribute to their formation as a critical subject. From this study, it was seen that the subject is only able to critically understand their reality and the factors that involve their practice when literate. In other words, in addition to mastering the technique of reading and writing, it is necessary to interpret what is implicit in the language, in the same way, that you will only understand science and art if you are scientifically and visually literate. By emphasizing the importance of literacy for this process, Paulo Freire becomes a relevant author, since his teaching proposal, developed in the Culture Circle, had as its starting point the presentation of some images, promoting the debate on the notions of culture and work. According to Freire (1967) images approach and express something specific to the subject. As it was possible to identify in the survey of the research carried out, the work with images establishes a relationship between scientific and visual literacy, as it presents possibilities to develop the dialogue between Science and Art. Furthermore, research has shown substantial relevance of this resource for the promotion of learning and appropriation of knowledge by students. Above all, if we really want our education to become a form of scientifically and visually literate subjects, it is important to promote relations between the different areas of knowledge, as the proposal defended in this study focused on Science and Art. Both in practice, especially in school institutions, and in the field of research, it is necessary to take a new look from the reading of images, which articulates a formation engaged in the sociocultural and scientific aspects, based on the reading and interpretation of the world and, therefore, in social reality.

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