



Educação & Formação

ISSN: 2448-3583

Universidade Estadual do Ceará

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A perspectiva freireana na formação de professores de Ciências Naturais: uma revisão de literatura  
Educação & Formação, vol. 7, no. 1, e8047, 2022  
Universidade Estadual do Ceará

DOI: <https://doi.org/10.25053/redufor.v7.e8047>

Available in: <https://www.redalyc.org/articulo.oa?id=585869643038>

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## Freire's perspective on the training of Natural Science teachers: a literature review

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### Abstract

This article aims to discuss Paulo Freire's contributions to the training of Natural Science teachers in Brazil (prioritizing the disciplines of Chemistry and Biology), considering the importance of Freire's legacy for education, especially in times of attack on critical thinking. In methodological terms, a qualitative approach was used, based on the survey of Brazilian literature in the Journals of the Coordination for the Improvement of Higher Education Personnel, Google Scholar and Bank of Theses and Dissertations of the Coordination for the Improvement of Higher Education Personnel considering the period 2010-2020. The analyzed productions indicate the potential of the contributions of the author's work to the training of teachers in science, but that there is a gap in terms of the articulation of methodological approaches with the central elements in Freire, that is: Freire's Liberating Education in its commitment to critical education. The issue is also verified by the lack of works that discuss political and human training in the context of teacher training.

### Keywords

teacher training; Paulo Freire; teaching Natural Sciences.

### A perspectiva freireana na formação de professores de Ciências Naturais: uma revisão de literatura

### Resumo

Este artigo tem como objetivo discutir as contribuições de Paulo Freire para a formação de professores de Ciências Naturais no Brasil (priorizando-se as disciplinas Química e Biologia), considerando a importância do legado *freireano* para a educação, especialmente em tempos de ataque ao pensamento crítico. Em termos metodológicos, utilizou-se da abordagem qualitativa, a partir do levantamento da literatura brasileira nas bases: Periódicos da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, Google Acadêmico e Banco de Teses e Dissertações da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, considerando o período 2010-2020. As produções analisadas indicam a potencialidade das contribuições da obra do autor para a formação de professores em Ciências, mas que há uma lacuna no que se refere à articulação das abordagens metodológicas com os elementos centrais em Freire, isto é:

a Educação Libertadora de Freire em seu compromisso com uma formação crítica. A questão também se verifica pela lacuna de trabalhos que discutem a formação política e humana no âmbito da formação docente.

**Palavras-chave**

formação de professores; Paulo Freire; ensino de Ciências Naturais.

**La perspectiva de Freire sobre la formación de profesores de Ciencias Naturales:  
una revisión de la literatura****Resumen**

Este artículo tiene como objetivo discutir las contribuciones de Paulo Freire para la formación de profesores de Ciencias Naturales en Brasil (priorizando las disciplinas de Química y Biología), considerando la importancia del legado de Freire para la educación, especialmente en tiempos de ataque al pensamiento crítico. En términos metodológicos, se utilizó un enfoque cualitativo, a partir del levantamiento de la literatura brasileña en: Periódicos de la Coordinación para el Perfeccionamiento del Personal de Educación Superior, Google Scholar y Banco de Tesis y Disertaciones de la Coordinación para el Perfeccionamiento del Personal de Educación Superior, considerando el período 2010-2020. Las producciones analizadas señalan la potencialidad de los aportes de la obra del autor a la formación de docentes en Ciencias, pero que existe un vacío en cuanto a la articulación de los enfoques metodológicos con los elementos centrales en Freire, esto es: la Educación Libertadora de Freire en su compromiso con una formación crítica. La cuestión también se verifica por la falta de trabajos que discutan la formación política y humana en el contexto de la formación docente.

**Palabras clave**

formación de profesores; Paulo Freire; enseñanza de las Ciencias Naturales.

**1 Introdução**

In this sense, the objective of this article is to map and analyze the literature that deals with Paulo Freire's contributions. Teacher training is a theme widely addressed by Paulo Freire in his work as a whole, in which many categories such as dialogue, praxis, ideology, liberation, and awareness are articulated to highlight the political character of education. Thus, from his first writings, Freire elaborated his conception of the teaching know-how, sometimes emphasizing the political, philosophical and anthropological foundations, thus building the scenario for the understanding of the teaching practice, sometimes deepening specific thematic cores related to teaching-learning and teacher training.

to the training of Natural Sciences teachers in Brazil, with a special focus on the subjects of Chemistry and Biology, considering the contributions to the practice and

teacher training committed to transformative education. This discussion is relevant given the attacks that critical thinking has been suffering, notably Freire's own works, and the importance of discussing the limits and possibilities of the discussions of this great Brazilian educator in his more specific relationship with Science teachers' education.

However, it is important to note that, considering the space-time limits of this article and the set of papers on the work, and the categories of the author in question, the discussion presented are centered on the elements of the review and the analysis of these materials.

## 2 Metodologia

In methodological terms, a qualitative approach was used (LÜDKE; ANDRÉ, 1986) based on a bibliographical survey of published works considering research carried out in Google Scholar, Periódicos da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes) and Repository of Theses and Dissertations of Capes. Three descriptors were used: “teacher training in Science” and “Paulo Freire”; “teacher training in Chemistry” and “Paulo Freire”; and “political education and teacher education” and “Paulo Freire”. In all search platforms, works from 2010 to 2020, in Portuguese, were considered. It should also be noted that the survey was carried out between March and November 2021.

The first step of “filtering” the texts was carried out from the analysis of titles and keywords, according to the descriptors and the research objectives. In the second stage, new filtering was carried out from the abstracts<sup>1</sup>. Finally, during the analysis of the works, the categories/axes were elaborated, and also new filtering<sup>2</sup>, resulting in the quantitative tables that follow<sup>3</sup>:

<sup>1</sup> At this stage, 16 articles were selected from the Capes Periódicos Portal, 10 theses and 16 dissertations from the Capes repository, and nine articles, seven dissertations, three theses and two monographs from Google Scholar.

<sup>2</sup> At this stage, dissertations (7), monographs (2), and theses (3) found by Google Scholar were excluded, since the selected criterion was “article” for this search engine.

<sup>3</sup> The authors of the selected works are connected to the Education Programs, Social and Human Sciences, Scientific Education and Teacher Training, Scientific and Technological Education, Chemistry, Science and Mathematics Teaching, Science Teaching, Teaching in Science and Mathematics Education, Training Interdisciplinary Teaching Course and Human Rights, Public Policies and Citizenship.

**Table 1** – Final number of selected works

Descriptors	No. of works
"teacher training in Science" and "Paulo Freire"	17
"political education and teacher education" and "Paulo Freire"	4
"teacher training in Chemistry" and "Paulo Freire"	6

Source: Authors' own (2022).

**Table 2** – Database and number of works

Database	No. of dissertations	No. of theses	No. of articles	Total
Capes repository	7	5	-	12
Google Scholar	-	-	6	6
Capes periodicals	-	-	9	9

Source: Authors' own (2022).

As can be seen in Table 1, the descriptor with the highest number of results considered was "teacher training in Science" and "Paulo Freire". In Table 2, it appears that the largest number of productions (for all descriptors) was located in the Capes repository.

### 3 Results and discussion

It was decided to organize the data from the bibliographic survey based on axes that group the main discussions in the mapped/analyzed works. However, it is important to emphasize that such axes are not unrelated or detached, but, on the contrary, are intrinsically related. Table 3 presents the developed analytical axes, the number of productions, and the Freirean categories that gain emphasis in the works of the respective axes.

**Table 3** – Axes of analysis

Axes	No. of works	Categories used in the works
Paulo Freire in teacher training	11	Praxis, criticality, dialogicity, awareness, generating theme
Contributions of Freire's pedagogy to Science teaching	6	Dialogicity, criticality, mediation, questioning, contextualization, reflection, emancipation, generating themes
Paulo Freire, teacher education and political education	2	Banking education, problematization, dialogicity, humanization

Source: Authors' own (2022).

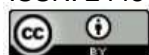
#### Axis 1: Paulo Freire in teacher training

In the productions analyzed in this axis, it appears that the main problem is the disconnect between pedagogical training and training for the specific area in training

Educ. Form., Fortaleza, v. 7, e8047, 2022

DOI: <https://doi.org/10.25053/redufor.v7.e8047><https://revistas.uece.br/index.php/redufor/index>

ISSN: 2448-3583



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courses for Natural Science teachers. According to Nascimento (2011, p. 29), “[...] the idea of dichotomy seems to prevail, as if, in addition to the precedence of one over the other, they could exist independently”. This central issue is related to at least two questions. The first refers to Teacher Training Policies (policies addressed to the area), while the second is guided by the analysis of course projects and interviews/questionnaires with undergraduates and professors, indicating internal problems in teacher training courses in Science.

Regarding the first axis (Teacher Training Policies), two works were found centrally dedicated to the theme. Silva (2018) investigated the presence/absence of categories of Paulo Freire's pedagogy in the National Curriculum Guidelines for Teacher Training in Licentiate Courses and in the Guidelines that guide the Pedagogical Projects (PPCs) of teaching courses in Federal University of Paraíba (UFPB). Even though this is not a discussion addressed only to licentiate courses in Natural Sciences, its conclusions are important to our discussion. The author found evidence of Freirean categories in the documents that guide the policy of teacher training and the institution. However, the author states that the documents did not express the central elements of Freirean pedagogy, which are related to the commitment to a liberating education. Thus, the use of Freirean categories in official documents could be understood as “discursively effective” and did not effectively express “[...] concern with the social order and the transformation of the individual and the world” (SILVA, 2018, p. 91).

This “disconnection” is also presented by Lunardi et al. (2013) when they analyze the critical perspectives in works on the training of educators in the area of Science Teaching. For the authors, critical ideas/references were often presented in an isolated and disconnected way from the understanding of education and training as political and pedagogical acts.

Less centrally, Freire's work is identified as a critical perspective in the research by Campos et al. (2017), in which the objective was to understand the concepts involved in the construction and formation of a critical individual committed to a just society. According to the production, themes such as critical pedagogy, the school classicist character, praxis, dialogue between the teacher and the student and between the student and the teacher and society, scientific knowledge, reflection and action, domination



aspect, and historical development are necessary themes for the strengthening of teacher training.

Therefore, Freire's contributions are important to teacher education in the sense of thinking of man as an unfinished being, a "being more", capable of encouraging "[...] problematization, dialogicity and awareness" (CAMPOS *et al.*, 2017, p. 7). It is an educational understanding centered on the relationship between awareness and liberation, a collective process of deconstructing irrationalisms and common sense to enhance the interests of those oppressed (BOTELHO, 2016; FREIRE, 1987).

As stated by Botelho (2016, p. 94):

For education to reach its most radical end for Freire, it also has to be fundamentally a process of humanization. It is not just biological man that Freire is talking about. It belongs to man, a biological and cultural being. As such, a being multiple builds different relationships with the world and others, so that being recreates and transforms itself in these relationships. The interpretative power of humanization in Freire's terms is precisely at this point: because they are capable of perceiving and recreating themselves as a being that consciously transforms themselves and transforms the world, the human being has, in relation to humanization, an intrinsic value. [...] An educational project that is not able to serve this purpose and organize its practices, means, and purpose for this purpose is irreconcilable with the Freirean educational project.

Concerning the second axis (Contributions of Freire's pedagogy to Science teaching), the works found were more specifically dedicated to understanding how the Freirean legacy has been part of initial teacher training courses, of Political-Pedagogical Projects (PPP), the syllabi of the Curricular Units or even the pedagogical proposals.

Silva's thesis (2017) aimed to understand the Freirean Dialogic Education (EDF) in license courses at the Universidade Federal do Ceará (UFC) based on course documents and interviews with professors, who stated that they did not recognize Freire's pedagogical proposal as a direct reference. Regarding the analyzed documents, few references to Freire's works were found, among them the concept of dialogicity. However, according to the author, this concept is presented, for the most part, superficially and intuitively.

It should be noted, then, that Freire understands dialogue as a force that drives critical-problematizing thinking and that enhances the possibility of looking at the world and our existence in society as an unfinished and changing reality. In this sense, Freire

forges the theory of dialogicity based on the understanding that dialogue is fundamental in the educational process since it is part of the communication between subjects, who know it is mediated by the world. To Freire (1996, p. 63):

Teacher training should insist on the constitution of this necessary knowledge and that makes me certain of this obvious thing, which is the undeniable importance that the ecological, social, and economic reality in which we live has on us. And to the theoretical knowledge of this influence we would have to add the theoretical-practical knowledge of the concrete reality in which teachers work. I already know, without a doubt, that the material conditions in which and under which students live shape their understanding of their own world, their ability to learn, to respond to challenges. Now I need to know or open myself to the reality of these students with whom I share my pedagogical activity. I need to become, if not absolutely intimate with their way of existing, then at least less strange and distant from it. And the decrease in my strangeness or my distance from the hostile reality in which my students live is not a question of pure geography. My openness to the negating reality of their project as people is a matter of real adherence on my part to them and to their right to exist.

Zaneti et al. (2019) discuss the insertion of Critical Pedagogies in undergraduate courses in Biological Sciences in federal institutions located in the state of São Paulo, based on the analysis of documents, teaching plans for mandatory subjects, and analysis of the PPP. Among the universities surveyed, the authors found that the Universidade Federal de São Carlos (UFSCar) was the institution that presented the highest number of didactic-pedagogical courses. However, this institution also had the lowest number of courses with the inclusion of works/authors from the critical field. Considering the didactic-pedagogical disciplines of all analyzed universities, the most cited authors were Dermeval Saviani (Historical-Critical Pedagogy) and Paulo Freire (Liberating Pedagogy). On the other hand, the authors conclude that there is “[...] a low expressiveness of the critical influence in the didactic-pedagogical disciplines in the license courses in Biological Sciences of Federal Institutions of the State of São Paulo” (ZANETI *et al.*, 2019, p. 7).

Santos (2015) brought to the debate the issue of Educação de Jovens e Adultos (EJA) in the initial training of the Science teachers based on the dialogue during the Supervised Internships. According to the author, the thematization proposed by Freire begins through the conscientizing practice, and this, in turn, does not comprise a naive conscientization, which is related only to the apprehension of reality. Thematization requires a programmatic content that can be built through the educator's own vision.



Still, about the Internship, Leite's (2015) thesis investigated the possibility of Supervised Internships in the Chemistry degree course being developed from a problematizing perspective, comprising the conceptions and practices of the interns, together with the factors that collaborate or hinder the development of this methodology while teaching Chemistry. Leite (2015) revealed that the investigated subjects understand the teaching-learning process from the transmission-reception logic. Thus, educational institutions are "fed" by valuing the dominance of some over others and, as a result, influence the conceptions and actions of the subjects who are formed by them.

The thesis also emphasizes the need for curricular changes to guarantee the identity of the teacher training course, integrating theory and practice with the particularities of teachers' work in the specific subject. In addition, the author states that it is necessary to overcome the model of teachers as only executors of decisions defined by other instances.

Silveira and Zanetic (2016) use children's works by Monteiro Lobato, especially *Serões de Dona Benta*, to identify passages where specific approaches to chemical knowledge appeared, interpreted following Paulo Freire's pedagogy. The grandmother/teacher makes it clear that shape is not training, teaching is not just transferring knowledge, trying to change the view on teaching that undergraduates have when they start at the university, which is, in most cases, based on a traditional conception of education. Thus, especially the subjects with a pedagogical approach in the degree courses in Natural Sciences are of great relevance in the construction of a broader vision of education, the school, and the teaching-learning process.

## **Axis 2: Teacher training and Science teaching: an approach between Science, Technology and Society (STS) and generating themes**

When discussing Science teaching, it is important to highlight that Freire's educational understanding is focused on questioning to overcome the repetition or recognition of knowledge. Without taking away the relevance of knowledge historically produced and socialized in the format of teaching subjects, Freire understands that education must be based on local problems and their conflicts, to "[...] build

understandings and sociability resistant to the dominant logic to hierarchize knowledge in the name of the instituted power and to make consciences docile to accept the contradictions in which they are socially and historically found” (BOTELHO, 2016, p. 106). This understanding has been the basis for the development of teaching approaches and methodologies, such as the STS approach and the generating themes, as we also identified in the literature survey.

It should be noted that the STS approach emerged as a curricular renewal movement. The main objective was to prepare citizens capable of judging and evaluating the possibilities, limitations, and implications of the development of scientific and technological training in schools, the processes that involve Science teaching and learning. The Freirean perspective is then highlighted significantly in the development of activities based on the STS perspective, to provide training focused on the subjects' emancipation.

As Lopes (2013) points out, although Freire does not make specific references to the STS perspective and Science teaching, it is possible to make connections based on concepts from Freire's works, such as epistemological curiosity. According to Lopes (2013), in the Freirean approach, it is considered that knowledge from experience is the starting point for the practice of dialogic education. In this sense, “[...] the interest of the students is directly linked to their experiences and must be foreseen in the organization of the contents, contained in the school curriculum” (LOPES, 2013, p. 209).

The research carried out by Jesus (2017) on the contextualization of Chemistry teaching through the STS approach linked to Paulo Freire's pedagogy stands out. According to the researcher, the use of generating themes contextualizes teaching. So it is necessary to know the student, recognizing them as individuals who are part of the social sphere (JESUS, 2017). The teacher, therefore, plays the role of a mediator of education, contributing to the formation of a critical student. A problem, however, pointed out by Jesus (2017) is that, although there are works that articulate Paulo Freire and STS, they are not effectively incorporated into the classes.

Vacheski (2016), in turn, analyzes the teacher training process of students in the undergraduate course in Chemistry at a state university. The author points out that the use of themes and materials that contemplate relationships between science, technology,

and society contributes to the formation of subjects capable of taking a stand and participating in controversial and current discussions in society.

It is also worth mentioning the research by Fernandes and Gouvêa (2019), which presents an analysis of different perceptions and appropriations of Science teachers on the STS perspective. According to the study, teachers have difficulty understanding and, above all, applying the principles of the STS approach, Freire's contextualization and proposal, as also indicated by Jesus (2017).

Neres and Gehlen (2018) identify studies that use Freire's assumptions in proposing formative processes for Science teachers and analyze how the Thematic Investigation stages are inserted in the context of initial and continued teacher training. These surveys aim to minimize problems in the school context, contributing to a curricular reconfiguration accompanied by reflections on teaching training and practice. According to the authors, the theoretical-methodological assumptions of problematizing and dialogical education, conceived by Paulo Freire, are used in Science teaching, in proposals focused on curricular reconfiguration, such as the Freirean Thematic Approach (DELIZOICOV; ANGOTTI; PERNAMBUCO, 2011) and Curriculum Praxis Through a Generator Theme (SILVA, 2004).

Specifically about the Generator Theme, Silva (2015) reinforces that its nature is dialogical and problematizing and can be understood as a starting point for a didactic-pedagogical organization that promotes a critical view of the world, that is, in which there is the promotion of the passage from the “naive curiosity” of the students to the “epistemological curiosity” (FREIRE, 1975).

### **Axis 3: Paulo Freire, teacher training and political education**

Although Freire's work is based on the understanding of education as a political act, few productions were found when researching the relationship between teacher training in Science and political education. This result, however, is not surprising, since a kind of “dichotomy” persists between specific and pedagogical areas in many undergraduate courses in the area of Natural Sciences.

Fortuna (2015), in her dissertation, states that Freire's perspective regarding the training of educators is imbued with practices that promote autonomy, emancipation, and

self-criticism. Other important aspects rescued by the author refer to the concepts of humanization, liberating education, and education as a political act. As such, education, in addition to the formative/pedagogical role, assumes a political, ethical, social, and historical role in the human constitution and the humanization.

Nicolodi and Silva (2016) report experiences with students from a class of licensing in Sciences and a class from the 9th-grade students on the coast of Paraná, supported by Freire's pedagogy. Through shared teaching<sup>4</sup>, the authors present their perceptions about the mediation processes in teacher education and human education.

Despite the limitation of articles on the subject, we noticed that the issue is raised in most of the selected works about teacher training. Some even indicate limits in the development of critical thinking in the Science teachers' training and the need for changes. However, the discussion does not occupy a central place of inquiry or is presented abstractly.

#### 4 Final considerations

Centered on the recognition of the university's social role in the initial training of Education professionals, this article sought to discuss Paulo Freire's contributions to the training of Natural Sciences teachers in Brazil (prioritizing Chemistry and Biology). In general terms, based on the literature review carried out, it is understood that, despite indicating the potential of Freire's work for the training of Natural Sciences teachers, such a perspective is barely used in undergraduate courses in Chemistry and Biology, as well as there is an epistemological disconnect regarding the use of the author's works in the context of teacher training.

Specifically, regarding the teaching of Natural Sciences and the training of teachers in their relationship with Freire's work, it can be seen that the association with the Generator Theme and STS was more expressive, although productions point out that such approaches are little used in classrooms.

In the research that considered articulation with political formation, few works were found. This indicates a "profile" of the appropriation of the author's works in the training of Natural Sciences teachers more based on the knowledge of methodologies

<sup>4</sup> In shared teaching, there is collective planning, instead of just one teacher responsible for the class.

(among them, the proposals anchored in Freire's logic) than specifically on the understanding of the educational and didactic-pedagogical proposals to which they are linked.

Thus, when understanding that teacher training concerns a dynamic, unfinished process, inserted in a historical context, it should be noted that, within the scope of capitalism and its instrumental reasoning, the teacher training process tends to occur predominantly in a fragmented and instrumentalizing way, with few spaces for broader and more human training, demanding the dispute over teacher training policies and also the counter-hegemonic movement on the "ground" of universities and schools.

Finally, it is emphasized that the article makes a punctual contribution to the subject in question and does not exhaust it. In this sense, other works, such as investigations about syllabi, teaching plans, course projects, questionnaires, or interviews are important to locate the limits, problems, and potential of this author's work for the training of Science teachers in Brazil.

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**Responsible editor:** Lia Machado Fiuza Fialho

**Ad hoc experts:** Roberto Cardoso Freire da Silva and Helena Marinho

### How to cite this article (ABNT):

THIENGO, Lara Carlette; AVELAR, Danila Graziele Silva de; OLIVEIRA, Sarah Karoline Natalino; SANTOS, Francielle Luzia de Souza. Freire's perspective on the training of Natural Science teachers: a literature review. *Educ. Form.*, Fortaleza, v. 7, e8047, 2022. Available at: <https://revistas.uece.br/index.php/redufor/article/view/8047>



Received on May 2, 2022.

Accepted on October 3, 2022.

Published on December 20, 2022.