

A questioning of the emergence of the Natural Science Teaching Methodologies in Brazil¹

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ABSTRACT

It seeks, through a genealogical perspective, to trace some lines that allow us to understand the forces that contributed to the establishment of the majority perspective, established in the 1980s and 1990s, which guides the discipline of Teaching Methodology of Natural Sciences in the curricula of initial teacher training in Brazil. From the important influence of Paulo Freire, Dermeval Saviani and Demétrio Delizoicov, attention is mobilized to the conditions of possibilities that made possible the consolidation of Methodologies for Teaching Natural Sciences. The intertwining of these forces has the potential to cultivate educational strategies with undergraduate students, to the detriment of the application, with protocol dyes, of a sequence of didactic procedures that guarantee the didactic transposition of scientific contents historically accumulated by humanity, linked to the double teaching-learning so well accommodated in the guarantees of schooling.

KEYWORDS: Didactics. Teacher training. Graduation.

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Uma problematização da emergência das Metodologias do Ensino de Ciências Naturais no Brasil

RESUMO

Busca-se, por meio de uma perspectiva genealógica, traçar algumas linhas que permitam compreender as forças que concorreram para o estabelecimento da perspectiva majoritária, estabelecida nas décadas de 1980 e 1990, que orienta a disciplina de Metodologia do Ensino de Ciências Naturais nos currículos de formação inicial de professores/as no Brasil. A partir da importante influência de Paulo Freire, Dermeval Saviani e Demétrio Delizoicov, mobiliza-se a atenção para as condições de possibilidades que tornaram possível a consolidação das Metodologias do Ensino de Ciências Naturais. O entrelaçamento dessas forças apresenta o potencial de cultivar estratégias educacionais com estudantes de licenciatura, em detrimento da aplicação, com tintes protocolares, de uma sequência de procedimentos didáticos garantidora da transposição didática dos conteúdos científicos historicamente acumulados pela humanidade, atrelados ao duplo ensino-aprendizagem tão bem acomodados nas garantias da escolarização.

PALAVRAS-CHAVE: Didática. Formação de Professores. Licenciatura.

Un cuestionamiento del surgimiento de las Metodologías de Enseñanza de las Ciencias Naturales en Brasil

RESUMEN

Buscamos, a través de una perspectiva genealógica, trazar algunas líneas que nos permitan comprender las fuerzas que contribuyeron al establecimiento de la perspectiva mayoritaria, instaurada en las décadas de 1980 y 1990, que orienta la disciplina de Metodología de la Enseñanza de las Ciencias Naturales en los planes de estudio de Formación inicial de profesores en Brasil. A partir de la importante influencia de Paulo Freire, Dermeval Saviani y Demétrio Delizoicov, se moviliza la atención para las condiciones de posibilidades que posibilitaron la consolidación de las Metodologías para la Enseñanza de las Ciencias Naturales. El entrecruzamiento de estas fuerzas tiene el potencial de cultivar estrategias educativas con estudiantes de

pregrado, en detrimento de la aplicación, con tintes protocolares, de una secuencia de procedimientos didácticos que garanticen la transposición didáctica de contenidos científicos históricamente acumulados por la humanidad, vinculados a la dualidad enseñanza-aprendizaje tan bien acomodado en las garantías de la escolarización.

PALABRAS CLAVE: Cosas didácticas. Formación de profesores. Graduación.

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Introduction

The concept of didactics developed by Comenius (2006) is linked to his work " Didactics Magna: a treatise on the universal art of teaching everything to everyone", published in 1657. A work established as the "founder" of modern pedagogy, which contributes to Comenius (2006) being taken as the main reference in the context of initial teacher training courses, including in Brazil, directly crossing the way in which we produce educational processes in formal schooling spaces.

In a study developed by Rigue and Corrêa (2021), they analyzed a genealogy of didactics through the bias of the initial training of chemistry teachers in Brazil and consider that:

[...] it can be inferred that Didactics goes through the promise of making an individual a teacher, a subject capable of teaching everything to everyone, as an art of teaching with a degree of divine perfection, as a practice that leads to student learning from point A to, inevitably, point B. This promise of Didactics is linked as a means by which someone becomes a teacher, as a way of technically and rationally organizing pedagogical practice (...) (RIGUE; CORRÊA, 2021, p. 03).

For a long time, initial teacher training was orientated according to the understanding that the combination of subjects from specific areas (Physics, Chemistry, Mathematics, History, among others) with General Didactics, understood as a series of teaching techniques, would provide future teachers with the necessary requirements for teaching practice (supervised internships and professional life).

The basic concepts of the various teaching areas, however, proved to require materials and means other than those emphasized by the teaching techniques of General Didactics: generally audiovisual techniques and group dynamics.

The disciplines of the Didactics spectrum in initial teacher training courses constitute the confluence between the specific knowledge of an area and the creation of educational strategies capable of promoting the understanding and use of the concepts of that same area by students (RIGUE; CORRÊA, 2021, p. 09).

The emergence of the notion of Special/Specific Didactics, or, as it came to be established in the jargon of the educational field, Teaching Methodologies, takes prominence with the emergence of discussions around the need for Methodologies that would account for the Didactic requirements for teaching the concepts and contents of the specific area.

To draw some lines that allow us to understand the forces that contributed to the establishment of the majority perspective that guides the discipline of Methodology of Teaching Natural Sciences in the curricula of initial teacher training in Brazil.

The present study is therefore based on the intention of drawing a line that pays attention to sparse points that dimension the field of Natural Science Teaching Methodologies in Brazil. To this end, it highlights three important influences in the debate that took place mainly in the 1980s and

1990s and that contributed to the consolidation of Teaching Methodologies, and specifically in this work, in the initial training courses for teachers of Natural Sciences in Brazil.

This debate was animated by numerous influences, among which we highlight the heated debate between the defenders of Paulo Freire's dialogical proposal, on the one hand, and the defenders of the historical-critical pedagogy of the contents defended by Dermeval Saviani, on the other. In a second moment, we discuss, based on the Foucauldian framework (2015), Demétrio Delizoicov's contribution to an updated theory of the Methodology of Teaching Natural Sciences in undergraduate programs.

Methodology

The present study develops a genealogy (FOUCAULT, 2015) interested in problematizing the establishment of the majority perspective, established in the 1980s and 1990s, which guides the discipline of Natural Science Teaching Methodology in initial teacher training curricula in Brazil.

The genealogy aims to understand the:

[...] conditions of possibility, in the domains of power and knowledge, of discontinuities, which produced the surface of emergence of specific statements and practices. These conditions contribute to the structuring of discursive fields and subjectivity-producing logics, including when it comes to the production of a notion of school and the initial training of its respective teachers (RIGUE, 2020, p. 40).

Gilles Deleuze (2013) clarifies that the sciences are not separated from the "[...] power relations that make them possible and that give

rise to knowledge that is more or less capable of crossing an epistemological threshold or forming knowledge" (p. 82). In this sense, the sciences are not exempt from their production contexts, which means that such dynamics of knowledge and power shape practices in schooling spaces (basic education; higher education; postgraduate; among others). Therefore, the genealogical enterprise initiated here starts from a reading of the world based on a poststructuralist epistemology that interweaves knowledge, power, understanding, "[...] history as an organized carnival" (FOUCAULT, 2015, p. 82).

It is part of the bias of methodologies in the teaching of natural sciences, through the bias of chemistry, but it is not denied that this movement of establishing the notions of teaching methodology is also common in all other areas of undergraduate education in Brazil. Thus, the way of knowing operates here by analyzing the conditions of possibilities/appearances that have allowed the consolidation of the methodologies of teaching science in the initial teacher training courses. To this end, the bibliographical productions of Freire, Saviani and Delizoicov, as well as some commentators, are the focus of the study, contributing to the identification of discursive fields and logics that produce subjectivities that affect (directly or indirectly) teacher training and pedagogical practices in science education.

A genealogical making: the Methodology of Science Teaching

In order to address the emergence of Methodology in the field of science education, the enterprise is modulated from the attention to some studies, among which the text produced by Demétrio Delizoicov, entitled "One in the carnation, another in the horseshoe" (s/d). We do this, first, because of the extreme visibility of the author's productions and his publications in the field in the national context, and second, because we understand this text as a source for the emergence of a

series of epistemological and methodological strategies taken in the field of natural sciences to teach children and adolescents.

The emergence of this text is characterized as an event⁴. An event because it emerges, in Brazil, within a clash of forces that had been taking place since the mid-1980s, between two perspectives of educational pedagogical thinking. First, the emergence of the thought of Paulo Freire, today the patron of education in Brazil. Second, the work of historical-critical pedagogy of Dermeval Saviani.

Paulo Freire⁵ produced a series of works with implications and impact on the national and international scene. "Pedagogy of the Oppressed", "Pedagogy of Autonomy", "Pedagogy of Hope" and "Education as a Practice of Freedom" were some of his texts that addressed issues of his time, framed by the contingencies of the Brazilian social and educational scenario.

Dialectics and critical thinking were theoretical trends that significantly influenced his productions. Works emerged that were defined by the writings and thoughts of Karl Marx, John Dewey, Antonio Gramsci and Jürgen Habermas, as well as the Brazilian whom Freire admired, Anísio Teixeira⁶. The concept of banking education, for example, emerged as a critique of attitudes that place the student as a mere receiver of concepts that emerge from the teacher's discourse. As an exercise in oppression that requires a permanently oppressed subject. Focusing on Freire's work 'Pedagogy of the Oppressed', especially chapters three and four, we go through traces that outline his perspective of thinking the didactic field.

⁴ As Gilles Deleuze (1974) writes: "All bodies are causes of each other, in relation to each other, but of what? They are causes of certain things of a completely different nature. These effects are not bodies, but, properly speaking, "embodied". They are not physical qualities and properties, but logical or dialectical attributes. They are not things or states, but events" (p. 5). The event is what happens, the virtuality of what affects beings and produces their transitions.

⁵ He was born on September 19, 1921 and died on May 2, 1997. According to Cordeiro (2007) Freire guided work in the field of the Catholic Church in the 1950s, guiding work from the perspective of solidarity with financially poor people.

⁶ Who operated with Dewey's thoughts in Brazil.

In the third chapter, "Dialogicity - The Essence of Education as a Practice of Freedom," Freire outlines his notion of dialogue for action in the world. It deals with the importance of the human being who speaks his word, his work and also his action-reflection in the world, as praxis. As "[...] reflection and action of human beings on the world in order to transform it. Without it, it is impossible to overcome the contradiction between oppressor and oppressed" (FREIRE, 1997, p. 38). In this context, Freire (1997) considers the act of speaking as an act of love and humility. For this reason, dialogue has a very important emphasis in Freirean thought, as an act of trust that is necessary for the development of critical thinking in educational processes.

In the point "Dialogue begins in the search for programmatic content", Freire (1997) presents the importance of education as a practice of freedom, a dialogical education only happens when "[...] one asks oneself what one is going to dialog with" (p. 47). Thus, the question linked to the context takes an important place in the language used to access the subjects, giving meaning, for example, to the programs of the disciplines, to the knowledge worked and to the situations of life.

From there, Freire (1997) emphasizes the importance of the existence of an efficient communication of the teacher, as one that dialectically contemplates the structural conditions of the students, as a strategy for establishing programmatic contents for education, emerging the understanding of the thematic universe and/or generating themes.

The thematic universe, also called the generating theme, appears as an investigation that favors a liberating education (FREIRE, 1997), as a historical and critical awareness of one's own existence - "[...] since the action provoked by them contains in itself the possibility of unfolding in many other themes, which in turn provoke new tasks to be fulfilled" (FREIRE, 1997, p. 10).

The study of the generating theme in Freire (1997) is contained in a practical thematic universe, in a concrete situation. In a dialectic that Freire

sees as a back and forth movement, "[...] from the abstract to the concrete, which occurs in the analysis of a codified situation⁷, leads, if the decoding⁸ is well done, to the overcoming of abstraction with the critical perception of the concrete (...)" (FREIRE, 1997, p. 55).

The generating themes are conceived as "[...] man-world relations" (FREIRE, 1997, p. 56), so their investigation concerns reality and their action in this context. This investigation is a methodology thought by Freire because, according to him, "the methodology we defend is to investigate, let us repeat, people's thinking related to reality, is to investigate their action on reality, which is their praxis" (FREIRE, 1997, p. 56). Thus, from the researcher's point of view, it is interesting to detect the beginning "[...] in his way of visualizing objectivity, to verify whether or not (...) some transformation in his way of perceiving reality has been observed" (FREIRE, 1997, p. 57).

Nevertheless, the method of studying the generating theme requires the problematization of the themes, their historical and cultural involvements. Therefore, the immersion in the spaces where the pedagogical work is carried out seems to be an important deepening for the awareness. This same study of the generating themes can be done, for example, first with the union of subjects interested in thinking together, followed by the approximation of the context of interest (thematic circle) and the critical look at its problems, its contradictions that will serve as material for "[...] codifications⁹ that will serve the thematic investigation" (FREIRE, 1997, p. 62). After this coding process, the subjects will have to decode the situations, revealing their views about what was experienced. Then, a "[...] systematic and interdisciplinary study" (FREIRE, 1997, p. 66) is carried out, which

⁷ As a codified life situation "[...] drawn or photographed situation that refers, by abstraction, to the concrete of existential reality" (FREIRE, 1997, p. 56).

⁸ As an externalization of worldviews, of perspectives on reality. Their awareness of the codified (objectified) real.

⁹ They can be painted, drawn, photographed, for example. They are like "[...] cognizable objects, challenges" (FREIRE, 1997, p. 62), thematic fans that reflect a kind of situation of existence.

allows a thematic delimitation by professionals in the field, with the emergence of a thematic reduction project.

In this movement of thematic reduction, some themes are highlighted, which allows a re-coding in order to select better communication channels to represent this theme (visual, graphic, tactile, among others) (FREIRE, 1997). From the elaboration of the program emerge didactic materials, strategies for reading texts, articles, interviews, among others. Thus, from the undertaking to look at the construction of Freire's (1997) generating themes, we can visualize an undertaking to establish a methodological strategy in education.

In the fourth chapter, "The Theory of Antidialogical Action," Freire reiterates the importance of dialogicity with the masses for a social revolution, an authentic revolution. As an opportunity to pronounce the world as a "[...] problematizing pedagogy" (FREIRE, 1997, p. 77). To this end, this chapter focuses on an analysis of dialogical and antidialogical theories, namely: a) Dialogical theories are built "[...] for the transformation of the world in collaboration" (FREIRE, 1997, p. 96), from the establishment of trust between peers and the collectivity.

An organization of the masses and their testimony strengthens the cultural transformation and allows a permanent problematization; b) Anti-dialogical theories appear as those that aim to conquer, to dominate, "Every act of conquest implies a subject to conquer and a conquered object" (FREIRE, 1997, p. 78), as a kind of host that oppresses. At the same time, they resort to permanent divisions in order to maintain their power, weakening collective and common movements, while at the same time using strategies of manipulation to conform the popular masses. Freire (1997) highlights strategies of cultural invasion as those undertaken by anti-dialogical theories to impose worldviews external to the context.

In both chapters of *Pedagogy of the Oppressed*, Paulo Freire elaborates on the construction of an educational method. It is in this

theoretical and methodological endeavor that Freire builds what many authors in the field of natural sciences have relied on years later. In turn, one cannot fail to mention Freire's investment in the education of adolescents and adults through the cultural circles, as a possibility for classroom work that comes to the meeting of non-hierarchizing the relationship between teacher and student in educational spaces.

In addition to Freire's work, there has been a movement of thought in which the figure of the teacher Dermeval Saviani stands out. In the 1980s, there was a significant effort for the emergence of a historical-critical theory in the field of Brazilian schooling. A movement of historical-critical-social pedagogy based on the writings of Karl Marx, in addition to the conceptions of Antonio Gramsci, Mario Manacorda and Georges Snyders (MARTINAZZO, 1993). For Saviani (2018), historical-critical pedagogy is elaborated "[...] based directly on the theoretical categories formulated by Marx, considering that students, as concrete individuals, manifest themselves as a unity of diversity" (p. 81). Thus, Saviani (2018) justifies this quest as follows: "[...] I resorted to some of Marx's foundational texts, especially the distinction between material and immaterial production" (p. 82). Moreover, "the conception of the world, of man and of society elaborated by Marx, which is the basis of historical-critical pedagogy, starts from the realization of man as a bodily being who produces himself materially by producing his means of existence" (SAVIANI, 2018, p. 80). For him, in the case of the New School movement, "the children of the elite went to school already having absorbed the contents of the environment in which they lived; contents that integrated their own experience" (SAVIANI, 1980, p. 211). This confirmed the education of the popular strata from the precepts of the elites.

According to Martinazzo (1993), a scholar of Dermeval Saviani, his writings show concern for the economic and social advancement of students who attend schools, in the sense that their purposes are socio-political in

education, and the educational question is related to the social and class problem (MARTINAZZO, 1993). As he writes, Saviani "[...] uses dialectics as a method; guiding path of teacher education in the teaching-learning process. Dialectics, in its cognitive dimension (...) as a valid method (...)". (MARTINAZZO, 1993, p. 104).

Taking as an important point of analysis the book "Rethinking Didactics" (VEIGA, 1988), we can produce an overview of the crossings of Savianist thought in the schooling process carried out in Brazil. The book is a sequence of texts articulated to think, specifically, didactics in the field of teacher training. In a review of the chapters that make up the aforementioned book, we can verify its strong materialist tendency when, for example, in the first chapter "Didactics: its relations, its assumptions" by Olga Damis, they affirm that "[...] the teaching of the "art of teaching" to be critical cannot be limited to the means disconnected from the social ends of schooling (...)" (VEIGA, 1988, p. 22).

In this perspective, the content of teaching and also a social practice appear as necessary as the purpose of education in historical-critical pedagogy, where "[...] educational activities would be planned with reference to the socio-cultural, economic and political problems of the context in which the school is inserted" (VEIGA, 1988, p. 45).

There is a concern with the "[...] politicization of the future teacher" (VEIGA, 1988, p. 39), which places the assumptions of Saviani's historical-critical pedagogy as a solution to the problems of the field of didactic and methodological teacher training. The criteria for the organization of knowledge, for example, appears within a sequential logic of the contents to assist the teacher from a logic of the matter and psychological conditions "[...] consistent with the structure and purpose of the discipline; graduality in the appropriate distribution in small steps considering the previous experience of the student; continuity (...)" (VEIGA, 1988, p. 70). Moreover, such sequential logic of the teacher appears allied to the teaching method, as "[...] one of the possible elements for structuring the paths to be traveled in the didactic action" (VEIGA, 1988, p. 85), which "[...] must correspond to a

correct learning method" (VEIGA, 1988, p. 88), which may "[...] correspond to a correct learning method" (VEIGA, 1988, p. 88), which may "[...] become a kind of educational totality, where the destinations of the educational and methodological process are drawn from the interrelation and integration (...) in the educational act" (VEIGA, 1988, p. 88). In this perspective, "every didactic situation, however simple it may seem, is complex. It requires that you make your decomposition based on the concrete elements that characterize it" (VEIGA, 1988, p. 88).

In this respect, logical and psychological structures are interwoven with pedagogical functions, with schooling in this sense having the formative purpose of the theoretical and practical emancipation of the student (VEIGA, 1988). In this way, Saviani's historical-critical pedagogy, or the critique of the content of school curricula, materialized in the 1980s as a possibility for the intellectual and financial advancement of students and their respective families. Considering the two endeavors of Paulo Freire and Dermeval Saviani, it is possible to identify the tensions in which the two share and in which the two, undeniably, oppose. They share as an opposition to the technicist educational proposal made years earlier, through the educational actions triggered between 1964 and 1985, in favor of consciousness. Both are intellectuals situated in a problematizing perspective of social conditions and contingencies, with references and inspirations in Karl Marx and Antonio Gramsci - in dialogicity. Although both were situated in a Marxist and Gramscian theoretical framework, with a special place for conscientization, their proposals diverged to the point of representing non-negotiable oppositions within the framework of educational thought. While Paulo Freire developed a line of thought based on dialogical premises and self-education, based on the appropriation of the words of the world by the oppressed, Dermeval Saviani developed a social critique of class division and the appropriation by the popular masses of the universal codes and contents historically accumulated by humanity, of which schools were the vehicles. In Saviani's thinking, while the elites

strengthened themselves by studying school content in order to pass entrance exams (higher education) and subsequently gain access to financial resources, the working class could not "waste time" in producing contextualization and dialogicity.

In general, they are opposed to each other insofar as one, Paulo Freire, proposes a process of autonomation of the oppressed through the autonomy acquired in educational processes of consciousness, production of meaning of words and dialogicity; and the other, Dermeval Saviani, invests in the popular classes taking over the educational processes available to the elites for their own advancement, with a historical-critical perspective.

These two perspectives have given rise to efforts and researches that have promoted investigations in different fields of knowledge. In the case of a relevant research that paid attention to the field of dialogicity and, in particular, to think about the notion of "banking education", there is the master's thesis entitled "Workshop: pointing out possible territories in education" (CORRÊA, 1998). In the dissertation, Corrêa (1998) asks: if education is given this dialogical character, who conscientizes whom? The researcher elaborates this problematization after presenting in his study a series of experiences within the school and the classroom, as well as his efforts directed in the practices to produce an educational intervention characterized as dialogical. After all the investment to realize such a work, he considered:

[...] as a teacher, instead of feeling like a banker, I felt, rather, bankarized¹⁰, that is, addicted to school, believing in school as the only way to education, admitting the teacher-student game as the only way to learn and believing in salaried work as what would transform someone useless into

¹⁰ "When someone enters a course that will prepare them for a career in teaching, they already know what it is to be a teacher, what a good lesson is, what a bad lesson is, what curriculum, discipline, grading and assessment mean. In short, they know what is desirable and what is not desirable in terms of education. This knowledge does not imply, however, that everything he knows can be verbalized, because it is not an intellectual knowledge, it is not available for discourses. The channel of this knowledge is the body. Those who have completed a secondary school course, aged around eighteen, have at least eleven years of schooling" (CORRÊA, 1998, p. 28).

someone useful and good; someone trained to put himself in his place, to be quiet, to fear his superiors. In the experience with my fellow teachers I could see how many of them wanted to do something new in education, however, when trying something different to develop a handout, to come up with a fairer system of evaluation, or even to invite professors from the University to give lectures on how to develop a political pedagogical project for 'the school always ended up, as I did, offering as a solution to a school practice that they considered outdated, the same old school practice (CORRÊA, 1998, p. 28).

Feeling banked¹¹ is a traversal that emerges from the experiences and educational undertakings that have been detached, which is fuel and also a symptom that, in one way or another, we have not been able, in terms of teacher education, to operate with what is projected to us as 'ideal' in the discursive sphere.

In any case, it is in the context of the two perspectives mentioned above, Paulo Freire and Dermeval Saviani, that the text 'One in the clove, another in the horseshoe' (s/d), by Demétrio Delizoicov, emerges, having as its central problem the limitation of General Didactics for the training of teachers in specific areas. The importance of the text lies in problematizing the role assumed by General Didactics, taken, until then, as sufficient for the work of didactic transposition of the contents in the teaching situations of Natural Sciences in teacher training. Although it may seem contradictory to attribute this importance to a text that has never been published, one cannot ignore its wide circulation on the scene of postgraduate courses and research in Science Teaching and, especially, in academic debates in the area.

¹¹ "[...] the meaning of this bankarization, the process to which someone is subjected in order to become a teacher, is not exhausted in the training through which the school makes the teacher emerge. What completes the meaning of this action are its effects that extend for almost the entire life of this individual, in turn, always incomplete and, therefore, always subjected to the school that continues to form him, offering continuing education courses, banking, that is: allowing him to continue wanting to do something new, giving him, however, a single matrix where he can put this desire: schooling, with all its unifying effects" (CORRÊA, 1998, p. 30).

The text was part of the readings indicated in the disciplines offered by Angotti and Delizoicov in the Postgraduate Program in Education of the Federal University of Santa Catarina, in the 1990s, in the line of research Education and Sciences. Access to such material was given by one of the authors of the present study, when he was still a graduate student at that institution and time. The ideas condensed in 'Uma no cravo, outra na ferradura' (One in the clove, one in the horseshoe')(s/d) were welcomed and debated by important exponents of research in Science Teaching in the 1990s. Among them, Marta Pernambuco and Eduardo Mortimer stand out.

Delizoicov's text can be thought from the reliefs that we perceive in his writings. Right in the introduction, Delizoicov mentions the work developed by Paulo Freire. It deals specifically with the difficulty of developing Freire's work¹² with young people and adults in Brazilian public schools, justified by the lack of thematic reduction in the teacher's work. Delizoicov highlights the importance that Freire's work makes possible in the field of methodological approach, which can come to "[...] guide the educational work in public school and even structure previously a (universal) programmatic content" (DELIZOICOV, s/d, p. 02).

Following Delizoicov's text, the author emphasizes Paulo Freire's approach, characterizing it as steps to obtain a program. The steps are as follows: First stage: preliminary survey; Second stage: analysis of situations and choice of codifications; Third stage: decoding dialogues; Fourth stage: thematic reduction; Fifth stage: work in the classroom.

In the fourth stage, thematic reduction, there is a concern with a specific vision of the thematic domain. A concern with programming, with regard to specific content, which emphasizes the so-called 'role of the specialist', as Delizoicov (s/d) writes when he mentions that "[...] the role of the specialist at this stage is not negligible (...)" (p. 04). This is expanded when he goes on to state that the fact of placing himself in a dialogical

¹² Fourth stage of Paulo Freire's work with young people and adults.

position "[...] does not imply, (...) in not maintaining control of the process, especially with regard to the establishment and development of universal knowledge" (DELIZOICOV, s/d, p. 04).

Delizoicov's thought (s/d) deals with the need for specialized knowledge, coming from the specialist of the area, so that the knowledge offered to students (in general) is possible to be carried out on a macro scale. Using Freire's writings, the author also reinforces that the place of the specialist is based on his/her ability to produce a thematic reduction project, with specific nuclei, allowing the student to be able to have a broad view of a reduced theme.

Delizoicov (s/d) points out that more important than the action of the specialist in the elaboration of the curriculum "[...] especially when thinking about public schools - is the proposal of inclusion by the specialist himself, when necessary, of other themes that Freire calls "hinges" "(p. 04-05). This affirmation allows us to say that the construction of a project of thematic reduction by the specialist, with the intention of establishing and also developing universal knowledge in the context of the Brazilian public school, is close to the formulation of a curriculum. At the same time, it reinforces the specialty of the professional of a certain area of knowledge in the construction of certain knowledge with students in public schools.

When analyzing the fifth stage of Freire's work, Delizoicov highlights the importance of thematic reduction (fourth stage), which deals with the importance of the work of the specialist. For Delizoicov (s/d),

[...] the non-consideration of the process of thematic reduction - an integral part of thematic research and problematizing education - both in practical action and in the analysis of the Freirian proposal, has as one of the consequences the assumption that there is no previous structuring of universal knowledge, which, however, does not represent the educator's proposal (p. 06).

In this sense, it emphasizes the place of the specialist in the construction of programs and curricula, even in the work with generating themes. This emphasis on the place of the specialist in education articulates and, at the same time, strengthens the issue of the special/specific didactics of the field of knowledge, as well as specific methodologies, to the detriment of the general didactics previously developed with greater strength by multipurpose teachers (RIGUE, 2020).

Corrêa (1997) states that the notion of specialist is also a legacy of the series of agreements between the Ministry of Education (MEC) and the United States Agency for International Development (USAID) - MEC/USAID Agreements, implemented in Brazil in 1968, and the specialist was not only a scholar in the field, but, on the contrary, any subject with a scientific discourse legitimized by training "[...] psychologists, school supervisors, counselors, pedagogues, curriculum specialists and educational administrators" (CORRÊA, 1997, p. 126).

The emergence of the logic and technocratic perspective of the specialist - in the MEC/USAID agreements - appears as a strategy to ensure the naturalization and diffusion of scientific discourses, as a driving force for the extinction of colonial and imperial notions that until now have guided the educational training developed in Brazil. With the resumption of Delizoicov's work, an important reference in Brazil, this emphasis is activated in the field of natural sciences.

In the third part of Delizoicov's text, "Beyond the speeches", the author tries to resume part of the studies carried out with emphasis on the natural sciences. These were elaborated by Angotti and Delizoicov. Angotti's study deals with the use of "unifying concepts" as a guide for specialists in the elaboration of programmatic content in thematic reduction. These are crossed by "[...] regularities and invariances that can constitute supra-disciplinary concepts and facilitate the apprehension and analysis of a

phenomenon and/or a situation of everyday life, regardless of the field of knowledge" (DELIZOICOV, s/d, p. 11).

In Delizoicov's master's program, which also deals with the natural sciences, there is a "didactic-pedagogical option" that approaches Freire's dialogicity. This option is characterized by three pedagogical moments: "Study of Reality (ER), Organization of Knowledge (OC) and Application of Knowledge (AC)" (DELIZOICOV, s/d, p. 12).

In addition to the Generating Themes, Delizoicov, together with Angotti, was inspired by the 'Structure of Knowledge' and the 'Structure of Thought' for the use of 'Generating Questions'. The 'Structure of Knowledge' is embodied by the 'Unifying Concepts' present in the Generative Themes and characterized by historical and epistemological themes. The 'Structure of Thought' is based on learning theories¹³ and considers the interpretations of the general population.

The generating questions, formulated by the specialist, aim that the search for the answers "[...] refers to the understanding of the contents that interpret the phenomena and/or situations that will be studied, giving guidance to the specialists - programmers to establish the programmatic sequence" (DELIZOICOV, s/d, p. 14). The Three Pedagogical Moments (TMP), called didactic model or didactic-pedagogical dynamics, are developed from the established didactic sequence, as well as from its own language, where it is necessary to consider broad aspects of language to approach the language of natural sciences (DELIZOICOV, s/d). From the coding and decoding model, the work of Delizoicov and Angotti triggers the interpretive exercise as a deep structure, or rather as an exercise in abstract thinking, thought as a thematic approach. For Delizoicov (s/d):

The process of coding-decoding allows the teacher to apprehend the student's interpretation of the situation,

¹³ From the Cognitivist Theory of Jean Piaget.

which can be problematized and critically valued, questioning its internal consistency, problematizing its limitations, verifying its scope and working on its contradictions.) just as important is to build another intellectual option from this and via problematization, originating from systematized universal knowledge, which in the model is linked to the "deep structure", capable of covering explanations that were not previously possible with common sense knowledge (...) (p. 19-20).

Abstraction, possible through deep structure, can be obtained from this exercise of coding, problematization and decoding. As a strategy that allows the student to understand knowledge at the level of abstraction, associating levels of consciousness (effective and maximum) that allow interpretation (DELIZOICOV, s/d). As a construction of the educational process, Delizoicov (s/d) states that this dynamic of encoding, problematization and decoding, from a distance, is a horizon to establish "[...] another system of categories". In the case of science teaching, the system of categories assumes its own character, given the specificity of the "map of reality" to be obtained" (DELIZOICOV, s/d, p. 24-25). There, the student has the ability to develop a critical analysis while exploring.

Having codification, problematization and decoding as operational (methodological) terms, there would also be the ideological capacity to develop a map of reality, as a dialogue between student and teacher. As "[...] a dialogue between the systems of categories used by each of these subjects of educational action, an exchange of knowledge" (DELIZOICOV, s/d, p. 25). As a horizon for the student to be able to interpret knowledge at the level of abstraction, "[...] providing, in a crescendo, on the one hand, the appropriation of content by the learner and, on the other, the use and approximation of this content to real and lived situations (...)" (DELIZOICOV, s/d, p. 27). In this sense, the TMP

materialized as a proposal for a thematic approach to the teaching of science in Brazil. They establish the possibility of a didactic model or didactic-pedagogical dynamic for teachers to teach content in the field of science to students. To this day, it has prevailed as an important model taught in initial teacher training courses in the field of science. In general, the TMP have been able to provide a kind of roadmap/path (epistemologically based) for the progress of teaching related to the disciplines of science in the national territory.

Like the TMP, other structuralist perspectives have emerged, such as the Science, Technology and Society (STS) approach. In most of them, what is at stake is the construction of roadmaps/steps that structure the construction of scientific knowledge based on curricula that are justified by the need to relate school knowledge to issues involving society as a whole - from Basic Education to teacher training in Higher Education.

Weaving shifts of thought from such undertakings, it is possible to consider that the text produced by Delizoicov (s/d) performs an opening and closing movement. Closure, because it contains a specific look at the scope of the epistemology of teaching and training of teachers of Natural Sciences (although it understands that a good part of its recurrences falls on the epistemological scope). Openness, given the expressive presence of a tone that addresses a need for specific Methodologies in the Natural Sciences (Chemistry, Physics and Biology). Openness that crosses the connection of multiple other productions in the field of training of Natural Sciences teachers, together with several researchers in the area, producing another look at this theme in Brazil.

The thoughts and reflections that flow in 'Uma no cravo, outra na ferradura' (DELIZOICOV, s/d), are condensed in the various editions published in the book 'Ensino de Ciências: Fundamentals and Methods' (2009) prepared by: Demétrio Delizoicov, José André Angotti and Marta Maria Castanho Almeida Pernambuco. In advance, the authors propose

the need for "[...] science for all, and not just for scientists, and for scientific knowledge that approaches contemporary production, considering its interface (...), its social relevance and its historical production" (DELIZOICOV; ANGOTTI; PERNAMBUCO, 2009, p. 24). This work emphasizes the characterization of science and also technology as socio-historically, determined human activities, defending the use and interpretation of significant situations (problem situations) for understanding and developing what they call "[...] teaching program (...)" (DELIZOICOV; ANGOTTI; PERNAMBUCO, 2009, p. 193).

From an attention to the work undertaken by Delizoicov (s/d), which unfolds years later in 'Science Teaching: Fundamentals and Methods' (DELIZOICOV; ANGOTTI; PERNAMBUCO, 2009), it is possible to identify that there is, then, an alliance to the field of Freire's generating themes with the premises of Saviani's historical-critical pedagogy (which deal with the materiality of the work carried out at school). They associate the historically accumulated contents, giving conditions of feasibility for the approach of these contents in the school institution by the school mechanics and its gears to the educational process.

What can be considered is that in all these three important influences on the debate that took place, mostly in the 1980s and 1990s, and that contributed to the consolidation of teaching methodologies, and specifically in this work, in the initial training courses for teachers of science in Brazil, what does not appear is a criticism of the issue of the indiscriminate presence of the school and its "class" strategies in educational situations and its schooling agencies. Since the emergence of the Law of Guidelines and Bases for the Teaching of 1st and 2nd Degree (LDB) No. 5,692 of August one thousand nine hundred and seventy-one (1971) (BRASIL, 1971), we can see a significant effort to establish a notion of teacher training characterized by an emphasis on the relationship of teaching-learning dualism, even in the training of teachers (RIGUE; CORRÊA, 2021).

In other words, emphases aimed at propagating the perspective that when someone teaches, there is someone who learns, or, in other words, the development of the ability to teach and to be taught is qualitatively different from what the expression teaching-learning usually suggests: the ability to teach that would generate learning. In all the cases mentioned, whether in the work of Freire, Saviani or Delizoicov, what does not take shape is a movement of critique of the guarantees of schooling "[...] that any work in schooling must respect" (CORRÊA, 2000, p. 82), which ends up competing with or reinforcing the maintenance of practices that take on a dimension of the artificialization of life and learning. For Corrêa (2000), the guarantees of schooling are the most active elements when school is understood as a device, since "[...] they involve a whole complex of controls over time, knowledge and bodies, exercised through teaching programs, content selections, laws, schedules, evaluations, etc." (p. 75), which makes discipline affect bodies, institutions, lives. These same guarantees, marked by a series of measures, aim to operationalize a school record that is consistent with the operation of schooling, which requires attention to understand its movements, since "[...] they have the quality of being very familiar to the point of being naturalized by their presence in our lives since we were born (...)" (DE LA FARE; CORRÊA, 2015, p. 342).

The idea elaborated by Corrêa (2014) contributes to the idea that "the coercive nature of schooling automatically creates didactic problems, or teaching methodology" (p. 05). This is because, according to Corrêa (2014), this is where the teaching-learning relationship is naturalized as a pedagogical action, established with "[...] specific and limited ways of educating" (p. 06). An exercise based on the assumption that the use of teaching techniques would guarantee the learning of each individual (RIGUE; CORRÊA, 2021). Such gear feeds "[...] teaching-learning processes linked to forms of evaluation focused on the production of indices of performance or learning: the task" (CORRÊA, 2014, p. 06-07), which feeds back a *modus operandi* that supports the

guarantees of schooling, since "teaching the content and then fixing exercises, solving problems and tests whose final expression is the grade or learning index" (CORRÊA, 2014, p. 07). In this tone, in general terms, what has appeared in terms of production and narrative about the field of initial teacher training, including science teachers (chemistry, physics and biology), has reduced the logic of Jan Amos Comenius' (2006) "everything for everyone" to "everything and everyone, in smaller and smaller circles" (CORRÊA, 2006) of special/specific didactics (RIGUE; CORRÊA, 2021) and teaching methodologies. What we have seen are practices that invest in "conscientization", that shape the lives (of teachers and also of students) within a teaching-learning dualism that ultimately expands the possibility of inhibiting the power of the dimension of creative and active experience in the actions that take place in different educational contexts/territories. In addition, what has been possible to identify has been an excess of behavioral theories from the field of psychology in courses and teacher training (RIGUE, 2020), which end up composing with a discourse of pedagogical renewal from the behavioral sciences. The prevalence of the notion of "specialist" is also an effect of such practices that intertwine didactics and methodologies in Brazil, which also agency teacher training curricula.

Financial considerations

The study allowed us to present the genealogical panorama of the main lines of forces that contributed, in Brazil, to the emergence of what came to be constituted as Natural Science Teaching Methodologies in teacher education. From a Comenian-inspired Didactics, through Freire (1997), Saviani (1980; 2018), Delizoicov (s/d), to Delizoicov, Angotti and Pernambuco (2009), it is possible to dimension the main influences on the contemporary constitution of Natural Science Teaching Methodologies in Brazil.

Within this movement, Delizoicov's text 'One in the clove, another in the horseshoe' (n.d.) became relevant as a source for the emergence of a series of epistemological and methodological strategies taken in the field of Natural Sciences to teach children and young people. As presented, this emerged as a criticism of the sufficiency of General Didactics, in the midst of a clash of forces that had been taking place since the mid-1980s, between two perspectives of educational pedagogical thinking. First, the emergence of the thought of Paulo Freire, today Patron in Education in Brazil. Second, by the work of historical-critical pedagogy defended by Dermeval Saviani.

The work undertaken by Delizoicov combines the field of Freire's generating themes with the premises of Saviani's historical-critical pedagogy. They associate the historically accumulated contents, giving conditions of feasibility for the approach of these contents in the school institution, by its mechanics of teaching and learning to the educational process.

Within this spectrum, the teaching of Natural Sciences content according to the Three Pedagogical Moments ends up restricted to teaching-learning mechanics so well accommodated in the guarantees of schooling. Compromising, therefore, to a large extent, the creative powers of Teaching Methodologies.

The work within the field of Natural Science Teaching Methodologies in teacher training courses has the potential to cultivate strategies for mobilizing thinking with students, to the detriment of the application, with protocol tints, of a sequence of didactic procedures guaranteeing the didactic transposition of scientific contents historically accumulated by humanity.

What quality of dialog is possible when the content of the dialogical situation is established a priori?

Teaching Methodologies, when they give way to curiosity and its inseparable modes of attention, study, conditions of systematization and exchange of what is learned in view of knowing with will, can be fertile territories for a wide creation of educational strategies with undergraduate students.

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