

Initial distance training in Natural Sciences: pedagogical foundations and educational purposes

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Abstract: The objective was to investigate what scientific productions, which discuss the initial distance training of teachers in the field of Natural Sciences, reveal about the relationships between their pedagogical foundations and educational purposes. In the context of a state of knowledge, 31 scientific articles that are aligned with conservative and neoliberal purposes were analyzed, with weaknesses in their theoretical, epistemological and methodological aspects regarding the conceptions of science and teacher training.

Keywords: Graduation. Distance Education. Teacher Training.

Formação inicial a distância nas Ciências da Natureza: fundamentos pedagógicos e finalidades educativas

Resumo: Objetivou-se investigar o que as produções científicas, que discutem a formação inicial a distância de professores da área das Ciências da Natureza, revelam sobre as relações entre seus fundamentos pedagógicos e as finalidades educativas. No contexto de um estado do conhecimento, foram analisados 31 artigos científicos que se aliam a finalidades conservadoras e neoliberais, com fragilidades em seus aspectos teóricos, epistemológicos e metodológicos sobre as concepções de





ciência e formação de professores.

Palavras-chave: Licenciatura. Educação a Distância. Formação de Professores.

Formación inicial a distancia en Ciencias Naturales: fundamentos pedagógicos y finalidades educativas

Resumen: El objetivo fue investigar lo que las producciones científicas que discuten la formación inicial a distancia de profesores en el área de ciencias naturales revelan sobre la relación entre sus fundamentos pedagógicos y sus finalidades educativas. En el contexto de un estado del conocimiento, se analizaron 31 artículos científicos alineados con propósitos conservadores y neoliberales, con debilidades en sus aspectos teóricos, epistemológicos y metodológicos sobre las concepciones de ciencia y formación docente.

Palabras clave: Licenciatura. Educación a Distancia. Formación de Profesores.

Received on: 2024-06-18

Accepted on: 2024-08-21



1 INTRODUCTION

Distance Education (EaD) in Brazil is legally recognized as a teaching modality in Law No. 9,394 of December 20, 1996, which establishes the guidelines and bases of national education (LDB/96) because it "has its own profile, a specificity in the face of a process considered as a reference measure. It is therefore a way of existing with its own characteristics [...]" (Cury, 2000, p. 26, translated by us). This is because this modality has a teaching and learning process with specificities, especially when combined with digital technologies, configuring itself as complex, interactive, and with an emphasis on the construction and socialization of knowledge, through collaborative, cooperative work and a specific educational structure directed at all those involved in the process.

In this context, worrying questions arise, such as: is it possible to guarantee the right to education to all Brazilians when there are no licensed and, therefore, properly trained teachers in the country to work in basic education? And how can we guarantee that this type of education is of high quality and socially relevant when the working conditions of teachers and the learning conditions of students are not conducive to the teaching-learning process?

These questions and the current Brazilian educational scenario are not recent and have been part of the political discussions in the country for more than three decades. Among the dialogues about this reality, the provision of courses in the form of distance education (EaD) has emerged as one of the ways to mitigate the problems related to the number of qualified teachers with adequate and updated training (Shiroma; Evangelista, 2015; Malanchen, 2007; Silva, 2019).

In highlighting the debate on initial teacher training, it is essential to recall the sociopolitical situation in Brazil in 2004, a time when the government stated that it wanted to make up for the deficit of Physics, Chemistry, Biology, Mathematics, and Pedagogy teachers, and therefore authorized the opening of 17,585 vacancies for these courses in public institutions in the five regions of the country, in the form of a consortium. After the implementation of these emergency vacancies, in the following years, 49 thousand vacancies in the Pro-Licenciatura¹ program and 32,880 for undergraduate courses were launched by the Brazil Open University (UAB). In addition, other projects developed by higher education institutions (HEIs) throughout the country were launched (Malanchen, 2015).

The study by Barretto (2015) from 2011, and Silva (2019), with rates up to 2017, show that

¹ Licenciatura in Brazil stands for a degree for teacher training courses in Higher Education.



the percentage of enrollment in teacher training courses in Natural Science, in the distance education modality, was higher in public higher education institutions than in private ones. It should be noted that there was a growing and significant offer of distance education courses through the private network in all the courses analyzed.

Until 2016, distance education in educational institutions was usually associated with notifications from Brazil Open University (UAB). In this regard, the CNE Resolution No. 001/2016 presents the institutionalization of distance education, understood as "the object is incorporated into the culture of the institution, and the institution accepts the values, norms, and procedures necessary for the development of the object within it" (Lima; Cruz, 2022, p. 53, translated by us).

Data from the 2022 Higher Education Census show that the natural sciences (Biology, Chemistry and Physics) are among the 15 largest undergraduate courses in Brazil in terms of enrollment, ranking 6th, 9th, and 12th, respectively, with 76,264 (4.6%), 34,699 (2.1%) and 27,916 (1.7%) of enrollments. Between 2013 and 2022, the retention and graduation rate is higher in Biology, Chemistry and Physics. On the opposite direction (Physics, Chemistry and Biology), there is a cumulative dropout rate (Inep, 2023). Oliveira, Bezerra and Torres (2021, p. 11, translated by us), in their research on dropout in distance education, inform us that the reasons for dropping out are related to exogenous causes, namely "lack of time, followed by personal conditions, problems with tutors or teachers, family context, and finally access to the Internet" and endogenous causes, such as: "course difficulties, course management and the use of the technological platform for distance education".

Due to the process that regulates the institutionalization of EaD, this research, based on historical-dialectical materialism (MHD), seeks to problematize issues related to the right to quality education as a principle of equity and human condition for the existence of the subject in the world, through the discussion of the initial distance training of teachers of natural sciences.

In this scenario, we ask what scientific productions that discuss the initial distance education of teachers in the field of natural sciences explain the relationships between its pedagogical foundations and the progressive educational purpose. Thus, the objective of this work was to analyze the scientific articles that dealt with the topic addressed, between the years 1996 and 2017, considering the main discussions made about the pedagogical backgrounds in the context of initial distance training, in order to provide subsidies for analysis of having a distance education from the perspective of a socially fair school.

This study is the result of theoretical research whose methodology was bibliographic in



nature, of the state of knowledge type. Research of this type is important to understand what has been studied in a given area of study, which makes it possible to highlight the cooperation of investigations, as well as the advances that need to be made in both the theoretical and methodological fields, in addition to revealing propensities for future studies (Vosgerau; Romanowski, 2014). The works analyzed, which formed the corpus of this article, were scientific texts that published the results of research on the initial distance training of science teachers. Therefore, it was decided to select scientific articles because they are one of the main means of disseminating research results.

The mapping of texts for data collection was based on the Sucupira Platform of Capes, which uses the Qualis-Periódicos system for classifying scientific production. Articles related to the topic and classified with Qualis A were selected. In addition, the period from 1996 to December 2017 was defined as the time frame for data screening. The year 1996 is justified by the fact that it was from the LDB 1996 that Distance Education began to be recognized as a component of the Brazilian formal education system, and 2017 was the year that marked the end of a defended master's research and the year in which the implementation of Resolution No. 01/2016 should have begun.

2 A FIRST LOOK AT THE ANALYZED PRODUCTION

The corpus of analysis for this research is composed of 31 scientific articles, identified by codes (A1 to A31). The field of knowledge of the productions about the initial distance training of teachers in the modality of the natural sciences field was distributed as follows: 11 articles related to the course of Biology, 11 to the course of Physics, three to the course of Chemistry and 6 to the field of Natural Sciences (Chart 1).

Chart 1. Relationship by code of the articles that make up the corpus of analysis of this research, authors and Higher Education Institutions (HEIs) to which they are linked

CODE	YEAR	JOURNAL*	TITLE*
A1	2017	Revista Perspectiva	O currículo das licenciaturas em Ciências Naturais e Matemática em cursos a distância nos Institutos Federais do Brasil
A2	2017	Revista Tecnologia Educacional	Design e educação a distância: experiência digital para uma disciplina da botânica
A3	2017	Revista Brasileira de Ensino de Ciência e Tecnologia (RBECT)	Integração entre o conhecimento teórico e aulas experimentais no ensino de Física a distância: um estudo exploratório do depoimento de acadêmicos
A4	2016	Revista Contrapontos	A educação a distância e a formação de professores em licenciaturas na UFT





CODE	YEAR	JOURNAL*	TITLE*
A5	2016	Ciências & Educação	Os saberes docentes nos cursos de licenciatura a distância em Ciências Naturais e Matemática nos Institutos Federais do Brasil
A6	2016	Educação e Pesquisa	Educação a distância na ótica discente
A7	2016	Revista da SBenBIO	A formação de professores de Ciências Biológicas no âmbito da educação a distância (EAD): um estudo do currículo na abordagem dos mapas conceituais
A8	2016	Revista da SBenBIO	A natureza da Ciência (NdC) veiculada nos módulos didáticos (MD) do curso de Biologia da UESC, modalidade a distância (EaD)
A9	2016	Revista da SBenBIO	A Lei nº 10.639/03 e a formação de professores de Biologia num curso de educação a distância
A10	2016	Revista da SBenBIO	Interação entre fatores ambientais e fitoplâncton como ferramenta de educação ambiental no curso de licenciatura em Ciências Biológicas UFPI/EAD
A11	2016	Revista Brasileira de Ensino de Ciência e Tecnologia (RBECT)	Contribuições de um planejamento conjunto entre as modalidades presencial e a distância na constituição de uma disciplina de prática de ensino de Física
A12	2015	Ensaio: Aval. Pol. Púb. Educação.	Avaliação institucional em Ciências Biológicas nas modalidades presencial e a distância: percepção dos egressos
A13	2015	Revista Educação <i>online</i>	Graduação a distância: uma reflexão baseada no perfil dos acadêmicos do curso de licenciatura em Biologia pelo consórcio
A14	2014	Revista Ensaio	Perfil e destino ocupacional de egressos graduados em Ciências Biológicas as modalidades a distância e presencial
A15	2014	Caderno Brasileiro de Ensino de Física	Crítérios para a avaliação de materiais didáticos impressos de História da Ciência para Educação a Distância
A16	2013	Revista Brasileira de Pesquisa em Educação em Ciências (RBPEC)	Análise da discussão em fórum sobre a estratégia projetos de trabalhos com uso de TIC em um curso de licenciatura a distância
A17	2013	Revista virtual de Química	A formação do licenciado em Química na UFC discutida nas modalidades Ensino à distância e presencial
A18	2013	Revista Atos de pesquisa em Educação	Políticas na formação inicial de professores de Ciências: o novo percurso formativo a distância
A19	2013	Revista Reflexão e Ação	Perfil dos alunos de licenciatura a distância e aspectos que contribuem para aprendizagem
A20	2013	Revista Teoria e Prática da Educação	Análise de ementas de mecânica geral em cursos de licenciatura em física a distância
A21	2012	Revista da SBenBIO	Avaliação externa do conteúdo de <i>Web sites</i> de instituições de ensino superior públicas brasileiras que ofertam curso de Ciências Biológicas na modalidade de ensino a distância
A22	2012	Caderno Brasileiro de Ensino de Física	Ensino de Física mediado por tecnologias digitais de informação e comunicação e literacia científica
A23	2012	Caderno Brasileiro de Ensino de Física	Produção de conhecimentos sobre ensino de física na modalidade a distância: tendências, lacunas, novas questões
A24	2011	Ciência & Educação	A carência de professores de Ciências e Matemática na Educação Básica e a ampliação das vagas no Ensino Superior
A25	2010	Caderno Brasileiro de Ensino de Física	Expansão do ensino superior: panorama, análises e diagnósticos do curso de licenciatura em Física a distância da Universidade Federal de Santa Catarina
A26	2009	Química nova na escola	A leitura dos estudantes do curso de licenciatura em Química: analisando o caso do curso a distância
A27	2009	Revista Novas tecnologias na Educação (CINTED)	Licenciaturas na modalidade a distância e o desafio da qualidade: uma proposta de indicadores para aferir a qualidade nos cursos de Física, Química, Biologia e Matemática
A28	2009	Caderno Brasileiro de Ensino de Física	Ensino a distância e tecnologias na educação: o estudo de fenômenos astronômicos
A29	2008	Eccos - Revista	Utilização didática de objetos digitais de aprendizagem na Educação





CODE	YEAR	JOURNAL*	TITLE*
		Científica	<i>On-line</i>
A30	2007	Revista Linhas (Florianópolis)	Materiais didáticos em educação a distância: gestão e mediação pedagógica
A31	2006	Revista Novas tecnologias na Educação (CINTED)	Análise do projeto de licenciatura em Química à distância da REGESD

* The name of the journals and the titles of the articles were not translated in order to keep their originality.

Source: Adapted from Silva (2019).

Regarding the period in which these articles were published, although the mapping was carried out in 1996, a period that marked the recognition of distance education as a formal educational modality in Brazil, it was only after 2006 that the first works related to the research topic of this research were found. During this period, the Brazil Open University System (UAB) was established by Decree No. 5,800, which provided for the interiorization of higher education throughout the country (Brasil, 2006). After this milestone, a negligible number of publications was observed over the years, with a modest growth in 2013, with five articles, and in 2016, with eight.

Another important aspect concerns the regions of the country where the Higher Education Institutions (HEIs) are located, with which the authors studying this topic are associated. A large number of researchers were observed in the South (25) and Southeast (24) regions. The North region had no representatives, the Northeast region had 17 authors and the Center-West region had 12. There is also an international collaboration with a researcher from the University of Coimbra.

In line with this number of works, Malanchen (2007) points out that the regions with the highest number of institutions offering distance training courses for teacher education are the South, the Southeast, and the Northeast. The South and Southeast regions each offer 27% of the courses that exist in Brazil. The Northeast region ranks third with 25%. This is followed by the North (12%) and Central-West (9%) regions. Therefore, the largest number of scientific productions and researchers are found in the regions with the largest number of institutions offering distance training courses and older postgraduate courses.

It is worth noting that the North region, which will have about 16.4% of the distance education degrees in 2020 and about 34.3% in 2023, was not the subject of the study (SEMESP, 2023). According to these data, the study by Araújo (2008) found that between 1996 and 2007 there were no publications by researchers from this region on the relationship between education and technology. In this sense, this absence indicates that the topic of distance education or the relationship between education and technology represents a gap in the scientific field and an object





of study to be explored.

Of the data collected, the majority (67.7%) of the studies analyzed were conducted in public institutions (federal or state). Studies that analyzed some aspect of public and private institutions accounted for 16.1% of the works, 12.9% did not delimit any institution and one study (3.2%) analyzed data from the National Institute of Studies and Educational Research Anísio Teixeira (INEP). It is possible that these data were obtained because private universities were not available for research and/or because the researchers were from public institutions and only studied public spaces. This reveals a vast field to be studied - the private sector, intending to understand the contexts of establishing the training of science teachers, through distance education, in this unexplored space.

In this context, among the 31 articles observed, only four delimited the research problem. The others indicated objectives or justifications for the study. Regarding the research method, only two made this information explicit (A1 and A5), referring to the phenomenological process. This lack of theoretical, methodological, and epistemological delimitation observed in most articles reinforces the perspective presented by Cedro and Nascimento (2017), who state that education research is "experiencing a crisis" concerning the object and method of study.

In turn, research in the field of education presents some specificities, among which is the fact that it investigates aspects relevant to human beings in the midst of their respective humanization processes. This allows the raising of numerous questions that can be investigated in different ways, which constitute the methods and methodologies that can be used in the development of studies (Cedro; Nascimento, 2017).

Nevertheless, for Cedro and Nascimento (2007), the act of delimiting the object of study involves knowing the best method and procedures to study it. In this regard, Zanella *et al.* (2007) emphasize that:

In the research process, it is fundamental to pay attention to the relationship between the object and the research method, because the way in which the researcher approaches the facts he wishes to study, elaborating them in the form of a research problem, already brings with it, in the view he casts on reality, a methodological filter, a view that must be refined in order to construct the path he proposes to follow in his investigation (p. 25, translated by us).

In this sense, it is appropriate to state that methodological issues must be addressed explicitly to understand the path taken by the researcher to reveal the object of study. On the contrary, in the articles analyzed, it was found that the authors tended to leave the methodological paths implicit,





which makes it difficult to identify the problem being analyzed.

Thus, of the 31 studies analyzed, 14 identified the type of research carried out, of which 12 were theoretical (documentary or bibliographic) and two were case studies. The remaining 17 did not provide this information. Regarding the type of research, 10 were classified as qualitative, four as qualitative-quantitative, and two as quantitative. The other 15 studies did not specify this aspect. And most of them are empirical studies with indications of qualitative research.

Many researchers have neglected the search for an understanding of the totality of a phenomenon, limiting themselves to the study of the micro, of an isolated case, in the justification of trying to understand the multiplicity of factors that make up the phenomenon analyzed. On the other hand, they also point out the need for future studies to understand the whole, transferring the responsibility to other researchers. From this point of view, it would be as if it was possible to reach the whole of a phenomenon through the simple combination of numerous fragmented and microscopic studies, which makes such studies even more necessary.

It is true that, especially in the present moment and in the society we live in, the activity and the effort of trying to understand the phenomenon in its internal dynamics is increasingly difficult. This is because it is a laborious process that requires time and dedication. We observe an increasing demand from institutions for productivity, speed, and agility. This reality can be a dominant factor in the academic environment, which is reflected in the superficiality of many researches and, consequently, in the limited training of such researchers.

Furthermore, in the analysis of the methodological aspects of the scientific articles that make up the corpus of this research, the main forms of data collection were: document analysis (12), followed by the application of questionnaires (6) and interviews (5). In the other works, this procedure was carried out through forums, AVA, Moodle (4), observation (1), and others. Most papers did not mention this information regarding the data collection process.

When analyzing the topic of the research subjects, it was observed that in nine articles they were students, teachers, and coordinators with three researches each, and in two articles they were tutors and graduates. The other texts dealt with teaching materials, course projects, curricula, and others.

Regarding the analysis process, 17 studies did not indicate their theoretical basis for this aspect. Two articles mentioned content analysis and two mentioned the use of ideographic and nomothetic analysis. In addition, the following were mentioned: analysis of discursive interactions, discourse analysis, exploratory analysis, skimming, and others. This fact highlights the need for





greater theoretical rigor regarding the epistemological basis of the research since this aspect provides the categories for analysis.

In this process of understanding the reality studied, 75 keywords were identified. Of these, the most frequently cited, in decreasing order, were: distance education (17 repetitions); teacher training (eight repetitions); Physics degree (three repetitions); curriculum (two repetitions); higher education (two repetitions); history of science (two repetitions); Biological Sciences (two repetitions); and learning (two repetitions). The other keywords were mentioned only once each.

It is worth highlighting that although distance education was the most cited keyword, a more in-depth discussion about this modality and the specificity of teaching was not identified in the 31 articles, as well as the models/conceptions of distance education that support the articles. Some authors explored more historical aspects of the process of legalization, expansion, and "democratization" of this modality.

The same applies to teacher training, which was the second most cited keyword and which was only superficially discussed in most of the texts. Many works presented a discourse in which training was more focused on practice or technical training concerning the teaching professional.

3 THEMATIC FOCUSES AND THE PEDAGOGICAL BACKGROUNDS ON WHICH THE RESEARCHES ARE BASED

Based on the analysis of scientific articles and the recurrence of the themes studied, the main thematic focuses discussed in the works were structured (Table 1).

Table 1 - Main thematic focuses discussed in articles that address distance training for teachers in the area of Natural Sciences

THEMATIC FOCUS	ARTICLE CODE
Teaching resources	A2, A3, A8, A15, A16, A21, A22, A28, A29 and A30
Profile and perception of students and graduates	A6, A12, A13, A14, A17 and A19
Content and curriculum	A1, A7, A9, A10, A20 and A31
Public policies and expansion of distance education	A4, A18, A24, A25 and A27
Teacher training	A5, A11, A23 and A26

Source: Adapted from Silva (2019).

Furthermore, a significant amount of research dedicated to the study of teaching resources





was identified. In this study, 32.3% of the works (10 articles) were dedicated to the discussion of this topic in the context of distance teacher training. This result confirms the studies by Teixeira and Megid Neto (2017), which show an increase of 4.2% in works dedicated to "teaching resources" between 2004 and 2011; in the period 2006-2011, this was the only topic among the main ones studied by these authors. Moreover, studies by Echalar, Paranhos and Guimarães (2020) indicate that, among the 99 works they analyzed, there are two most recurrent trends: research that discusses the perception of what teachers think; and those that discuss pedagogical work mediated by teaching resources/methodologies, with or without the use of technologies.

The theme of "profiles and perceptions of students and graduates" was identified in six works, representing 19.3% of the total productions analyzed. This result points to another trend in research in the field of science education and confirms the studies of Teixeira (2008) and Teixeira and Megid-Neto (2017), since, according to these authors, the characteristics of students and teachers correspond to six of the main objects of study in academic productions in biology teaching in Brazil.

In this sense, the articles analyzed, which dealt with the subject in question, aimed to evaluate the perception of students and graduates on the following points the course (A6); the level of satisfaction of the students in relation to the course and infrastructure issues, as well as the curriculum, practical classes and the quality of the teachers (A12); the evaluation of the profile of the academics (A13 and A17); the professional destination of the graduates in the job market and the average salary they receive (A14); and the point of view of the distance education students in relation to the teaching materials and technological resources used (A19).

In view of this, it is clear that it is important to be aware of such issues in order to understand the audience of the courses and the point of view of students and graduates, in order to identify aspects that can be improved, such as the structure and organization of institutions and distance learning courses. On the other hand, analyzing and discussing issues that are limited to everyday life and subjective aspects of analysis, the result is an opinion that is limited to an immediate and apparent reality.

Concerning the "content and curriculum", this topic is covered by six articles, of which A10 deals with content, A9 explores the relationship between content and curriculum, and the others deal strictly with curriculum (A1, A7, A10, A20 and A31).

In addition, five articles (16.1%) dealt with the thematic focus "Public policies and the expansion of distance education". This is a low percentage, given the nature and importance of





discussing this element for a better understanding of the field.

Finally, the theme of "teacher training" was addressed by four articles, representing 12.9% of the works. Therefore, since productions were selected that dealt with teacher training, it is observed that this number characterizes a low percentage of studies dedicated to this topic.

Based on the analysis carried out and the theoretical framework adopted in this research, the perception emerges that a large part of the scientific productions that make up the corpus of this investigation focus their studies on the field of the apparent. One of the data that support this perception are the first two themes that are dealt with in this session. These aspects, taken together, correspond to 51.6% of the works whose analysis is strictly directed towards the teaching resources and the profile and perception of students or graduates.

This scenario is complex and requires even more complete and in-depth studies in order to identify the determinants that make up this entire context. To this end, it is necessary to analyze the political, economic, social and cultural issues of the universities involved and of the public they serve. Thus, questions arise such as: What are the causes of dropout? What is the concept of quality and educational rigor of the courses and their evaluation?

Therefore, in order to understand the theoretical orientation present in the texts, it is essential to point out all the authors cited in the bibliographic references of the 31 scientific articles analyzed. A total of 463 authors were mentioned. However, we will present those who were cited in at least three articles, that is, those who had a greater frequency, since the others were mentioned in only one or two articles (Table 2).

Table 2 - Authors most cited in the references of the texts investigated in this research

Order	Author	No. of repetitions
1	Paulo Freire	4
2	Michael G. Moore and Greg Kearsley	4
3	Silvio Luiz Souza Cunha	4
4	José Manuel Moran	4
5	Lev Semyonovich Vygotsky	3
6	Otto Peters	3
7	Fábio Sanchez	3
8	Maria Luiza Belloni	3
9	Maurice Tardif	3
10	José Andre Peres Angotti	3

Source: Silva (2019).

It is worth noting that the low recurrence of studies indicates a theoretical fragmentation on





the subject. Studies such as those by Cedro and Nascimento (2017), Silva (2019) and Alves Filho (2022) warn of the tendency of the field of science education not to have a well-defined theoretical framework for the study of the same phenomenon, which can cause a crisis in the construction of the object of study and the research method.

However, it is important to note that among the ten most cited authors, seven discuss distance education in their research. Thus, five researchers are Brazilian (José Manuel Moran, Maria Luiza Belloni, José Andre Peres Angotti, Silvio Luiz Souza Cunha, Fábio Lúcio Sanchez) and three are foreign (Michael Grahame Moore and Greg Kearsley and Otto Peters).

A first glance at this result reveals a great diversity of authors cited. However, it was not possible to identify a common theoretical line among the researchers in this corpus, especially about teacher training and the field of natural sciences. Although the aforementioned authors have been used in discussions that relate this teaching modality to teacher training, based on critical logic, a centrality on the subject and its choices is still observed.

In the field of learning development, professor and researcher Paulo Freire was cited in four articles, followed by Lev Semyonovich Vygotsky and Maurice Tardif with three citations each. The works of Paulo Freire were generally used to highlight issues related to the critical and autonomous formation of individuals. In A1 and A5, the authors cite the book "Pedagogy of Autonomy," in which:

The author reflects on the knowledge necessary for educational practice, defending the principles of dialogicity and politicality, in other words, the awareness and political formation of subjects, based on nine fundamental skills for conducting the teaching-learning process (A1 and A5, p. 6, translated by us)².

One of the most important tasks of critical pedagogical practice is to create the conditions in which students, in their relationships with each other and with the teacher, rehearse the profound experience of coming to terms with themselves. To accept oneself as a social and historical being, as a thinking, communicating, transforming, creative being, a dreamer, capable of being angry because one is capable of loving. To assume oneself as a subject because one is capable of recognizing oneself as an object. Accepting ourselves does not mean excluding others. It is the "otherness" of the "not me" or the "you" that makes me assume the radical nature of myself (Freire, 1996, p. 41, translated by us) (A1 and A5, p. 6, translated by us).

In articles A9 and A26, the authors cite the book "Pedagogy of the Oppressed" to discuss the role of the teacher in the student's education process. In A9, the authors use this text to address "banking education", a mode of education in which the teacher holds knowledge and has the role of

² Excerpts taken from the research *corpus* will be written in italics to differentiate them from direct quote.





transferring it to the student.

Individuals trained in a banking vision of education are passive and naive without the ability to reflect and think about the world in which they live; they are people who adapt to the purposes prescribed by the dominant minority (Freire, 1987) (A9, p. 5).

Many teachers use this methodology and thus contribute to the maintenance of the various existing inequalities, but not all are aware of the power of the methodology they use to maintain this framework of inequalities. In reducing inequalities, it is necessary for schools to be inclusive, not only opening their doors to students from different social strata, but providing the necessary conditions for the development of their potential (A9, p. 5).

Lev Semyonovich Vygotsky was cited in A13, A20, and A22. In A13 and A20, the authors cited Vygotsky only once in each paper, with A13 referencing him to support an argument about interaction, language, and social relations, and in A20, the authors mentioned Vygotsky only in the middle of a sentence that contained the word mediation, but did not delve into or discuss this issue further.

For Vygotsky (2007), interaction consists of interpersonal relationships with other individuals, contact with the social other, which promotes the internalization of culturally established ways of organizing the world and contributes to human psychological development. To this end, language plays a fundamental role in communication and in establishing shared meanings (A13, p. 4, translated by us).

In the context of EaD, mediation (Vygotsky, 1989) is carried out through information and communication technologies, especially with the development of the worldwide computer network (Internet) and the globalization of its access (Pires, 2001) (A20, p. 2, translated by us).

In A22, the authors drew on Vygotsky's studies and cited four of his works to support their research. They addressed the issue of language and social mediation in students' learning and development, and also considered the aspect that mediation becomes broader and more complex with the use of digital technologies:

We propose that an essential aspect of learning is that it creates the zone of proximal development; that is, learning awakens various internal developmental processes that can only operate when the child interacts with people in his or her environment and in cooperation with peers. Once internalized, these processes become part of the child's independent developmental acquisitions (Vygotsky, 1991, p. 101, translated by us) (A22, p. 9, translated by us).

We can consider that the introduction of ICT in physics education creates new and different relationships between culture and the individual, making mediation broader and more complex. In this case, recognizing the level of real development and its potential in mediation with culture becomes even more essential for learning (A22, p. 10, translated by us).





us).

Maurice Tardif was cited in A1, A5 and A15 of the discussions that address teaching knowledge.

Tardif (2002, p. 36, translated by us) defines teaching knowledge as "a plural knowledge formed by the amalgam, more or less coherent, of knowledge derived from professional training and disciplinary, curricular, and experiential knowledge". The author gives teaching knowledge a broad meaning that includes the knowledge, skills, abilities (or aptitudes), and attitudes of teachers, everything that is called knowledge, know-how, and expertise (A1 and A5, p. 4, translated by us).

For Tardif (2002), the teacher's knowledge is different from the knowledge of the subject specialist and focuses on knowing the subject in order to teach it. Thus, printed teaching materials must present methodological suggestions for teaching the content of the history of science (A15, p. 11, translated by us).

When analyzing the models of science teacher training that support the research under consideration, it was possible to observe that such paradigms were systematized by formal or dialectical logic. In this context, for the conceptions of teacher training, there are 21 articles (67.7% of the total corpus) that present a preponderance of dichotomy between technical and practical rationalities, namely: the withdrawal of theory, the centrality on the subject (profile of subjects, skills, and practice) and the focus on the theoretical/technical apparatus and techniques; and for the conceptions of science, 19 works (62.3%) do not discuss nor signal issues that make it possible to carry out the analysis of this article (Table 3).

Table 3 – Teacher and science training models that underpin academic research on distance training for Natural Sciences teachers

LOGIC OF KNOWLEDGE	TEACHER TRAINING MODEL	CONCEPTION OF SCIENCE
FORMAL	A2, A3, A6, A7, A9, A10, A12, A13, A14, A16, A17, A19, A21, A22, A25, A26, A27, A28, A29, A30 and A31	A1, A2; A3, A4, A5; A6; A7, A9; A10, A11, A12, A13, A14, A16, A17, A18, A19, A20, A21, A23, A24, A25, A27, A28, A30 and A31
DIALECTIC	A1, A4, A5, A8, A11, A15, A18, A20, A23 and A24	A8, A15, A22, A26 and A29

Source: The authors.

Table 3 shows that most of the studies (18) have a formal knowledge logic linked to the teacher training model and the conception of science; on the other hand, 11 studies (A1, A4, A5,





A11, A18, A20, A22, A23, A24, A26, and A29) oscillate their conceptions between formal and dialectical logic; and two other studies (A8 and A15) are based on dialectical logic. Thus, in the movement to understand the logic and formative models that support the scientific articles analyzed in this research, the studies of Lefebvre (1991), Kosik (1976) and Kopnin (1978), whose studies analyze the assumptions of formal logic and dialectical logic, were used as references.

Lefebvre (1991) claimed that formal logic is the basis for the organization of scientific knowledge, the so-called modern science. Therefore, it begins with rational thinking, a moment of grasping the phenomenon, since it guides and reveals its apparent immediacy. Such logic, in the understanding of the social and educational world, leaves many gaps for the phenomena studied because it can suppress the political, ethical, and epistemological contexts, revealing the dichotomous view that recognizes and considers the part and not the whole. The studied phenomenon becomes hermetic to its context, neglecting that the phenomena are part of a dynamic movement, permeated by transformations and constituting a historical, contradictory, and critical process.

In capitalist society, formal logic is characterized by neo-positivism, the basic principle of which is the notion of science as a set of information derived from the rules of formal logic (Fataliev, 1966). Thus, in order to have a better understanding of a given subject, it is necessary to simplify, reduce, and specialize. Thus, it is understood that this logic contains technical rationality and practical rationality, since both have, to some extent, a dichotomous, ahistorical, uncritical, and reductionist aspect.

In technical rationality, content, knowledge, and technique assume an autonomous role in relation to the use to which they are put. In practical rationality, the subjects are fully responsible for their practice, they are placed at the center of the pedagogical process, they have "autonomy" to carry out their practice and the valorization of their knowledge, allowing adaptations and adjustments to the systems.

This professional must, above all, be able to constantly reflect on his or her practice. He or she must be able to focus his or her pedagogical actions on problem-solving, constantly exercising interdisciplinarity and multidisciplinary work (A31, p. 5, our emphasis, translated by us).

The REGESD Distance Training Licenciatura's Degree in Chemistry has a well-defined and structured theoretical framework from the perspective of training teachers capable of reflecting on their own practice. The course curriculum encourages this reflection and is centered on generating themes, which articulate the objectives established for each semester in an integrative seminar centered on practice, based on research, extension and





teaching (A31, p. 8, our emphasis, translated by us).

[...] requires that teachers know and understand the innovations that are intended and calls for innovative, learner-centered teaching and learning strategies that begin by paying attention to what learners already know about the natural world – an essential step in processes of conceptual change guided and stimulated by Science teachers –, use knowledge of how students think scientifically and of current and well-founded ideas regarding Science teaching to help students learn various scientific concepts (Pedrosa, 2008, p. 6) (A9, p. 6107, our emphasis, translated by us).

In the context of the centrality of practice, another frequent element in the analyzed works is the term "competencies", which appears in 17 works and with 57 repetitions. This combination of the centrality of practice, "reflective thinking" and competencies may refer to the debate on learning to learn, present in the National Common Curricular Base (BNCC) and in CNE Res. No. 002/2019, which results in the decline of theory and, consequently, affects the right to quality education.

The pedagogy of skills establishes the pragmatic and necessary link with neo-schoolism, but now it adapts the construction of operational skills required by the market to the cognitive development of the subject. It begins to drive the discourse of multilateral organizations and becomes a necessity for implementation. (Alves Filho, 2022, p. 2, translated by us).

This context was widely exploited by large technology conglomerates during the Covid-19 pandemic. The neo-technicist logic, combined with the context of social inequality in Brazil, increased the precariousness of teaching work, with an exhausting overload of administrative activities and pedagogical improvisation, due to the lack of a real state project for Brazilian education (Marques *et al.*, 2021; Peixoto, 2022; Saviani; Galvão, 2021).

The discourse of democratization that emerges from much research, international organizations, and the State is effective in the intensification of digital technologies in teaching and learning processes, including distance education in teacher training, which hides many aspects instead of democratizing a social right.

Baptista *et al.* (2022), in the study of distance training courses in Biological Sciences, offered in the State of Goiás, indicate that the vast majority of higher education institutions (HEIs) (19 of the 22 HEIs found) are part of the private education network, of which five are non-profit and 14 for-profit. Of these, 11 form the largest private higher education conglomerates in Brazil. Of the courses offered by public HEIs, "a certain distribution of centers across Goiás is observed, with greater centralization around the metropolitan region of the state and the Federal District" (Baptista *et al.*, 2022, p. 331, translated by us).

The two studies (A8 and A15) are consistent in their conception of teacher education and





science from a dialectical/critical perspective. Furthermore, these studies emphasize the need for a training process that guarantees historical, political and philosophical foundations for specific knowledge, as well as solid didactic-methodological training.

The inclusion of components of the History and Philosophy of Science (HFS) in several national curricula can, on the one hand, enable students and teachers to go beyond the recording of facts and the mere chronicling of scientific knowledge, which is often limited to the description of names, dates, and results. On the other hand, it makes it possible to better understand the history of the construction of knowledge and to provide a more appropriate scientific education, as it prioritizes the dynamic aspect of scientific knowledge, awakening the student to the possibility of reflection. Matthews (1995) argues that it is necessary to teach HFC so that students a) can establish parameters between the present and the past; b) are able to characterize the process of knowledge production as a dynamic search for reality; c) know the aspect and the factors that have contributed to the emergence and development of the topics addressed in the manuals (Matthews, 1995, p. 165, translated by us) (A8, p. 7756).

The choice of the history of science as a guiding axis for the proposal of criteria was made because the teaching of this discipline seeks to present scientific knowledge as a relative truth, because it seeks to consider the influence of values and interests on scientific practice, and because it seeks to list physics contents in their social, historical, cultural and economic aspects. [...] the document suggests that the future elementary school teacher must meet the conditions to overcome the fragmentation of contents (Brasil, 2002, p. 28, translated by us) (A15, p. 433).

Knowledge deliberately organized and planned by the teacher, within the movement of unity and struggle, denies, incorporates, and overcomes the existing immediate knowledge and can make possible a new whole that recognizes the internal connections and multiple determining factors that constitute that knowledge. For Kopnin (1978), the notorious character of dialectics as logic is due to:

[...] its ability to reconcile the objectivity of the content of the concepts and theories of science with their mutability and instability. Furthermore, dialectics shows that it is impossible to obtain objective truth outside of development. Contemporary science needs a logic that reveals the laws of knowledge as a process of knowing the object through thought (p. 82, translated by us).

Because of the study carried out so far, it has been possible to perceive that scientific research in teaching, especially in the field of science education, needs to discuss more the importance of theoretical and methodological rigor in the research process since a large number of studies have been identified that do not delimit the object or the research method, nor do they present the methodological path followed for their development. This indicates a theoretical weakness in these works, with a possible "retreat of theory" (Moraes, 2001).



4 PROGRESSIVE EDUCATIONAL PURPOSE AND DISTANCE EDUCATION: LINKS TO BE BUILT

From 2016 to 2024, Brazil experienced political turmoil with a legal-parliamentary coup, which resulted in significant changes in national resolutions regarding teacher training and distance education. Within the framework of this teaching modality, new resolutions and decrees emerged, such as MEC Regulation No. 11/2017, Decree No. 9,057/2017, among others. In the area of teacher work and training, a National Common Curricular Base (BNCC) for basic education was implemented in 2019, as well as the appointment of new guidelines for teacher training (CNE Res. No. 002-2019 and CNE Res. No. 001-2020). In addition, between March 2020 and April 2022, the world experienced a health crisis - declared the Covid-19 pandemic - which had numerous consequences, including for Brazilian education.

In this context, it is worth remembering that technology in schools has always existed, to a greater or lesser extent, whether in textbooks, supplementary materials, whiteboards, games, and other resources. In addition, after the 1980s, digital technologies began to be introduced to public and private schools to some extent through various federal projects, programs, and partnerships. However, the period of the Covid-19 pandemic, experienced worldwide, in addition to several impacts on life in society (loss of peoples' lives, increase in diseases that affected mental health, increase in the state of poverty), increased the use of digital technology, as well as the sale of technological devices to various educational networks and other sectors of the population.

Aware of the data discussed in the previous sections and the educational context of recent years, this section aims to problematize the democratization of knowledge and social justice in distance education over the last seven years, based on the data collected and analyzed. To this end, there will be an approximation between the studies of Lima and Alonso (2021), when discussing the conceptions of quality in distance education (merco-economist and socially referenced), and the discussions on the educational purposes of Libâneo (2019). This is because both analyses allow us to understand the clashes of interests, values, and ideologies that constitute the logic of the functioning of the educational institution itself and its formative process. Thus, it is possible to summarize two main strands to think about educational purposes in distance education: conservative (containing the merco-economist bias) and progressive (containing the socially referenced bias).

Ultimately, the conservative educational purpose aims to establish the social reproduction of





the current status quo, preserving the values and traditions of the bourgeois class, in which there is a commitment to profit, linked to indexes and metrics, fragmentation, resulting in the formation of students adapted to the job market. The progressive purpose of education, on the other hand, is one of the most important instances of the democratization of knowledge and social justice, since it must guarantee the means of appropriating socially constituted, systematized knowledge as a basis for the development of intellectual capacities and the formation of personality.

In Brazil, 2019 marked the first time that the country had more students enrolled in distance education compared to the traditional teaching modality. The context of the Covid-19 pandemic intensified this reality, resulting in 62.8% of students enrolled in Brazilian undergraduate courses associated with the distance education modality (INEP, 2021). Of the 1,648,328 enrollments in undergraduate courses in 2021, 35.6% were registered in public institutions and 64.4% in private institutions. More than 80% of undergraduate students at public institutions attended presential courses. In the private network, distance learning courses predominate with almost 85% of students (INEP, 2021, n/a).

However, in the context of the Covid-19 pandemic crisis, the failure of the government and public universities to adopt distance education and the implementation of an "educational process" without pedagogical backgrounds, called distance education, had several justifications and nuances. One of them could be related to the fact that, in Brazil, this modality was "strongly linked to capitalist and financial interests, to the detriment of the human, autonomous and civic formation so inherent to the provision of quality and socially referenced distance education" (Lima; Cruz, 2022, p. 54, translated by us).

In addition, this period has highlighted the devaluation and precariousness of the teaching profession through low salaries compared to other higher education professions, and this problem is linked to the business logic that has created poor working conditions and the emergence of increasingly intense demands and requirements. As a result, such behavior has led to sickness among the teaching staff and increased the shortage of teachers in basic education, as well as increased dropout rates in undergraduate courses.

From another point of view, the studies carried out in this analysis pointed to the trend of training projects linked to formal logic, even before the pandemic. This peculiarity was particularly evident in its neo-technical nuances, that is, with assumptions of a conservative educational purpose, whether through discussions of the immediate itself (use of resources, profile, and perception of students and graduates of undergraduate courses) in the conceptions of teacher training, or the



dichotomous segment between theory and practice in the conceptions of science.

Furthermore, there are gaps in the research on teaching as an ontological issue and the sciences as a historical and social production of humanity. Such omissions reveal a focus on the study of change and not on the process of constitution or transformation that is always present in the object of study. Thus, to a large extent, the productions not only captured external and apparent indications of the object of study but above all treated the issues analyzed in a way that concealed the process.

These data show that research in the field of initial distance training, in the field of natural sciences, must advance in the sense of seeking to understand the phenomenon analyzed as a whole, observing the multiple determinations, the real movement, and the conditions by which they are linked to the object studied.

Recognizing how the economic, political, and social context influences the paths of education, teacher training, and, consequently, academic production, is a way of reading reality that allows us to build paths of subversion and the construction of a society based on different ideological foundations. This is essential because, in capitalist society, countries with greater economic power, through monetary control agencies (multilateral organizations), determine standards and strategies for education, health, security, and social policies, that is, they determine the paths to be followed by the nations that depend on them for financial support.

Finally, to effectively democratize knowledge and guarantee social justice, it is necessary to institutionalize distance learning, with a progressive educational purpose and with pedagogical bases supported by comprehensive training of the participants to guarantee the appropriation of the knowledge produced by humanity.

Acknowledgements

Capes research assistance scholarship.

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