



Interdisciplinary teacher training in Brazil: an analysis of current developments in the field of Natural Sciences

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ABSTRACT. In Brazil, the training of teachers dedicated to Natural Sciences in High School has been remodeled since 2018 through the promulgation of the National Common Curricular Base (BNCC) and its postulates aimed at interdisciplinarity in the teaching and learning process. Therefore, this study is responsible for analyzing the proposals and discussions regarding interdisciplinary teaching training in Natural Sciences in the Brazilian territory during the period from 2018 to 2022, specifying the context of educators working in the High School stage. The investigation was guided by the concerns: what are the current proposals and discussions regarding interdisciplinary teacher training in the field of Natural Sciences? Do the BNCC postulates meet the desires of the Brazilian educational reality? Is there a possibility for interdisciplinary improvements? What contributions are observed for science education? To this end, systematic qualitative bibliographical research of an exploratory nature was carried out in 1768 scientific articles on teacher training and interdisciplinarity in natural sciences, acquired in three (03) databases: SciELO, DOAJ and REDIB. From the total number of studies, 10 articles were selected for discussion. The chosen compilation underwent the content analysis technique of Bardin (2016). The observations raised were considered in the epistemological positions of Fazenda (2013), Japiassu (1976), Morin (2003) and Pombo (2011). The results exposed five (05) contributions to science education, they are: interdisciplinary science curriculum, initial and continued training from an interdisciplinary perspective, interdisciplinary projects, contextualization of knowledge and multiple interactions in the structuring of teaching identity. Furthermore, it was observed that interdisciplinary science teacher training lacks too many developments in Brazil, perhaps public policies that instigate new models of initial and continuing teacher training, enabling teaching methodologies that aspire to integral and dialogical learning skills in the High School, henceforth the curricular interrelationship of social complexity.

Keywords: natural sciences; interdisciplinary teacher training; interdisciplinarity.

A formação docente interdisciplinar no Brasil: uma análise dos atuais desdobramentos no âmbito das Ciências da Natureza

RESUMO. No Brasil, a formação de docentes dedicados às Ciências da Natureza no Ensino Médio tem sido remodelada desde 2018 mediante a promulgação da Base Nacional Comum Curricular (BNCC) e seus postulados direcionados à interdisciplinaridade no processo de ensino e aprendizagem. Assim, compete a este estudo analisar as propostas e discussões acerca da formação docente interdisciplinar de Ciências da Natureza no território brasileiro durante o período de 2018 a 2022, especificando o contexto dos educadores atuantes na etapa do Ensino Médio. A investigação foi norteada pelas inquietações: quais as atuais propostas e discussões acerca da formação docente interdisciplinar no campo de Ciências da Natureza? Os postulados da BNCC atendem aos anseios da realidade educacional brasileira? Existe possibilidade de aperfeiçoamentos interdisciplinares? Quais contributos são observados para a educação em ciências? Para isso, efetuou-se uma pesquisa bibliográfica sistemática qualitativa de cunho exploratório em 1768 artigos científicos sobre formação docente e interdisciplinaridade nas ciências naturais, adquiridos em três (03) bases de dados: SciELO, DOAJ e REDIB. Do total de estudos, selecionou-se 10 artigos para uma discussão. O compilado escolhido passou pela técnica de análise de conteúdo de Bardin (2016). As observações levantadas foram ponderadas nas colocações epistemológicas de Fazenda (2013), Japiassu (1976), Morin (2003) e Pombo (2011). Os resultados expuseram cinco (05) contributos para a educação em ciências, são eles: currículo interdisciplinar de ciências, formação inicial e continuada na ótica interdisciplinar, projetos interdisciplinares, contextualização do conhecimento e múltiplas interações na estruturação da identidade docente. Observou-se, além disso, que a formação docente interdisciplinar de ciências carece de demasiadas evoluções no Brasil, quiçá de políticas públicas que instiguem novos modelos de formação inicial e

continuada dos professores, viabilizando metodologias de ensino que aspirem competências de aprendizagem integrais e dialógicas no Ensino Médio, doravante a inter-relação curricular da complexidade social.

Palavras-chave: ciências da natureza; formação docente interdisciplinar; interdisciplinaridade.

La formación interdisciplinaria de profesores en Brasil: un análisis de los desarrollos actuales en el campo de las Ciencias Naturales

RESUMEN. En Brasil, la formación de profesores dedicados a Ciencias Naturales en la Enseñanza Media se remodeló desde 2018 a través de la promulgación de la Base Curricular Común Nacional (BNCC) y sus postulados orientados a la interdisciplinariedad en el proceso de enseñanza y aprendizaje. Por lo tanto, a este estudio compete analizar las propuestas y discusiones sobre la formación interdisciplinaria de profesores de Ciencias Naturales en el territorio brasileño durante el período de 2018 a 2022, especificando el contexto de los educadores que actúan en la etapa de Enseñanza Media. La investigación estuvo guiada por inquietudes: ¿cuáles son las propuestas y discusiones actuales sobre la formación interdisciplinaria de profesores en el campo de las Ciencias Naturales? ¿Los postulados de la BNCC atienden las aspiraciones de la realidad educativa brasileña? ¿Hay posibilidades de mejoras interdisciplinarias? ¿Qué aportes se observan para la enseñanza de las ciencias? Para ello, se realizó una investigación bibliográfica sistemática cualitativa de carácter exploratorio en 1768 artículos científicos sobre formación docente e interdisciplinariedad en ciencias naturales, adquiridos en tres (03) bases de datos: SciELO, DOAJ y REDIB. Del total de estudios, se seleccionaron 10 artículos para discusión. La compilación escogida pasó por la técnica de análisis de contenido de Bardin (2016). Las observaciones planteadas fueron ponderadas en los enunciados epistemológicos de Fazenda (2013), Japiassu (1976), Morin (2003) y Pombo (2011). Los resultados exponen cinco (05) aportes a la enseñanza de las ciencias, ellos son: currículo interdisciplinario de ciencias, formación inicial y continua desde una perspectiva interdisciplinaria, proyectos interdisciplinarios, contextualización del saber y múltiples interacciones en la estructuración de la identidad docente. También se observó que la formación interdisciplinaria de profesores de ciencias carece de demasiados desarrollos en Brasil, tal vez políticas públicas que susciten nuevos modelos de formación inicial y continua de profesores, posibilitando metodologías de enseñanza que aspiren a aprendizajes integrales y dialógicos en la Enseñanza Media, en adelante el currículo interrelación de la complejidad social.

Palabras clave: ciências de la naturaleza; formación docente interdisciplinaria; interdisciplinariedad.

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Introduction

In Brazil, the training of Natural Sciences teachers was, and continues to be, a central factor in countless argumentative contests developed by the academic community. Currently, this process is attenuated, above all, by the new curricular policies and their ambiguity of interests in education, bringing the proposals of the Common National Base for the Initial Training of Basic Education Teachers (Ministério da Educação, 2019) and the Common National Base for the Continuing Training of Basic Education Teachers (Ministério da Educação, 2020), which were evidenced after the changes to the National Common Curricular Base (BNCC) (Ferreira, Silva, & Alves, 2021). This scenario, full of uncertainty, occurs in the same period in which several educational reflections require civic education composed, especially, of students who challenge the social problems of their daily lives and who are equipped with reflective skills through the insertion of school knowledge into human complexity (Morin, 2000, 2015, 2018; Sá & Behrens, 2019).

At this juncture, interdisciplinarity emerges as a way to bring perspectives of human complexity closer to social problems through a dialogical, reflective and totalizing educational model of learning. And, certainly, teacher training is at the apex of this entire integrative process of knowledge, as it is in teaching praxis that many educational transformations are formed (Nóvoa, 2019). Thus, the training of science educators aims to promote interdisciplinary scientific education, articulating curricular changes and their teaching identity (Pinheiro, Matos, & Bazzo, 2007). It is admitted that the area of natural sciences, in this sense, acts as a unique intellectual territory, where learning about nature and its phenomena is developed. In fact, this area is formed as a segment of association between the knowledge of science and the daily lives of students (Dias, Ferreira, Luz, & Marinho, 2021).

It is noted, in this position, that educational transformations in Brazil were expected through curricular definitions of a national nature and common to basic education, an element highlighted in the Law of

Guidelines and Bases of National Education n°. 9,394, covering all stages of basic education: Early Childhood Education, Elementary Education and Secondary Education (LDBEN) (Lei n° 9.394, 1996). In fact, this reality was also manifested in the guidelines for interdisciplinary didactics of science present in the Curricular Parameters for Secondary Education (PCNEM) (Ministério da Educação 2000), as well as in the discussions generated by these documents for more than two decades, always analyzing knowledge – what to learn? – and the teaching and learning process – how to do it?. It is understood that this combination culminated in the emergence of the National Common Curricular Base (BNCC) of 2018, modifying the contexts of basic education to foster interdisciplinarity in Brazil, especially in the High School stage (BNCC, 2018; Castro, Santo, Barata, & Almouloud, 2020).

Among the branches of knowledge covered in High School, the area of Natural Sciences was directly influenced by the educational characteristics of interdisciplinarity, since its new teaching materials and teaching approaches would be established through dialogicity, reflexivity and collaboration in pedagogical projects developed between scientific fields, that is, the collective knowledge of society and its interaction in the scientific perspectives of the disciplines of Chemistry, Physics and Biology would be reiterated. Thus, many discussions dealt with global, regional and local student issues within the school and non-school context (Oliveira & Fenner, 2020). This scientific interrelationship must occur through the general topics of “Matter and Energy” and “Life, Earth and Cosmos”, derived from the science area of Elementary School in its subfields of “Matter and Energy”, “Life and Evolution” and “Earth and Universe” (BNCC, 2018).

It is noteworthy that the teaching and learning process aimed at an interdisciplinary bias demands public policies for the training of teachers throughout the national territory, enabling the development of interdisciplinary concepts about teaching and learning in basic education. Therefore, certain concerns arise: what are the current proposals and discussions regarding interdisciplinary teacher training in the field of Natural Sciences? Do the BNCC postulates meet the desires of the Brazilian educational reality? Is there a possibility for interdisciplinary improvements? What contributions are observed for science education? Therefore, this study is responsible for analyzing the proposals and discussions regarding interdisciplinary teaching training in Natural Sciences in the Brazilian territory during the period from 2018 to 2022, specifying the context of educators working in the High School stage. The peculiarity of this work lies in the argumentative conduct of an elucidation about what was presented to the area of Natural Sciences in High School and what is expected from this future science education in Brazil.

The methodological procedures of this essay met the character of a systematic bibliographical research with a qualitative approach and exploratory nature. The bibliographic material collected was peer-reviewed scientific articles, produced in Brazilian territory, written in Portuguese and disseminated in periodicals indexed in the databases: SciELO, DOAJ and REDIB, between January 2018 and February 2022. The selection of productions scientific studies was carried out with the help of the Zotero 6.0 bibliographic material management application, developed by American researchers from George Mason University. The selected articles – 10 productions – were evaluated through content analysis by Bardin (2016), described in the stages of pre-analysis, content exploration and treatment of conclusions.

This scientific production is delimited by four (04) writing stages. The first corresponds to the theoretical argument of the essentiality of interdisciplinary teaching actions, considering interdisciplinarity as a privileged issue in contrast to the inevitable educational dynamics of teachers. The second reiterates the methodology of this investigation, its data collection, selection and evaluation characteristics. The third highlights the results of the systematic review and its epistemological support in Fazenda (2013), Japiassu (1976), Morin (2003) and Pombo (2011). And, finally, the fourth stage presents the final considerations of the outcome and the contributions observed for science education.

Interdisciplinarity: Privilege or Indispensable Teaching Action?

The need to overcome the dichotomy between world and teaching led to periodic student crises that began in 1960 and continued throughout subsequent decades (Thiesen, 2008). This affliction, compounded in the scenario of a post-modern Europe, intensified, mainly, in countries such as France, Germany and Italy through the theme of excellence: “agony of our civilization”. This assertion, title of the project presented by the philosopher and epistemologist Georges Gusdorf to the United Nations Educational, Scientific and Cultural Organization (UNESCO), brought with it a strong call for academics to lead, at that first moment, a movement of knowledge that broke the standard model of specialized knowledge through the

interrelationship between disciplinary fields, bringing, through this mediation, a new schooling (Santos, Souza, & Rosa, 2021).

Gusdorf's integrative projection dealt with interdisciplinarity in the intellectual domain of Human Sciences, bringing together notable scientists of that period in circumstances of convergence, sharing and dialogue to plan a cohesive typology of human thought (Fazenda, 2012). However, it is also important to highlight that that interdisciplinary movement did not represent a direct opposition to the pragmatism of disciplinarity, but made the theorization of educational practices across disciplines essential, emphasizing that the pedagogical product of learning, that is, the knowledge of students, would have to be permeate a disciplinary, social and factual relationship experienced by them in the school environment, producing epistemic knowledge with an integral characteristic among students, but which would not be separated into fragmented knowledge (Lenoir, 1998).

The foundation that formed and preserved the existence of disciplines in education, specifically fields of specific studies, was attested by the Cartesian need for elaborate and unilateral analyses, that is, by investigations of factors separately, an aspect that, in a certain way, resulted in the exclusion of dialogue, sharing and reciprocal distinctions between disciplines (Mangini, 2010). In this sense, the phenomenological design of interdisciplinarity was constituted in "[...] mutual exchange and reciprocal integration between various sciences [...]", preserving what can be called "[...] scientific frontiers [...]" – the division of knowledge into disciplines in schooling – in a common projection of learning, without which the interdisciplinary movement, even in the purely theoretical field, could not exist, as occurs in transdisciplinarity (Piaget, 1981, p. 52).

In this paradigm, Gusdorf's desire became a relevant concept for that community of scholars, but without enough strength to generate more in-depth discussions and, for a certain time, it remained that way. Until, at the beginning of the 1970s, the *Center de Recherche et Innovation dans L'Enseignement* (CERI) of the Organization for Economic Co-operation and Development (OECD) proposed a scientific meeting entitled "International seminar on pluridisciplinarity and interdisciplinarity in universities" in the French city of Nice. And, thus, more concrete conceptualizations began about what interdisciplinarity and its approach to knowledge would be among scientists. This convention brought together numerous scholars, such as: Jean Piaget, Heinz Heckhausen, Eric Jantsch, Marcel Boisot, Georges Gusdorf, Asa Briggs and Leo Apostel. From them, discussions arose regarding the terminology of the term interdisciplinarity and the implications of this young phenomenology for the academic context of teaching and learning (Pereira & Nascimento, 2016).

In this way, this new postulate raised, still not having an empirical aspect, began to have the characteristic of an indispensable procedure for teachers, that is, an extremely necessary pedagogical action, which would approach human thought through a new reality: complexity of social phenomena and their relationship with knowledge. For Morin (2003), the fragmentary act of knowledge – an educational driver of thoughts since Cartesian rationalism – made it impossible for students to obtain broader notions of humanity's problems and their causes, as well as, consequently, preventing more dialogically solutions from being taken. viable for the complexity that has increasingly increased in its problem situations, considering the world wars, famine and religious persecution in Germany, but, in general, educational, political, cultural and social problems. Thus, Morin (2003, p. 20) highlighted that:

[...] It is impossible to democratize knowledge that is closed and esoteric in nature. But, from then on, it would not be possible to conceive a reform of thought that would allow us to face the extraordinary challenge that leaves us with the following alternative: either suffer the bombardment of countless information that rains down on us, daily, through newspapers, radio and television; or, alternatively, we give in to doctrines that only retain information that confirms them or that which is intelligible to them, and reject as error or illusion everything that contradicts them or is incomprehensible to them. It is a problem that arises not only in the knowledge of the world on a daily basis, but also in the knowledge of everything human and in scientific knowledge itself.

In this way, the vision of the complexity of human controversies linked to the vast knowledge of scientific fields awakened characteristics in the construction of a worldview, specifically a knowledge that directs convictions beyond "academic walls" (Ferreira, 2013). And, therefore, from these assumptions interdisciplinarity was structured, a strand of consciousness that was not exclusive when reflecting on the expected result of education, teachers, students, teaching and learning, but a way of internalizing pedagogical practices and daring already structured erudition, returning the philosophical discernment of "know yourself" to contemporary educators and rescuing a Socratic conception of reflection (Yared, 2013).

Over time, interdisciplinarity could be defined in different ways, such as: methodology, concept, process, way of thinking, philosophy and/or reflective ideology. In the methodological conception, the interdisciplinary motivating agent is guided by the itineraries aimed at the integration of knowledge. The process, self-explanatory, referred to the covetous course of an interdisciplinary product. The way of thinking guaranteed the reflexive arrival of the process. Philosophy, in its own way, defined interdisciplinary conduct in the fields of science. And, finally, reflexive ideology faced the “mutilation of knowledge”, whether from a humanist perspective, human or social complexity. In summary, all definitions converged on a central danger: the losses of the division of knowledge reflected in an unhealthy – very poor – nature of knowledge (Japiassu, 1976; Klein, 1990).

Just as the social context guides interdisciplinarity, cultural logics also do so, including from predefined perspectives. Culture, being an expression of identity constructed by certain native peoples of a region, influences them mutually in the definitions of their characteristics and in the ways of thinking and transmitting knowledge (Lenoir, Rey, & Fazenda, 2001). In this view, teaching practice expresses the core of their work as “[...] mediating teaching intervention with learning subjects, postulating a professional practice that articulates knowledge and expertise” (Therrien, 2010, p. 310). Therefore, the practice of teaching validates interdisciplinary cultural logics, among which the following stand out: the Francophone, the North American and the Brazilian.

Francophone culture understood scientificity and its ordering through beauty, where abstraction operated the visions of this interdisciplinary researcher, creating the figure of knowledge about knowledge. The North American vision distinguishes itself by incorporating meanings into practice – what duty does this occupy in space? – is, therefore, a task of judgment that makes ideas relevant or not, a vision conceived as knowing how to do (Lenoir, Hasni, & Lebrun, 2013). The third logic, the Brazilian one, comes from both previous ones, in which the determining union is established between knowing and knowing how to do, establishing “knowing how to be” (Fazenda, 2013). Cultural markers, adaptations and conceptions come together to legitimize the dissenting thoughts among the majority of theorists regarding a closed definition of interdisciplinarity, making it very difficult, or practically impossible, to describe a direct, specific and precise notion regarding it. Thus, “[...] each author makes it, based on historically constructed concepts, manifest itself in a unique way in the eyes of the individual researcher” (Mueller, 2006, p. 21).

In Brazil, the interdisciplinary movement was consolidated by researchers Hilton Ferreira Japiassu and Ivani Catarina Arantes Fazenda, through two lines of research on interdisciplinarity: epistemology and the educational phenomenon. In the epistemological field, Japiassu focused his reflections on the regulatory guidelines of interdisciplinarity regarding the nature, stages and limits of definition as a scientific field. In the educational sphere, Fazenda investigated the scope of interdisciplinary schooling, considering interdisciplinary contributions to teaching work and the reason for “being interdisciplinary” – a transformative figure – in the learning system, considering that “[...] notions, purposes, skills and techniques aim to favor, above all, the learning process, respecting the students’ knowledge and their integration” (Fazenda, 2013, p. 26).

The interdisciplinary relationship idealized by the school field, although made up of countless factors, aims to transform the divided – dichotomous – teaching into multiple relationships during the formation of the “social being”, a unified subject, in students. This social individual will reflect on explanations, concepts and propositions of the most heterogeneous knowledge (Mota & Araújo, 2021). Therefore, this purpose will only happen through a broad review of pedagogical practices and areas of knowledge, in which both are reformulated to aim at conscious and contextualized criticality in changing the situation of solitary disciplinarity, engaging learning in specific, regional and planetary perspectives. of science (Morin, 2018).

Teaching aimed at interdisciplinarity requires multiple directions of disciplines and their relationship with students’ daily lives, especially in the teaching of natural sciences. From this perspective, teachers play a fundamental role, as it is through their mediation in teaching that learners may or may not awaken an awareness of an integral aspect of the content explained in the classroom (Thiesen, 2008). Therefore, educators need, in addition to mastering their area of knowledge, acquired from university training and perfected in the school environment, to know, even if in an abstract way, the subjects of students’ daily lives and the contents present in the curriculum of other subjects, especially if are in the same area of knowledge or educational stage that can represent interactions with a common purpose for students (Fazenda, 1979).

Learning in interdisciplinarity, in turn, does not see the student as an inert being and disconnected from their reality, on the contrary, the interdisciplinary learner participates in questions and

assimilations that, in a way, are directly linked to mistakes and successes during the course. learning, this implies that the knowledge evidenced by the educator remains in the students” discussions from different perspectives, that is, the content acquires different approaches that help in the formation of complex thinking (Costa & Pinheiro, 2013). Therefore, this learning product becomes multi-articulated across disciplinary fields. Furthermore, it involves a critical conduct that reflects on the problems involved from a multidimensional perspective, creating interdependence and interactivity that does not fragment a situation, but translates the specific parts of a general phenomenon and its context (Morin, 2003, 2015).

The interdisciplinary school is the place where a large part of the pedagogical action present in interdisciplinarity emerges, because, even if interdisciplinarity uses attitudes, elements and learning acquired by students in their daily lives. It is in the school environment, according to the desired teaching-learning objectives, that the systematization between everyday knowledge and subject knowledge occurs. Therefore, the school starts to have a much more participatory and decisive aspect in the citizenship formation of students, so that educational actions carried out in its environment directly interfere with teaching practices that provide opportunities for collectivity and solidarity between learners, educators and society as a whole (Thiesen, 2008). However, it is understood that it is very common in Brazil to still find school dynamics inadequate for the development of interdisciplinary projects. This implies that the school, first of all, needs to promote dialogue between education professionals and their areas. To achieve this, school managers need to understand and provide opportunities for a dynamic transformation of the fragmentation of subjects, in the awareness of educators and in the willingness of partnerships between students to learn in an interdisciplinary way (Martino & Boaventura, 2013).

Teaching and learning in an interdisciplinary school environment aim at the cooperation of meanings of knowledge. Thus, the teacher has the duty to go beyond the exposition of content, bringing real situations in society and its relationship between knowledge. This is not a simple task, but it certainly provides a very satisfactory result, which is the emancipatory and reflective learning of students. students (Delizoicov, Angotti, & Pernambuco, 2011). Students, in turn, need to assume and incorporate their role in school and understand, above all, their role in society and the discussion of its problems. Therefore, this change from the Cartesian educational perspective to the interdisciplinary one seeks ways to reach a phenomenon of school collectivity, something developed in small work groups that may eventually expand (Fazenda, 2008).

In summary, interdisciplinarity in Brazilian education was considered an alternative to the teaching and learning process since the Curricular Parameters for Secondary Education (PCNEM) (Ministério da Educação, 2000). However, in recent times, this debate has resurfaced with great intensity and reached new levels with the National Common Curricular Base (BNCC) of 2018. At BNCC, it is admitted that the transfiguration of the specialized to the integrated in educational projects will occur through interaction-inclusion of knowledge (Oliveira et al., 2021). In this way, learning crosses the disciplinary intersection of convergence and complementarity in new study approaches, where researchers analyze, above all, the attitudes of students towards the emergence of reasoning (Souza, Bussolotti, Cunha, & Fazenda, 2020). Therefore, the teaching act of being interdisciplinary is no longer a privileged option, becoming an indispensable teaching practice in the 21st century, bearing in mind that it permeates all training, political and social contexts of teaching in all areas of knowledge, including Natural Sciences.

Methodology

This was systematic bibliographical research with a qualitative approach and exploratory nature. The qualitative approach explained the phenomena involved in the analyzed contributions to the training of science educators and their nuances for interdisciplinary improvement. The exploratory nature aimed to detail current Brazilian developments regarding what was proposed and discussed between 2018 and 2022 within the scope of interdisciplinary teacher training for the area of Natural Sciences in High School. Thus, the research was developed with the objective of analyzing the proposals and discussions regarding interdisciplinary teaching training in Natural Sciences in Brazilian territory during the period from 2018 to 2022, specifying the context of educators working in the High School stage. To this end, the questions were confronted: what are the current proposals and discussions regarding interdisciplinary teacher training in the field of Natural Sciences? Do the BNCC postulates meet the desires of the Brazilian educational reality? Is there a possibility for interdisciplinary improvements? What contributions are observed for science education?

Data search, exclusion and inclusion steps

Scientific articles present in the databases were chosen: Scientific Electronic Library Online (SciELO), Directory of Open Access Journals (DOAJ) and Red Iberoamericana de Innovación e Conocimiento Científico (REDIB). In the search, the combinations of keywords in the databases were used: “interdisciplinarity OR interdisciplinary teacher training” and “teacher training OR BNCC OR Natural Sciences OR natural sciences”. From this process, a total of 1864 scientific articles indexed on the platforms were found in the time frame delimited between January 2018 and February 2022.

In the data exclusion and inclusion stages, the authors defined some criteria, presented in Table 1, to both exclude and include articles in the discussion of interdisciplinary science teacher training in Brazil.

Table 1. Data exclusion and inclusion criteria.

Exclusion criteria	Inclusion criteria
(1) Investigations unavailable in full or with access for fees on the bases.	(1) Investigations available in full and free of charge on the bases.
(2) Articles produced in languages other than Portuguese.	(2) Articles produced about the High School stage.
(3) Duplicate productions on the same or different bases.	(3) Productions that were related to this study.
(4) Articles that do not address the interdisciplinary training of science teachers in Brazil.	(4) Articles that deal with the interdisciplinary training of science teachers in Brazil.

Source: Prepared by the authors (2022).

Throughout the exclusion and inclusion process, the free and open-source software reference manager Zotero 6.0, developed by George Mason University, was used to process the data – a priori – and select the revised material – a posteriori. From these processes, we obtained the quantity of productions, duplications in the databases, exclusions and inclusions according to the criteria and selection of articles for analysis in this study (Figure 1).

	(A)	(B)	Duplicates	Excluded	Included	Selected
<i>SciELO</i>	103	529	63	554	15	04
<i>DOAJ</i>	149	933	32	1030	20	03
<i>REDIB</i>	138	12	01	134	15	03
<i>TOTAL</i>	390	1474	96	1718	50	10

Figure 1. Quantitative number of scientific articles analyzed. (A) Combination: “interdisciplinarity OR interdisciplinary teacher training”. (B) Combination: “teaching training OR BNCC OR Natural Sciences”.

Source: Prepared by the authors.

In the first search, 1864 scientific articles were found. After analyzing the software used regarding the studies that were duplicated in the databases, the real number of 1768 scientific articles were found, 569 of which were in the SciELO database, 1050 in the DOAJ database and 149 in the REDIB database. Of this total, 1718 trials were excluded, a value corresponding to the sum of duplicate studies and studies that met the exclusion criteria. From this, 50 productions were included, as well as 10 of them selected for an in-depth analysis, this selection followed some pre-established parameters (Figure 2).

Data selection and analysis steps

The compilation of research that met the inclusion criteria, to be analyzed during the selection stage, resulted in 50 scientific articles. These trials underwent an evaluation guided by selection criteria (Figure 2).

WEIGHT	Description	Maximum value
P1	General objective defined and achieved	02
P2	Consistency of theoretical argumentation	02
P3	Rigor and organization of methodological procedures	03
P4	Plausibility of the results regarding this investigation	03
PF	Final sum of weights	10

Figure 2. Selection criteria for scientific productions.

Source: Prepared by the authors.

The weights had different relevance during the selection and, therefore, the 10 productions that obtained the highest final weight (PF) were chosen. These selected studies were conducted for a thorough content analysis. Therefore, after the selection, the material was examined, that is, a cohesive and integral observation of its scientific contributions in the discussion of interdisciplinary teacher training in science, following the procedures referring to a content analysis. It is understood that content analyzes generally consist of three stages: pre-analysis, exploration of the material and treatment and interpretation of data (Bardin, 2016).

In this research, the pre-analysis consisted of reading and observing the research objective of these selected articles, bringing a homogeneous conception of their research purposes in view of interdisciplinary science teacher training, that is, developing a broad view of what was proposed in the works. The exploration of the material took place in the coding, categorization and listing of the occurrence of the terms “interdisciplinarity OR interdisciplinary OR interrelationship” and “teacher training OR teacher training OR educator training OR teacher training”. And, finally, the interpretation of the data, or summary of information, integrated the message about teacher training transmitted by the research, that is, the contributions that these essays made possible to raise in the general context of interdisciplinary teacher training of Natural Sciences teachers in Brazilian High School.

To facilitate the understanding of the research procedures, this systematic literature review study proceeded through the steps defined according to processes of search, exclusion, inclusion, selection, analysis and summarization of the material, illustrated in the following flowchart (Figure 3).

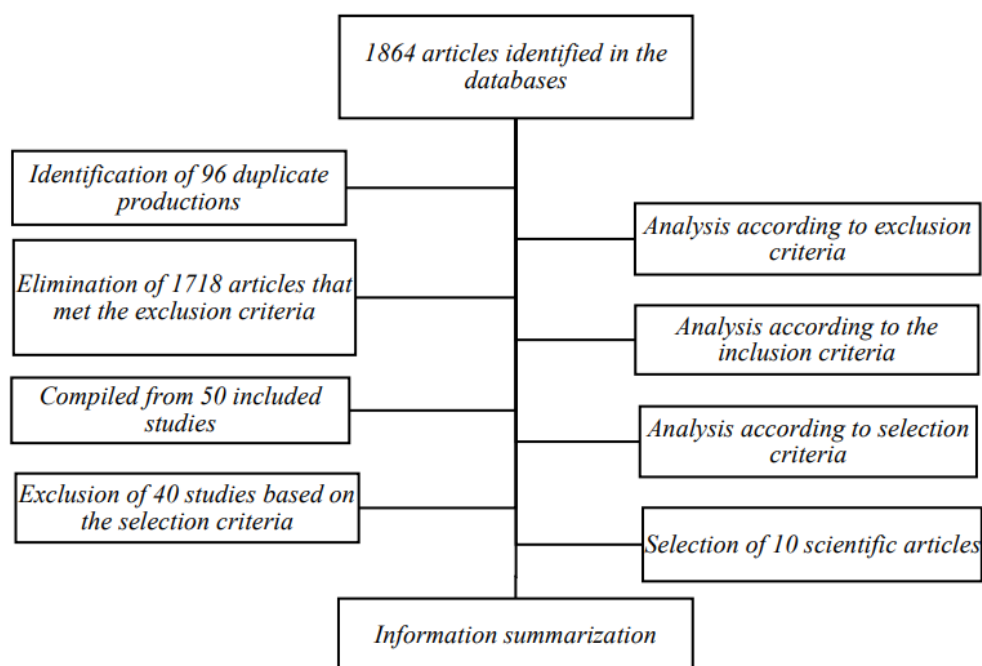


Figure 3. Flowchart of the systematic review.
Source: Prepared by the authors (2022).

Results

The selected scientific articles were characterized according to the number defined for the article, indexed database, title, authors and year of publication (Figure 4).

After this characterization, the works were examined according to their research objectives, the pre-analysis stage, in order to observe certain homogeneities in their research concepts, that is, purposes that were of a common nature to the discussion of this work (Figure 5).

It is observed that the investigative perspective on interdisciplinary teacher training through teaching projects was used in studies A3, A4, A7 and A10. Meanwhile, articles A6 and A9 highlighted research perspectives more associated with the exposure of historical aspects and theoretical discourse of teacher training, in order to demonstrate to the academic community both the creation and establishment of the interdisciplinary praxis of science teachers. In articles A1 and A8, the reflection covered the specificities present in teaching networks and their relationship with interdisciplinary teacher training. Study A5 briefly

presented the disciplinary relationship between natural sciences in high school, leading its understanding to the generalist training of science educators in Brazil. And, finally, essay A2 outlined a discussion about the way in which the curricular guidelines of an interdisciplinary teaching practice are associated with the life stories of science teachers. Therefore, there was a great wealth of panoramas in these works.

Following the methodological procedures, the productions underwent coding and categorization according to the scientific production number established and the textual occurrence of the terms stipulated in the material exploration stage, that is, the repetition used of this expression throughout the work (Figure 6).

Nº	Database	Title	Authors	Year
A1	SciELO	Interdisciplinary practices in the initial training of natural science teachers: different contexts, similar questions	Moura, Rosa e Massena	2021
A2	SciELO	Physics teacher training and interdisciplinarity: episodes of policy refraction in curricular reform narratives	Calado e Petrucci-Rosa	2019
A3	SciELO	The training of science teachers in the interdisciplinary perspective on the fluctuation of life on the planet: through the paths of Co-Teaching	Santos, Queiroz, Domingos e Catarino	2019
A4	SciELO	Continuing training of science teachers using Aquaponics as a teaching tool	Souza, Souza, Oliveira e Takahashi	2019
A5	DOAJ	The National Common Curricular Base (BNCC) and Paul Karl Feyerabend's epistemology in science teaching: terminological issues	Benassi, Ferreira e Strieder	2020
A6	DOAJ	Interdisciplinary teacher training: perceptions of graduates of a natural sciences and mathematics course	Trevisan & Dalcin	2020
A7	DOAJ	Contextualization in the training of chemistry teachers	Lara & Duarte	2018
A8	REDIB	Continuing training of natural science teachers and relationships with teaching practice	Veloso & Sobrinho	2021
A9	REDIB	Interdisciplinarity and teacher training: brief considerations	Perin & Malavasi	2019
A10	REDIB	Interdisciplinarity and Dicumba: intertwining knowledge in teaching	Bedin	2021

Figure 4. Typification of selected scientific articles.

Source: Prepared by the authors.

Nº	General Objective
A1	"How interdisciplinary practices are engendered in the initial training of Natural Sciences teachers, within the scope of supervised internships at two public universities, one in the Southeast, the other in the Northeast of Brazil"
A2	"Understand how the notion of interdisciplinarity present in the National Curricular Guidelines for Teacher Training changes along the path between curricular policies and life stories"
A3	"To present the aspects that enhance co-teaching in teacher training and the possibilities for developing teaching practices from an interdisciplinary perspective, providing an example of the importance of fluctuation for life on the planet"
A4	"Develop the training of high school teachers, seeking to understand how Aquaponics can support pedagogical activities, emphasizing the development of science"
A5	"Look at its foundations, its purposes and objectives, and, with regard mainly to the aforementioned study, the disciplines that make up the Natural Sciences and their Technologies, Biology, Physics and Chemistry"
A6	"Discuss the initial training of Science and Mathematics teachers, with the aim of indicating potentialities and weaknesses of an interdisciplinary training proposal put into action"
A7	"Those undergraduate students understood the contextualization process through active involvement in the preparation of a workshop on the chemistry of perfumes"
A8	"Analyze the interrelationships between continuing education and the teaching practice of Natural Sciences teachers linked to the municipal education network in Teresina-PI"
A9	"Reflect on the concept of interdisciplinarity and teacher training from a historical perspective"
A10	"Present an activity developed in an interdisciplinary way in the light of Natural Sciences in Basic Education with an emphasis on Learning through Student-Centered Research"

Figure 5. Description of the general objectives of the articles.

Source: Prepared by the authors.

Expression	Scientific Article Number									
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
(1)	30	61	46	16	03	52	11	05	68	27
(2)	08	19	15	05	04	35	16	09	15	08

Figure 6. Coding of the number of repetitions of the terms determined. (1) Terms: "interdisciplinarity OR interdisciplinary OR interrelationship". (2) Terms: teacher training OR teacher training OR educator training OR teacher training".

Source: Prepared by the authors.

This analysis regarding the occurrence of terms made it possible to identify some textual characteristics in the productions, such as: logicity of ideas within the textual structure, theoretical assumptions used

during the discussion raised and contributions evidenced about the projects and planning with reference to interdisciplinary teaching training in sciences. Thus, it was observed, for example, that the highest number of repetitions according to the sequence of terms 1 is present in works A2, A6 and A9, while A5 and A8 have the lowest occurrence value in this same sequence, this means, after the interpretation, that the recurrent, or occasional, use of expressions reinforces certain ideas that the authors of this work wanted to convey about interdisciplinarity and its academic role in high school. On the other hand, sequence 2 was more observed in works A6 and A2, representing their discursive emphasis on the training of Brazilian educators. This analysis continues the discussion of the contents of the 10 scientific articles.

Content discussion

Scientific production A1 articulated, through a discursive analysis, the implementation of interdisciplinary practices in the teaching of Natural Sciences and their contributions to initial teacher training. It is noteworthy that this initial training scenario, although endowed with multiple uncertainties, directly reflects on the principles that will support the praxis of these teachers in the initial stage of training. In this way, it is admitted that the organization of an interdisciplinary curriculum, as well as democratic and communicative between knowledge, requires, first of all, in-depth mastery of the specific areas of training of these educators (Chemistry, Physics and Biology), since the Interdisciplinarity requires teachers to belong to professional practice within the scope of natural sciences, so that, from this, transformations occur in the areas of teaching, something that, consequently, reflects in more complete learning processes: an interdisciplinary ambition (Moura et al., 2021).

This factor returns to the philosophical paradox that constitutes the training of educators in two aspects: the being that learns and the being that changes. In this first, the teacher is the agent who teaches and simultaneously learns within the classroom environment, a process called teaching (Pimenta & Anastasiou, 2017). This phenomenon involves the constant incorporation of professional knowledge acquired from school experiences. In the second, the teacher is a being of plasticity, that is, of changes in his own human and pedagogical scope, with an emphasis on his pedagogical characteristic. In fact, the interdisciplinary teaching profession, in addition to seeking a cohesion of knowledge – values transforming its practice into a more inclusive standard of teaching (Pombo, 2011).

The inclusion of knowledge throughout the creation and management of interdisciplinary practices in natural sciences called for, through the BNCC of 2018, the destabilization of disciplinary fields in high school, that is, a review of their subjects demarcated in the basic education curriculum. According to Goodson (2018), the perspective that basic education teachers have a consolidated pool of content arising from their specific university training stands out, configuring a certain educational culture, highlighted in the fragmentation of content, which continues to influence its professional performance in basic education. In this sense, breaking this professional episteme requires numerous strategies, for example, the use of interdisciplinary approaches progressively incorporated into supervised internship contexts in undergraduate courses, as evidenced by the study by Moura et al. (2021).

Article A2 brings some of the current arguments about interdisciplinary teacher training, specifying its analysis in the context of Physics teachers at the University of Campinas (Unicamp). This discussion highlights characteristics of the integrative curricular guidelines offered by the National Common Curricular Base (BNCC), as well as political-governmental positions and support on how teacher training should be implemented in public policies. In this way, the teacher training situation, inserted in an educational development proposal, can consider both the training of teachers who work in High School and the training of educators who are yet to come. In this way, it is established that “[...] interdisciplinarity becomes a relevant curricular demand for teacher training institutions, with regard to the management of degree programs, their planning, their evaluation processes and their regulation” (Calado & Petrucci-Rosa, 2019, p. It is, in this sense, that teacher uncertainty and concern regarding a double professional identity can be observed: the generalist teacher versus the specialist teacher. However, interdisciplinary movements work to preserve specific identities in teaching natural sciences, but with a rich vision of scientific integration of knowledge (Petrucci-Rosa, 2007).

Work A3 articulated arguments about the training of science teachers through the theme: “floating for life on the planet”, outlining a didactic sequence for co-teaching, that is, the division of a subject by two or more teachers, in which All responsibilities are shared, as well as ways of planning classes, content and evaluating

students are shared. This theme provided an opportunity to expand the didactic experiences of teachers in their initial years of training, in undergraduate courses in Biology, Physics and Pedagogy, discussing the urgency of an educational standard that promotes dialogic knowledge related to society (Santos et al., 2019). Therefore, it is necessary to disseminate a scientific education of interdependencies between the formal and informal means of education to students, both involved in a reflection on aspects present in science, technology and society, encouraging students to identify and reflect on problem situations (Cachapuz, Praia, & Jorge, 2004). Thus, science as an educational direction resumes its ability to structure socio-scientific panoramas in the world and transform realities (Chassot, 2018).

In analysis A4, interdisciplinarity was considered an essential phenomenon for the practice of teachers in the area of Natural Sciences present in High School, being an element that crosses the pre-established disciplinary division. However, the difficulty in developing pedagogical projects for continuing teacher training is also demonstrated, given that basic education teachers have a very busy professional routine and have few moments to plan and apply interdisciplinarity in scientific education (Souza et al., 2019). The division of knowledge in the area of science harms the exchange of knowledge in teacher training. In this way, it is understood that the nature of interdisciplinarity in the context of the continued training of teachers benefits the teaching praxis itself, understanding that scientific knowledge rescues the ontological conception of human completeness, defining for educators a continuous reflection on their praxis and interaction with knowledge (Pombo, 2011).

Study A5 addressed a focus on the pre-established curriculum in the area of Natural Sciences in the National Common Curricular Base (BNCC) of 2018, rescuing arguments about the composition of the disciplinary fields of Chemistry, Physics and Biology. The essay described the skills and abilities provided by BNCC to Natural Sciences and their Technologies in High School, supporting Feyerabend's epistemological bias. It was observed that the curriculum for teaching natural sciences used attitudinal, procedural and conceptual verbal topics at BNCC. It was admitted that Feyerabend's epistemology reflects the appeal of basic education, especially in high school, for reflective and communicative teaching (Benassi et al., 2020). The communicative sense of knowledge is remote from the experience of human language itself, observing that dialoguing is the displacement of oneself towards the other. Therefore, "[...] there are not two isolated beings in dialogue, but one being between two. Dialogue requires an attitude of openness, a relationship of reciprocity, friendship and receptivity to actually occur" (Fazenda, 2012, p. 56). For this reason, science teaching expands the dialogicity of its fields of knowledge by linking it to the problems of human reality (Castro et al., 2020).

Research A6 discussed the initial training of science teachers, indicating skills and obstacles to interdisciplinarity, in a proposal for teacher training. The perception of graduates of the Degree in Natural Sciences and Mathematics (LCNM) at the Federal University of Mato Grosso (UFMT) was observed as an investigative aspect. It was demonstrated that by bringing together professionals from different areas in discussion environments, aiming at collaboration and sharing of knowledge, the aspect of knowledge exchange is presented as the generator of a new vision of teaching knowledge that broadens its professional perspectives. However, the initial training of natural science teachers is still a major challenge in LCNM courses, as their curriculum makes broader training itineraries involving the entire area of Natural Sciences unfeasible (Trevisan & Dalcin, 2020).

In investigation A7, the reflection on the influence of contextualized Chemistry teacher training was used, based on a socio-scientific contextualizing notion, as an antagonist to individualist university training, a reflection of the Cartesian philosophy arbitrated in the traditional curriculum, and derived from the Bakhtinian pragmatic linguistic perception and Wittgensteinian (Lara & Duarte, 2018). It was observed that the initial years of training of Brazilian high school natural science teachers are not yet fully focused on the development of interventions and contextualized teaching methodologies, that is, that apply scientific content to the students' life experiences. In effect, these new approaches are implemented through themes of science, technology and society (Cachapuz et al., 2004). Thus, based on the conception that teaching knowledge is built on the permanent need to know oneself to improve oneself as a person and professional, acts sought through a dreamed integrity (Fazenda, 2012).

Article A8 discussed the situation between the continued training of Natural Sciences teachers and its relationship with teaching practice. In this aspect, it has been established that science teachers build new professional knowledge through interactions between their university training and other knowledge outside their academic training (Veloso & Sobrinho, 2021). Therefore, the interdisciplinary character, as well as other

professional knowledge, takes advantage of acquired knowledge and, through professional improvement proposals, aims to form a more cohesive teaching identity regarding teaching (Nóvoa, 2019). Therefore, the interdisciplinary teacher reflects on his profession as he encounters challenges that make it impossible to develop it, but not only because of this, his reflection is typical of the human desire that wants to be completed by all knowledge. This otherness is perpetual and continuous, as “[...] the incompleteness of being or its inconclusion is characteristic of vital experience” (Freire, 1996, p. 22).

The A9 production elucidated what is expected from an interdisciplinary teacher, demonstrating, through an analysis of the birth and trajectory of the interdisciplinary educational movement, the urgency of a scientific education that generates reflection and transformation on contemporary social reality (Perin & Malavasi, 2019). In this way, the educational crisis in the teaching of natural sciences will be faced, accommodating its more abstract contents in the circumstances experienced by students. The crisis in science teaching, described by Fourez (2003) in the Belgian scenario, still persists in recent years, and, in addition to the European dimension, it also has repercussions in Latin America, especially in Brazilian territory. It is noted that students are unhappy with scientific principles and knowledge that are incongruent with their social reality. In fact, the study demonstrates that the educational context of natural sciences, as it presents itself, separates the interest of seeking interconnected knowledge in one’s life (Leite & Radetzke, 2017).

Finally, production A10 resumed the argumentative focus regarding the structuring of the identity of natural science teachers. This research interweaves all the others analyzed in this study, since interdisciplinary teacher training in Natural Sciences is conditioned by ambiguous definitions: “what is expected from interdisciplinary teaching in Sciences?” and “what is the identity of the new interdisciplinary teacher?”. In this way, work A10 demonstrates the science teaching identity articulated in the need to develop cognitive skills and attitudes essential to training, professional knowledge and the cooperative conduct of learning (Bedin, 2021). It is considered that the scenario of science teacher training in Brazil incorporates the experiences of students during the teaching process and, consequently, their learning will be the result of the relationship between subjects covered in the disciplines and their contexts (Souza & Dias, 2020).

Interdisciplinarity descends as a product of the distance between science and reality, that is, the constant fracturing of the experience of students at university and the dynamic reality of a complex and inseparable society. Therefore, his bias did not shape a simple theorization or just a plan of knowledge, but a concrete action or “[...] effective intervention in the field of social and human reality” (Japiassu, 1976, p. 44). Thus, an educational transformation that questions the training of teachers and their task of “[...] perceiving themselves as interdisciplinary” (Fazenda, 2012, p. 77). The core of this discussion encompasses the trends and curricular transformations stipulated in undergraduate courses, where the teacher training process is committed to contemporary realities, interacting with graduate students from different courses and carrying out the exchange of common knowledge between education professionals, in an intercalated manner. to the professional training segment. Therefore, the university environment is this space created by genuine interdisciplinary conception (Pretto, 2017).

Information summarization

Having analyzed the research proposals and discussions on interdisciplinary Natural Sciences teacher training in the Brazilian context, five (05) argumentative paths/contributions to science education were conducted (Figure 7).

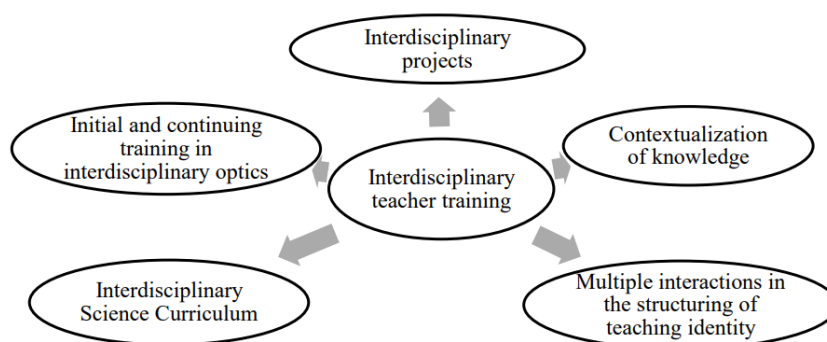


Figure 7. Diagram of contributions to interdisciplinary teacher training in natural sciences.

Source: Prepared by the authors (2022).

The interdisciplinary science curriculum, discussed in productions A1, A2, A5, A6 and A8, is a fundamental undertaking for the standard of interdisciplinary education in natural sciences in high school. However, a curriculum without the representation of an educational action, or even a pedagogical movement, that is truly interdisciplinary impoverishes the proposal of any style of education that aspires to inter/pluri/multi/transdisciplinarity (Trevisan & Dalcin, 2020). The basic concept of school curriculum is associated with a path of knowledge prescribed in a course or educational stage, where students need to experience cycles of theoretical training, assimilation and construction of knowledge. Therefore, the interdisciplinary curriculum shows that “[...] new educational positions will require the combination of other theoretical-didactic schemes, which could eventually contribute to the construction of different organizations and structures of knowledge” (Fazenda, 2008, p.12).

Initial and continued training from an interdisciplinary perspective, a topic covered in articles A1, A2, A3, A6 and A8, aims, like the interdisciplinary science curriculum, to develop and structure in science education a teacher training policy that wants a human being one and of integral knowledge – based on the Greek concept of rescuing its source of integrity – making up the identity of the science educator (Veloso & Sobrinho, 2021). Furthermore, it is stated that, although the BNC-Training documents cover certain points about the association of knowledge in teaching, it is necessary to deepen and direct teaching towards interdisciplinarity through training projects that articulate initial and continued training in an interdisciplinary perspective, in that this proposal be widely discussed, supported and developed together with basic education educators and those responsible for government education bodies. Typical aspect of the ontological character of teacher training itself, whether initial or continued, where professional experience guides “knowing how to be” a transformative agent of education (Fazenda, 2013).

The structuring of interdisciplinary projects, a theme described in essays A3, A4 and A10, highlights that, in a proposal for integral and reflective education in natural sciences in high school, teacher training will be supported by the creation and execution of collaborative projects between areas of knowledge (Santos et al., 2019). These projects may be of multiple natures, such as extension, research and teaching approaches, but they must always form a discussion between disciplines and incorporate everyday phenomena faced by students. Scientific education aims to equip learners with a reflective and critical awareness so that they can be agents who question their social reality. In this logic, interdisciplinary science projects enable changes in the fragmentation of knowledge and its already established disconnected form of teaching, since interdisciplinarity is characterized by “[...] intensity of exchanges between experts and the degree of real interaction of disciplines within the same research project” (Japiassu, 1976, p. 74).

The positioning of a contextualization of knowledge, described in investigations A1, A5 and A7, was a constant demand in the interdisciplinary training of Natural Sciences educators, since interdisciplinarity rescues the integral dimension of human beings and, certainly, requires a relationship very direct application of knowledge in everyday life (Lara & Duarte, 2018). The interdisciplinary teacher contextualizes the contents of natural sciences through the reality experienced by students and, in the dynamism of this approach, seeks to transform his pedagogical action into a contextualized education model, in a pattern that provides scientific views about general situations in society among students., whether derived from the school or non-school environment. This contextualization does not only want the understanding of the content to reach students, but aims to form emancipatory and critical learning that can be associated with socio-scientific issues and interpretations (Delizoicov et al., 2011).

The last factor observed regarding interdisciplinary science teacher training dealt with the multiple interactions in the structuring of teaching identity, an aspect manifested in productions A2, A6, A8, A9 and A10. From this perspective, the development of an identity for natural science teachers goes through various theoretical and practical interactions of their interdisciplinary training (Perin & Malavasi, 2019), through a sense that considers the training obtained in the academic environment and the training acquired in the school environment, that is, professional knowledge (Moura et al., 2021). In the teaching profession, these theoretical-practical interactions shape the professional characteristics of their interdisciplinary identity, validating the sense of polycompetence in teaching, in a way that expands teacher’s professional conceptions and knowledge (Fazenda, 2008).

In summary, it was observed in the analysis of proposals and discussions on interdisciplinary teacher training in Brazil, specifying the area of Natural Sciences stipulated for High School, that the field for changes and improvements in interdisciplinary teacher training has too many advances to face in its aspects for the

creation of public policies that favor the training of teachers, reorientation of school curricula, modernization of school structures, as well as the prioritization of teacher training in particular over the concept and application of interdisciplinarity. It is understood that such topics still constitute a very broad space for arguing new curricular proposals (Calado & Petrucci-Rosa, 2019). Thus, after analyzing the material, it was realized that the BNCC and its derivatives BNC-Formação of 2019 and 2020 are still not sufficient to “interdisciplinaryize” the area of natural sciences in high school, as they do not deal with a training proposal solid and broadly suitable for the contexts of basic education teachers. In this sense, it is reiterated that this improvement in teaching still presents colossal challenges and many ambiguities, as these are crucial aspects of a society, as highlighted by the instigating sociological perspective: “[...] society produces the school, which produces society” (Morin, 2018, p. 100).

Final considerations

This study analyzed the proposals and discussions regarding interdisciplinary teaching training in Natural Sciences in the Brazilian territory during the period from 2018 to 2022, specifying the context of educators working in the High School stage. To this end, systematic qualitative bibliographical research of an exploratory nature was structured in scientific productions from three (03) indexed databases. The search resulted in the collection of 1768 scientific articles. These works were subsequently analyzed and selected, a process that resulted in the choice of ten (10) articles for a detailed analysis and the construction of epistemological notes on interdisciplinary science teacher training. The systematic evaluation methodology used in this work ensured the impartiality of the results, since the evaluation was guided by criteria and interpretations acquired from the research products, that is, the elements evidenced in the scientific articles. In this way, the outcomes found corresponded to the general objective of this investigation, demarcating understandings from a perspective of current developments in the scope of Natural Sciences in Brazil, through reflections directed to teacher training, specifically the implications of the interdisciplinary education model stipulated in the BNCC.

Briefly, the results of this investigation showed that the debate on the training of science teachers and the insertion of interdisciplinarity in natural sciences in Brazil still requires progressive improvements, perhaps the implementation of new public policies that encourage the initial and continued training of natural science teachers. In fact, the essential importance of encouraging teachers to develop a culture for integral and communicative learning in high school is highlighted. This phenomenon occurs through the interrelationship of knowledge of the new school curriculum, its articulations between teaching and learning, and its involvement in the students’ realities. It is clear that the postulates of the BNCC are insufficient to achieve what is desired from the Brazilian educational reality in the area of Natural Sciences, as the ideal interdisciplinary educational model requires that the knowledge of the curriculum appropriates social epistemologies and that, in this way, they can face without deviating the reality of students and their relationships with socio-scientific issues.

Finally, it is evident that the proposals and discussions of research on interdisciplinary teaching training in Natural Sciences in the Brazilian context, according to the observation of this work, lead to five (05) argumentative pillars for science education: interdisciplinary science curriculum; initial and continued training in interdisciplinary optics; interdisciplinary projects; contextualization of knowledge; as well as multiple interactions in the structuring of teaching identity. Therefore, such aspects need to be observed more closely in teacher training that seeks interdisciplinarity. It is claimed that, to improve these observations, future investigations into interdisciplinary teacher training within the scope of Natural Sciences should emphasize, mainly, the construction of interdisciplinary teaching identity in the natural sciences, that is, on the characteristics that are implicated in their teaching skills. professional knowledge and practice.

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