

State of knowledge on continuing education processes for Science Teachers and their relationships with teaching conceptions

Estado do conhecimento sobre processos de formação continuada de professores de Ciências e suas relações com concepções de ensino

Camila Boszko¹

<https://orcid.org/0000-0003-4257-622X> 

Roque Ismael da Costa Güllich²

<https://orcid.org/0000-0002-8597-4909> 

1. Departamento de Biologia e Zoologia do Instituto de Biociências, Universidade Federal de Mato Grosso, Cuiabá, Brasil. E-mail: camila.boszko@ufmt.br

2. Universidade Federal da Fronteira Sul, Cerro Largo, Brasil. E-mail: bioroque.girua@gmail.com

Abstract: This study presents a bibliographic review from the CAPES Journal Portal on continuing education in Science and its relationship with teaching conceptions. The research follows the state-of-knowledge approach and thematic content analysis, with a corpus of seventy-one studies categorized into three dimensions: study overview, training model, and teaching conception. The findings indicate that most training processes take place in short-term courses. Regarding teaching conceptions, we identified the technical (19:71) and practical (18:71) perspectives, with a predominance of the critical/emancipatory perspective (34:71). The results suggest that continuing education based on the investigation-training-action approach is a viable model for fostering a critical/emancipatory teaching conception in Science education.

Keywords: teacher education, science teaching, bibliographic study.

Resumo: Este estudo apresenta um levantamento bibliográfico no Portal de Periódicos da CAPES sobre a formação continuada em Ciências e suas relações com as concepções de ensino. A pesquisa segue a abordagem de estado do conhecimento e análise temática, com um corpus de setenta e um trabalhos, categorizados em três eixos: panorama dos estudos, modelo de formação e concepção de ensino. Os dados indicam que a maioria dos processos formativos ocorre em cursos de curta duração. Quanto às concepções de ensino, identificamos as perspectivas técnica (19:71), prática (18:71) e uma predominância da crítica/emancipatória (34:71). Os resultados sugerem que a formação continuada, baseada na investigação-formação-ação, se mostra viável para promover uma concepção crítica/emancipatória no ensino de Ciências.

Palavras-chave: formação de professores, ensino de ciências, estudo bibliográfico.

Introduction

Education is a vast field, permeated by various areas that, interconnected, enable meaningful constructions of knowledge and human development. Teacher training is a central part of educational processes, as it allows for various paths in teaching and learning. This occurs because teachers' knowledge has its roots in educational theories, experiences, and the training processes in which they participate (Piotrowski & Güllich, 2021).

According to Nóvoa (1995, p. 24), teacher training can "play an important role in shaping a new teaching professionalism, stimulating the emergence of a professional culture within the teaching staff and an organizational culture within schools." In this sense, it is important to understand how the movements that guide the various processes of continuing education occur, aiming to comprehend, among various important issues, which teaching conceptions are being stimulated, how teaching is approached, which references are discussed, and the importance of reflection on practices in this context.

Gatti (2010), in summary, outlines the timeline of higher education course offerings, showing how the current characteristics of teacher training courses were constructed, as well as the prejudices and devaluations faced. In this context, the author emphasizes that

regarding teacher training, a true revolution in the formative institutional structures and curricula is necessary. There are already many amendments. The fragmentation of training is clear. It is essential to integrate this training into articulated curricula focused on this primary objective. Teacher training cannot be conceived from the sciences and their various disciplinary fields as an addendum to these areas, but rather from the social function inherent to schooling - teaching new generations the accumulated knowledge and consolidating values and practices consistent with our civil life (Gatti, 2010, p. 1375).

Furthermore, Imbernón (2011) highlights that teacher training is conceived as a continuous process of professional development. This process begins with school experience and extends throughout life, surpassing specific moments of improvement. Moreover, according to Imbernón (2010), individual development always occurs within a specific social and historical context, which influences their nature and actions. Therefore, in constituting our identity as teacher subjects, we cannot overlook this context and its effects on our training and teaching.

Understanding the importance of ongoing training in teaching practice and in the construction of professional identity is fundamental. This process of professional and identity development implies that teachers assume a teaching identity over time. This change in perspective involves recognizing that teachers are interactive subjects

in their own training and not mere manipulable objects in the hands of others, a position reinforced by Imbernón (2010). In the Brazilian context of Science education, processes and research on teacher training have historically demonstrated weaknesses, with efforts since the 1970s focusing on initial teacher training to the detriment of ongoing training (Gozzi & Rodrigues, 2018).

In summary, teacher training plays an essential role in valuing human development processes, going far beyond teaching specific scientific knowledge. Thus, precisely because of this importance, teacher training processes have been the subject of numerous studies over the past decades (Cunha, 2013; Piotrowski & Güllich, 2021; Dobal & Wenzel, 2024). Regarding training, Estevão (2001, p. 185) discusses that:

training as a specific social practice and as a true institution that fulfills certain social functions related to the reproduction, regulation, and legitimation of the social system. [...] training, at the same time, celebrates certain values, sometimes contradictory, linked both to the business and managerial world and to the civic and citizenship world.

Thus, the conception of training is never neutral. This study aims to analyze formative processes from a perspective that distances itself from a merely technical understanding, removing any possibility of denying subjectivity. This is because "each device of looking and observation modifies the object of study [...] therefore, we never study a neutral object, but always an implicated object, characterized by the theory and the device that allows us to see it, observe it, and know it" (Gauthier, 1999, p. 24).

On this spectrum, it is understood that the formative model is intrinsically related to the conception of teaching intended to be developed, as both dimensions feed into each other. From this perspective, considering that the formative process is permeated by the subjectivity and historicity of individuals, it is possible to understand that different conceptions of teaching produce distinct ways of being and acting as educators. As defined by Contreras (1994) and adapted by Rosa and Schnetzler (2003), three main conceptions are identified: (1) technical, in which the teacher is conceived as an executor of methods and techniques, acting instrumentally and focused on applying theories to solve previously defined problems; (2) practical, which understands teacher training as a learning process of, for, and about practice, recognizing the teacher as a reflective professional; and (3) critical or emancipatory, which plays a central role in continuing education processes, as it fosters professional development and promotes teaching anchored in critical reflection and the transformation of educational reality.

Based on the importance of the theme, the central question of this article can be summarized as follows: how do the predominant continuing education processes

in academic research in the field of Sciences unfold, and what are their relationships with teaching conceptions? To achieve this purpose, we conducted a bibliographic research aimed at contextualizing the conceptual debate on the different teaching conceptions and the models of continuing education intended for Science teachers.

Methodology

In terms of methodological approach, the study relies on a qualitative approach, as we consider it the most appropriate given that the objective of the research is to comprehend and interpret a phenomenon beyond numbers (Bogdan & Biklen, 1994). In this perspective, in this approach, "the data collected are designated as qualitative, which means rich in descriptive details regarding people, places, and conversations, and of complex statistical treatment" (Bogdan & Biklen, 1994, p. 16).

In this sense, for data production, a state-of-the-art knowledge-type research was conducted to identify scientific production under specific criteria. In this type of study, there is an "identification, recording, categorization that leads to reflection and synthesis on the scientific production of a certain area, in a certain period of time, gathering journals, theses, dissertations [...] on a specific theme" (Morosini & Fernandes, 2014, p. 155).

In the national context, according to Vasconcello, Nascimento da Silva, and De Souza (2020, p. 12), there is an association between the terminologies "state of the art" and "state of knowledge." In this regard, some researchers consider them synonyms, while others categorize them as similar but recognize significant differences in the established time period, the research objective, the scope, and the analysis. Therefore, it is pertinent to highlight that, for the purposes of this research, we adopt the investigation as a "state of knowledge", following Romanowski and Ens (2006), recognizing that the research was delimited as a cut within a specific database.

In the present study, we chose the CAPES Periodicals Portal as the research locus, as this periodicals portal is one of the largest virtual scientific collections in Brazil, providing content produced nationally, as well as others published with international publishers, by educational and research institutions in the country, online and free of charge (Piton & Machado, 2019). We emphasize that no temporal, thematic, or any limiting nature cuts were made. The analysis of these data was conducted through content analysis, developed in three stages (Bardin, 2011).

In the pre-analysis, based on a floating reading, we developed the first delimitation of the corpus, identifying the proximity of the material to the research objective and selecting the works that produced data with affinity to the research problem. The data collection was conducted using "Continuing education for teachers" AND "sciences" as search terms. Initially, we found 1,628 works. Then, through the process of floating reading, we selected the works that aligned with the prerequisites, namely: discussing the process of continuing education for teachers, being directly related to the field of science education, and not being a bibliographic survey article. In addition, some works that appeared more than once were also discarded. As a result, we arrived at a total of seventy-one works, which are displayed in Table 1.

Table 1
Analysis corpus

Code	Author	Title	Year
T1	Oliveira <i>et al.</i>	Formação continuada de professores de Ciências em Educação Especial: indicadores de desenvolvimento profissional	2022
T2	Ramalho; Oliveira; Nascimento	Evidências de engajamento docente na formação continuada de professores de Ciências e Biologia	2023
T3	Bremm; Güllich	A importância do diário de formação para a sistematização de experiências na formação continuada de professores de Ciências	2020
T4	Oliveira; Vera	Diálogos entre a astrobiologia e a pedagogia da terra: uma proposta e contribuição para a formação continuada de professores de Ciências	2023
T5	Piotrowski; Güllich	A reflexão como categoria formativa: dos dilemas às potencialidades do processo de formação continuada de professores de Ciências e Biologia	2022
T6	Silva; Milaré	Saberes populares e alfabetização científica: possibilidades de um curso a distância na formação continuada de professores de Ciências	2022
T7	Hammel; Santos; Miyahara	Fragilidades e potencialidades das UEPS sob a perspectiva CTSA na formação continuada de professores de Ciências e Matemática	2021
T8	Person; Bremm; Güllich	A formação continuada de professores de Ciências: elementos constitutivos do processo	2019
T9	Santos <i>et al.</i>	Formação continuada de professores de Ciências e Biologia no litoral do Paraná: relato de experiência	2019
T10	Souza <i>et al.</i>	Formação continuada de professores de Ciências utilizando a aquaponia como ferramenta didática	2019
T11	Silva <i>et al.</i>	Metodologias ativas de aprendizagem: relato de experiência em uma oficina de formação continuada de professores de Ciências	2019
T12	Velasco; Morey; Silva	A utilização de pressupostos do educar pela pesquisa na organização e oferta de um curso de extensão para a formação continuada de professores de Ciências	2020
T13	Ferreira; De Arruda Silva	Reflexão compartilhada na formação continuada de professores de Ciências: relato de experiência envolvendo relações CTS	2016
T14	Vale; Firme	Análise de um processo de formação continuada de professores de Ciências para a abordagem de questões sociocientíficas	2017
T15	Gonçalves; Mello; Mello-Carpes	Oficina "circuito sensorial" como metodologia utilizada na formação continuada de professores de Ciências	2016
T16	Goi; Santos	Formação continuada de professores de Ciências: elaboração	2016

		de situações-problema solicitação correção	
T17	Iatskiu <i>et al.</i>	Relato de experiência: capacitação e formação continuada de professores de Ciências e Biologia	2015
T18	Resende; Freitas; Bassoli	A residência docente como espaço formativo: narrativas sobre a construção de saberes e da identidade profissional de professoras de Ciências e Biologia	2023
T19	Monteiro; Gouvêa; Sánchez	A abordagem CTSA sob a perspectiva dos temas geradores em freire para formação continuada de professores de Ciências: um campo de conflitos simbólicos na região de angra dos reis	2010
T20	Leite; Terra; Brasil	Ensino investigativo com enfoque CTS/CTSA e sustentabilidade na formação continuada de professores de Ciências da Natureza	2016
T21	Leite; Rodrigues; Júnior	Ensino por investigação na visão de professores de Ciências em um contexto de formação continuada	2015
T22	Santana; Passos	Representações sociais de professores em formação continuada sobre o termo jogo no ensino de Ciências	2013
T23	Goi <i>et al.</i> *	Formação continuada de professores de Ciências da Natureza: a experimentação na educação básica	2019
T24	Oliveira; Alvim	A história das Ciências com enfoque CTS na formação continuada de professores de Química	2020
T25	Muniz; Barros	Percepção e utilização do ensino híbrido entre professores em formação continuada do ensino de Ciências	2022
T26	Luciano; Veloso; Mozzer	Reflexões sobre valores morais por professores de Ciências em um curso de formação continuada	2022
T27	Camilotti; Gobara	Formação continuada e permanente de professores e o planejamento coletivo das aulas de Ciências	2023
T28	Oliveira; Aires	Experimentando Ciência: análise de um curso de formação continuada para professores do ensino fundamental	2020
T29	Goi; Santos	Formação continuada de professores de Ciências: elaboração de situações-problema solicitação correção	2016
T30	Uhmman	Estratégias formativas na formação inicial e continuada de professores de Ciências	2019
T31	Leite; Rodrigues; Júnior	Ensino investigativo: análise de sequências didáticas produzidas por professores(as) de Ciências em um contexto de formação continuada	2019
T32	Bretones; Compiani	A observação do céu como ponto de partida e eixo central em um curso de formação continuada de professores	2010
T33	Oliveira; Silva	A coordenação pedagógica como espaço de formação continuada de professores dos anos iniciais no contexto do ensino de Ciências	2020
T34	Goi; Silva; Medeiros	Formação continuada de professores: extensão universitária sobre a metodologia de resolução de problemas no ensino de Ciências na modalidade remota	2022
T35	Bremm; Güllich	Do diário de formação à sistematização da experiência: o processo de (auto)formação de professores de Ciências	2022
T36	Santos; Machado; Marandino	As vozes dos professores ribeirinhos da Amazônia: reflexões e (re)significações a partir de uma experiência de formação continuada em Ciências da Natureza	2021
T37	França; Augusto	DNA, a molécula da hereditariedade: História da Ciência na formação continuada de professores	2021
T38	Aviles; Galembeck	Formação de professores de Ciências em tempos de pandemia: uma estratégia de EAD sobre enfoques construtivistas e remotos do laboratório didático de Ciências	2021
T39	Almeida; Diniz	A tomada de consciência sobre o uso de analogias espontâneas: contribuições de uma formação continuada desenvolvida com professoras de Ciências	2020
T40	Machado <i>et al.</i>	Formação continuada de professores dos anos iniciais: uma ação de extensão em Ciências da Natureza	2021
T41	Bremm; Güllich	O papel da sistematização da experiência na formação de professores de Ciências e Biologia	2020
T42	Bourscheid; Wenzel	O espelhamento de práticas na formação continuada de professoras da educação infantil: reflexões compartilhadas sobre ensinar Ciências	2023

T43	Cavagis; Filho	Uso da plataforma construct 2® na formação continuada de professores em jogos educativos virtuais	2023
T44	Medeiros; Pinto; Salvador	Padrões de interação e mediação em dois fóruns online em um curso para a formação continuada de professores de Biologia	2022
T45	Piotrowski; Güllich	Significados atribuídos e contribuições: limites e possibilidades da formação continuada no desenvolvimento profissional docente em Ciências	2022
T46	Bonzani; Bastos	Estratégias de formação continuada de professores: análise de uma experiência	2013
T47	Siqueira <i>et al.</i>	Produção de situações-problema em curso de extensão universitária por professores de Ciências da Natureza dos anos finais e ensino médio da rede básica de ensino	2019
T48	Souza; Francisco	Contribuições formativas para professores de Ciências/Química: diálogos entre metacognição e ambientes virtuais de aprendizagem	2024
T49	Santos; Panseira-de-Araújo; Carvalho	Educação em saúde, mediada por filme comercial, na formação de professores de Ciências da Natureza	2019
T50	Bremm; Michelon; Güllich	Conhecimentos docentes: formação de professores no âmbito do projeto Ciência na Escola	2022
T51	Cabral; Sepini; Maciel	Competências científicas, CTS e formação continuada de professores da educação básica	2019
T52	Paz; Avila; Leal	Indicadores de alfabetização científica de professores em serviço: a bioquímica como contexto formativo	2019
T53	Silva <i>et al.</i>	Formação continuada de professores com metodologias ativas de ensino - dificuldades e conquistas	2021
T54	Moretto <i>et al.</i>	Formação de professores e educação ambiental: desafios e conquistas no contexto imposto pela pandemia de covid-19	2021
T55	Pena; Gastal	Narrativas autobiográficas: metodologia de investigação e de formação de professores para o tema da sexualidade humana	2017
T56	Benite <i>et al.</i>	Formação de professores de Ciências em rede social: uma perspectiva dialógica na educação inclusiva	2011
T57	Medeiros; Pinto; Salvador	Abordagem, métodos e perfil de trabalho docente para o ensino de Biologia Molecular na educação básica: relatos de professores em um curso de formação continuada on-line	2020
T58	Bartelmebs; Figueira	Astronomia no google classroom: uma experiência da formação continuada em tempos de pandemia	2021
T59	Schneider; Meglhioratti; Corazza	Discursos de professores em formação continuada acerca da relação entre a manipulação genética e a possibilidade de melhoramento em humanos	2016
T60	Santos; Rodrigues; Júnior	A construção de narrativas digitais por professores de Ciências: análise de uma experiência de formação mediada pelas tecnologias	2019
T61	Santos; Rodrigues; Júnior	“Tenho um tablet, e agora?”: a produção de narrativas digitais como estratégia na formação de professores de Ciências	2018
T62	Martins; Schnetzler	Formação de professores em educação ambiental crítica centrada na investigação-ação e na parceria colaborativa	2018
T63	Silva; Schnetzler	Buscando o caminho do meio: a “sala de espelhos” na construção de parcerias entre professores e formadores de professores de Ciências	2000
T64	Marques <i>et al.</i>	Educadores ambientais: os desafios e as possibilidades da formação continuada para atuar na educação básica	2020
T65	Person; Güllich	Concepções de ensino e a formação de professores de Ciências e Biologia	2016
T66	Bervian; Panseira-de-Araújo	A comunidade autorreflexiva na constituição dos conhecimentos de professor pela investigação-formação-ação	2020
T67	Bonzanini <i>et al.</i>	As narrativas como fontes de reflexões sobre práticas pedagógicas no ensino de Ciências	2017
T68	Almeida; Diniz	Reflexões de professoras de Ciências sobre as analogias: uma experiência formativa pautada nos princípios de reflexão e colaboração	2021
T69	Moser; Moreira	Peças educacionais socioambientais: experiência de um processo de formação continuada em educação ambiental	2020

T70	Oliveira; Fusinato; Batista	O whatsapp como possibilidade para a construção do conhecimento de forma colaborativa: um recurso significativo para o ensino de astronomia	2022
T71	Kierepka; Güllich	La formación continua de profesores de Ciencias: constitución docente por la narración reflexiva	2013

In the exploration stage of the material, after the initial analysis, one returns to the data with greater attention to categorize and code them. These works were systematized using basic information and key categories for data discussion. This systematization and categorization are presented below, based on three categories, one of which is emergent: overview of the studies, and two defined a priori by the study's objective: training model and teaching conception. To facilitate the flow of discussion throughout the text, the works were distributed by code, starting with T (text), followed by numbers: T1, T2,... up to T71.

In the end, we proceeded with the treatment of the obtained results and their interpretation, aiming to cross them with the relevant theory in the field, with the intention of deriving meanings from the constructed discussion.

Reflecting on the Training Processes in Science and Teaching Conceptions

The selected works were analyzed under three categories: overview of the studies, training model, and teaching conception. The first relates to general data of the studies that structure the research, seeking to identify characteristics of the place and the subjects that compose the study. In the second category, there is a discussion of training models, aiming to identify how the national scenario has presented itself regarding the ongoing training of Science teachers. The third categorization is intended to present the teaching conceptions stimulated in the context of the analyzed training groups, with the aim of discussing the relationship between the training model and the teaching developed.

General Overview

This category presents an overview of the analyzed studies, distributing them as follows: year of publication, institution, and the state in which they were conducted (considering the institutions), the journal's Qualis, and the main theme of the study's discussion. Because of this, we understand it as a macro category.

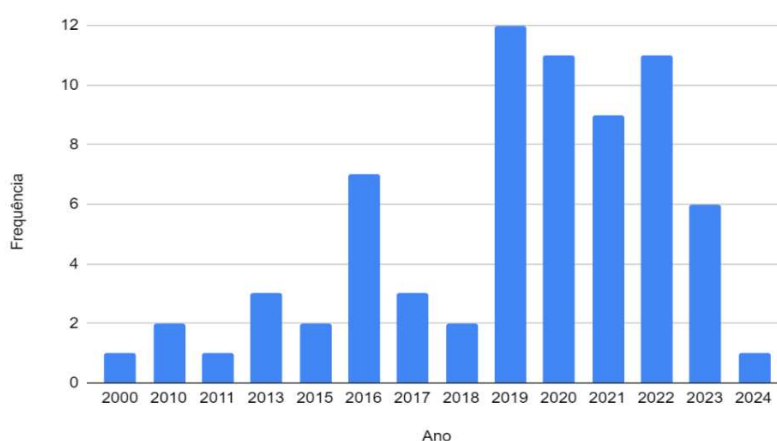
Figure 1 illustrates the concentration of studies by year of publication. We emphasize that the search for articles did not limit it to specific years, so the temporal trace faithfully reflects the journal's publications. Based on this, we can observe that teacher training is not a recent topic, as Zeichner (2009) and Cunha (2013) have

already pointed out, with a study dating back to 2000. However, the cut made showed a significant increase starting in 2019.

Specifically, the distribution of studies by year occurred with the following frequency: the years 2000, 2011, and 2024 each had a frequency of 1 occurrence (1:71). Meanwhile, 2010, 2015, and 2018 each had 2 occurrences (2:71), while 2013 and 2017 each had 3 occurrences (3:71). The year 2023 occurred 6 times (6:71), and 2016 had 7 occurrences (7:71). In 2021, the frequency was 9 occurrences (9:71). In the years 2020 and 2022, there were 11 occurrences each (11:71), and finally, 2019 had the highest frequency, with 12 occurrences (12:71), showing the highest production. It should be clarified that 2024 had no significant expression, which can be justified by the fact that the data were collected in May of that year.

Figure 1

Frequency distribution of articles by year



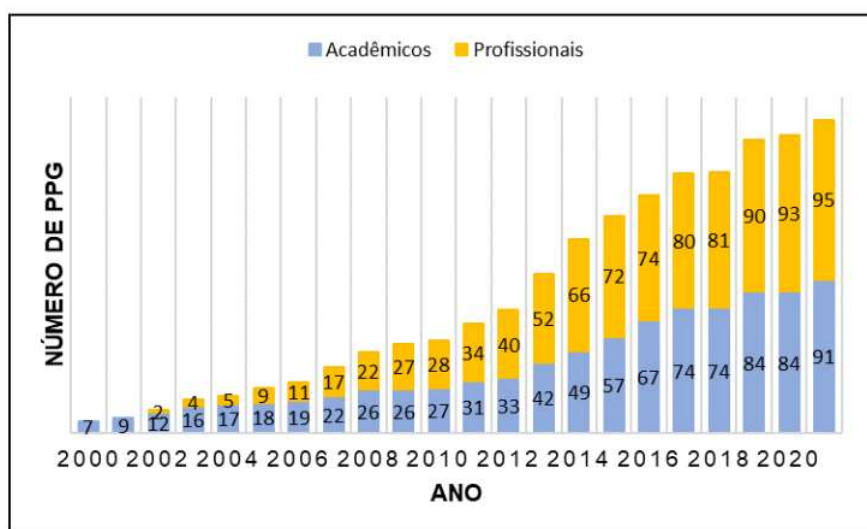
Note. [Image description] Vertical bar graph representing the frequency distribution of articles published over the years. The graph has a light background with blue bars. The horizontal axis (x-axis) shows the years, ranging from 2000 to 2024. The vertical axis (y-axis) indicates the frequency of articles, with increasing numerical values. It can be observed that the first years show a low frequency of publications, with values between 1 and 3 articles. From 2016 onwards, there is a more significant increase, reaching 7 articles in that year. The peak occurs in 2019, with 12 articles. In the following years, between 2020 and 2022, the frequency remains relatively high, varying between 9 and 11 articles per year. In 2023 there is a reduction to 6 articles, and in 2024 a decrease is observed again up to the time of the research, with 1 article published. [End of description]

This increase can be explained by three hypothetical avenues in this study: 1. by the growing influence of educational research, which has increasingly encompassed new spaces and identified production gaps (Sasseron & Carvalho, 2011; Piotrowski & Güllich, 2021; Agostini & Massi, 2023); 2. by the configuration of the current scenario, in which education and teacher training have attracted the interest of large private education conglomerates (Oliveira & Prata, 2023); 3. by the expansion and consolidation of the Teaching area in CAPES, as in 2000, area 46 had a different configuration and included 7 related Graduate Programs (GP) (Almeida & Nardi, 2013; Agostini & Massi, 2023), as illustrated in Figure 2.

The first two actors influence the formulation and implementation of educational policies; however, in many cases, these interests aim to position education as an additional commercial niche. Furthermore, there is an assumption that teacher training can be offered as a product to be consumed on a large scale. However, in 2009, the discussion about the reformulation in the area began, and in 2011, area 46 was designated for "Teaching," resulting in a significant increase in GPs and, consequently, in the production of works and the training of researchers, as can be observed below.

Figure 2

Evolution of the number of GP in area 46 between 2000 and 2021



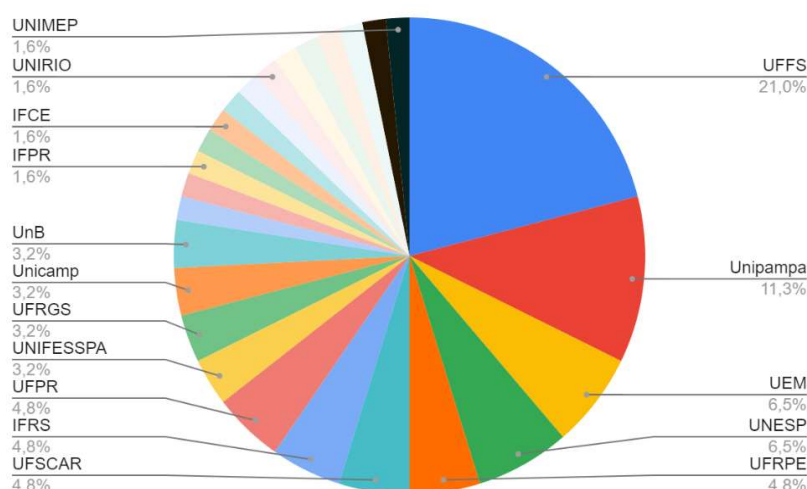
Note. [Image description] Stacked vertical bar graph showing the evolution of the number of Graduate Programs (PPG) in area 46 over the years. The graph has a light background and is delimited by a frame. The horizontal axis (x-axis) shows the years from 2000 to 2021. The vertical axis (y-axis) indicates the number of PPGs. The bars are composed of two colors: blue, representing academic programs, and yellow, representing professional programs, as indicated in the legend located at the top of the graph. It can be observed that, in the initial years, there is a predominance of academic programs, with reduced numbers and little presence of professional programs. Over time, there is continuous growth in both categories, especially from 2010 onwards, when professional programs begin to increase more significantly. In recent years, between 2015 and 2021, there has been a significant increase in the total number of programs, with particular emphasis on the expansion of professional programs, which now represent a considerable portion of the total. In 2021, the graph indicates the highest values for both categories, highlighting the expansion of postgraduate studies in the area analyzed. [End of description]

Source: Agostini & Massi (2023).

Figure 3 presents the institutions where the studies were conducted and their respective frequencies. There was a significant representation of Brazilian institutions, with the Universidade da Fronteira Sul (UFFS) and the Universidade Federal do Pampa (Unipampa) standing out as the origins of a large portion of the studies. Specifically, the works were developed at the following institutions:

UNIFESSPA (T1, T62*¹), UFRPE (T2, T14, T25), UFFS (T3, T5, T8, T30, T35, T41, T42, T45, T49, T50, T65, T66, T71), UFLA (T4), UFSCAR (T6, T37, T43), UNICENTRO (T7), IFPR (T9), IFAM (T10), IFCE (T11), IFRS (T12, T53, T64), UFMG (T13), Unipampa (T15, T16*, T23, T29*, T34, T40, T47), UEM (T17, T21, T31, T70), UFJF (T18), UNIRIO (T19), IFES (T20), IFBA (T22), UNESP (T24, T39, T46*, T68), USP (T46*), UFOP (T26), UFMS (T27), UFPR (T28, T58, T69), UFRGS (T16*, T29*), Unicamp (T32, T38), UnB (T33, T55), and UNIMEP (T62*).

Figure 3
Frequency of studies by institution



Note. [Image description] Pie chart showing the frequency of studies distributed across different educational and research institutions. The chart has a light background and is composed of multiple colored slices, each representing an institution, identified by name and percentage. The slices are connected to external labels by lines, indicating the institutions and their respective percentages. The largest slice corresponds to UFFS, with 21% of the studies. Next is Unipampa, with 11.3%. UEM and UNESP each have 6.5%. Other institutions, such as UFRPE, UFPR, IFRS, and UFSCAR, each have a 4.8% share. UnB, Unicamp, UFRGS, and UNIFESSPA each have 3.2%. UNIMEP, UNIRIO, IFCE, and IFPR have the lowest frequencies, with 1.6% each. The remaining slices, of quite small size, represent other institutions not individually identified in the chart. [End of description]

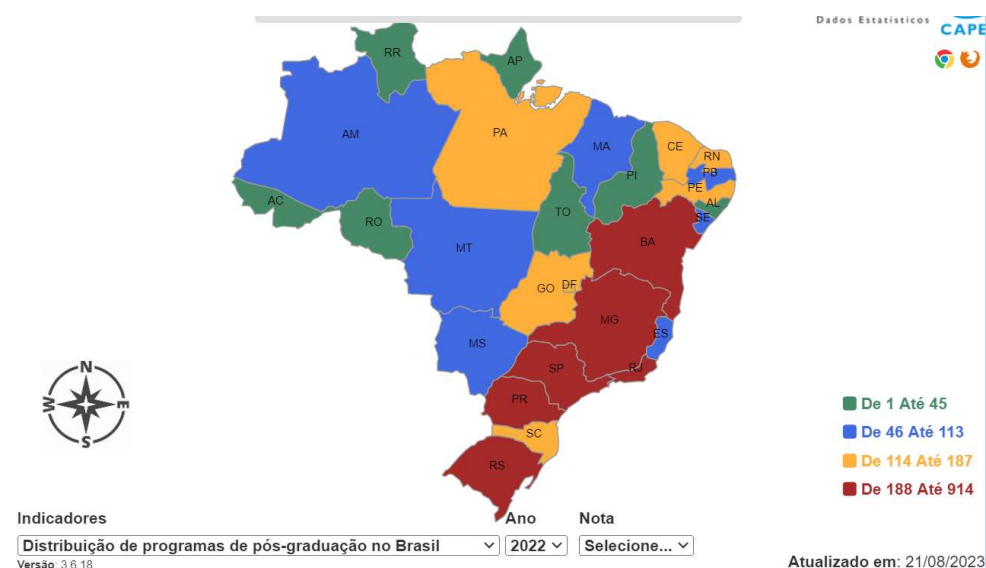
In this scenario, the productions by state were distributed in the following frequency: RS (23:71), SP (15:71), PR (10:71), MG (06:71), RJ (03:71), PE (03:71), DF (02:71), PA (02:71), MS (01:71), ES (01:71), GO (01:71), TO (01:71), BA (01:71), CE (01:71), AM (01:71). These data are corroborated and can be explained by the survey available on the CAPES Georeferenced Information System platform (GEOCAPES), which indicates the number of graduate programs in the country. The data collected in this study relate to the number of programs reported by the platform, as shown in Figure 4, with RS, SP, PR, and MG being among the states with the highest number of programs (between 188 and 914), which justifies the larger quantity of productions found. This fact is also justified when we look closely at area

¹ The works identified with (*) were developed by researchers from more than one institution, thus, they were counted multiple times in this survey.

46 – Teaching, which, according to GEOCAPES data, had, in 2022, 178 GPs, with the majority in RS (24:178), PR (24:178), and SP (21:178).

Figure 4

Distribution of GPs in Brazil by GEOCAPES



Note. [Image Description] Map of Brazil showing the distribution of Graduate Programs (PPGs) by federative unit, based on data from the GEOCAPES platform. The map has a light background and the states are highlighted by different colors, according to the number of programs. The colors follow a categorical scale indicated in the legend to the right of the image: green represents 1 to 45 PPGs; blue indicates 46 to 113; yellow corresponds to 114 to 187; and red represents 188 to 914 programs. Each state is identified by its abbreviation. It can be observed that the states in the Southeast region, such as São Paulo (SP), Minas Gerais (MG), and Rio de Janeiro (RJ), appear in red, indicating a higher concentration of PPGs. In the South region, Rio Grande do Sul (RS) also stands out with a high concentration. States classified in yellow and blue are mainly distributed in the Central-West, Northeast, and part of the North regions, indicating intermediate concentrations. The states shown in green, predominantly in the North and part of the Northeast regions, have fewer programs. In the lower corner of the image, there are interface elements indicating filters and visualization parameters, such as the selected indicator ("Distribution of postgraduate programs in Brazil"), the year (2022), and selection options. There is also an indication of data update (August 21, 2023). The map highlights the uneven concentration of postgraduate programs across Brazil, with a higher density in the Southeast and South regions. [End of description]

Source: Screenshot taken from GEOCAPES. Available at: <https://geocapes.capes.gov.br/geocapes/>.

Another criterion analyzed for constructing the overall picture of the works was the analysis of the Qualis of the journal in which the work was published on the Qualis CAPES website. As systematized in the following Table 2, we identified that the vast majority of the works are concentrated in the highest qualification strata. That is, in strata A (A1 - A4), fifty-nine works (59:71) are concentrated, with A1 and A3 standing out. This data confirms the quality of the analyzed production, as journals with a high stratum tend to have higher quality criteria for accepting works.

Table 2
Qualis of the journals in which the works were published

Qualis	Codes of the works	Frequency
A1	T2, T10, T14, T18, T22, T32, T35, T39, T44, T45, T46, T48, T49, T55, T56, T59, T62, T63, T67	9:71
A2	T4, T11, T21, T25, T33, T36, T37, T38, T41, T52, T61, T64	2:71
A3	T5, T8, T12, T16, T17, T20, T28, T29, T34, T50, T51, T53, T65, T66, T69, T71	6:71
A4	T3, T6, T7, T13, T15, T26, T27, T30, T31, T40, T42, T54	2:71
B1	T9, T19, T43, T60	:71
B2	T47, T58, T68	:71
B4	T1, T57, T70	:71
SQ	T23, T24	:71

Source: Research data prepared by the authors, 2024. *SQ: Without qualis.

The main theme of the study's discussion was quite diverse. When possible, we sought to group the works into themes based on semantic criteria, as Bardin (2011) specifies, making them broader to facilitate the interpretation and analysis of the data. Thus, Table 3 presents the themes discussed in the studies, which were categorized based on the complete reading of the works, considering the object of study addressed in each research.

Table 3
Guiding themes of the analyzed studies

Subcategory and Frequency	Units of Record	Works
Teacher Training (44:90)	Narratives and Diaries	T3, T18, T71, T55, T60, T61, T65, T66, T67, T71
	Teacher Training	T8, T9, T12, T15, T17, T30, T36, T40
	Action Research	T5*, T35, T62
	Reflection	T13, T63
	Teaching Collective	T27, T70
	Systematization	T41
	Teacher Engagement	T2
	Reflection of Practices	T42
	Teaching Knowledge	T50
	Teaching Conceptions	T65
	Teacher Constitution	T66
	Professional Development	T45
	Pedagogical Coordination	T33
	Teaching Residency	T18
Teaching Methodologies (28:90)	Science-Technology-Society and Environment (CTSA)	T7, T13*, T19, T20, T24*, T51*

	Problem Solving	T16, T29, T34, T47
	Investigative Teaching	T20, T21, T31
	Experimentation	T23, T28
	Active Methodologies	T11, T53
	Analogies	T39, T68
	Scientific Literacy	T6, T52
	Games	T22, T43
	Metacognition	T48
	Potentially Significant Teaching Units (PSTU)	T7
	Educating through Research	T12
	Socio-scientific Issues (SSI)	T14
	Movies	T49
	Astronomy	T32, T58, T70
	Genetics	T46, T59
	History of Science	T24, T37
Contents (12:90)	Astrobiology	T4
	Earth Pedagogy	T4
	Biochemistry	T52
	Molecular Biology	T57
	Women in Science	T10
	Ed. Ambiental	T54, T62, T64
	Ed. Special	T1, T56
Themes Across Disciplines (09:90)	Health Education	T49
	Sexuality	T55
	Moral Values	T26
	Interdisciplinarity	T67
	Distance Education (EaD)	T6, T38, T58
Technologies (07:90)	Digital Technologies	T60, T61
	Hybrid Teaching	T25
	Virtual Environments	T48

Source: Research data prepared by the authors, 2024. *In the subcategory Action Research, we also grouped a study that referred to reflection-action and in STSE, studies that referred to STS. **The total frequency of themes summed to 90, as some articles focused on discussing more than one subject.

In general, what is identified from the analysis of the themes are the highest frequencies of works focusing on teacher training (44:90), teaching methodologies (28:90), specific content in Sciences (12:90), transversal themes (09:90), and technologies (07:90).

In the category "teacher training," works (44:90) were included that discussed formative aspects from various perspectives, but that had as a central axis the main discussion of the search/study developed here, aiming, for example: *"the training of*

the reflective and investigative professional in their class where the process aims to culminate in teacher constitution through more practical means and with less influence from the traditional technical model" (T71, p. 58). In this scenario, it was possible to identify the importance of reflection on one's own practice as a formative category, as this is expressed and identified, mainly, in studies centered on narratives and training diaries, as we see in: *"analyzing the narratives leads us to reflect on the identities we are continuously (de/re)constructing in formative paths"* (T18, p. 10). This reflection also manifests in the mirroring of practices and in other aspects present in the various themes of this subcategory. The identification of reflection as the core of teacher training in a large part of these studies leads to discussions with theoretical-methodological foundations in Action Research (AR), or in Research-Training-Action (RFA), themes that also appear in this category.

In training for Science teachers, the AR and RFA model has stood out as an approach that promotes the development of reflective skills (Rosa *et al.*, 2003; Imbernón, 2010; Kierepka & Güllich, 2016). This model is based on practical knowledge developed through reflective processes, offering an alternative to traditional training centered on technical approaches (Carr & Kemmis, 1988; Imbernón, 2010). While lectures, workshops, and short courses usually focus on training and conceptual review, AR proposes a continuous cycle of stages in the form of a self-reflective spiral: observation, problematization, planning, and action (Alarcão, 2010) or problematization, planning, action, evaluation, and modification, as defended by Radetzke, Güllich, and Emmel (2020), always permeated by reflection.

Teaching methodologies (28:90) were also identified expressively in the works, as well as the objectives, generally pointed out in a very specific manner, as we see in:

The general objective of the Workshop titled: 'The History of Sciences under the STS focus in the pedagogical practice of Chemistry teachers' was to develop continuing education activities with practicing chemistry teachers, incorporating the History of Sciences and STS education as guiding threads of the discussions and theoretical framework for the elaboration of the didactic units carried out by the participants (T24, p. 71).

Furthermore, we identified the following methodologies in the analyzed studies: CTSA (06:71), problem-solving (04:71), investigative teaching (03:71), experimentation (02:71), active methodologies (02:71), analogies (02:71), scientific literacy (02:71), games (02:71), metacognition (01:71), UEPS (01:71), educating through research (01:71), QSC (01:71), and films (01:71). All these works present the objective of continuing education as mastering a specific methodology.

Regarding specific contents (12:90) and transversal themes (08:90), the topics that composed these categories were mostly presented as methods of updating,

based on specific discussions about knowledge, whether specific or interdisciplinary.

To this end, they were guided by the conception that

the search for continuing education courses by teachers [...] is often related to the difficulties faced by these education professionals in teaching certain contents that present a high degree of abstraction, such as those involving theoretical models (T57, p. 5).

This fact may indicate a fragility in the development of both the research process and the continuing education processes, as they still follow a simplistic view of training, which the literature has pointed out for years as a necessity to be overcome (Gadotti, 2005; Tardif, 2002). In this sense, Gadotti (2005) emphasizes that, for a long time, teacher training was centered on content. However, the author already stated in 2005 – a consideration that now has, at least, 19 years – that mastering content, both specific and pedagogical, is as important as attitudes and values.

Therefore, a teacher training process needs to consider that

the continuing education processes that have already been tested and can yield positive responses have some relevant characteristics: groups of teachers who decide to "take matters into their own hands" regarding the type of class and content they will teach, having broader guidance – such as curricular parameters – as a reference and not as an end; the prevalence of organized collectives over isolated individuals as a form of action; interaction with university professors who are involved and committed to the training of new teachers; the commitment of schools to the continuing education of their teachers and to the training of new teachers by sharing their spaces and achievements (Maldaner, 2003, p. 25).

The last highlighted subcategory was related to the use of technologies in education (07:90). These works sought to discuss the use of tools in conjunction with teaching, such as T60 and T61, which are works from the same group that aimed to discuss "*the incorporation of tablets in everyday didactic activities [...] and narrate the situations they were facing with TDICs*" (T60, p. 106). According to Pastorio (2018), Digital Information and Communication Technologies (TDICs) provide a diverse set of ideas, encouraging many teachers to step out of their comfort zones and seek new supports for the development of their classes. In this scenario, virtual environments, distance education (EaD), and hybrid teaching were also the backdrop for works, justified by the fact that "*technology plays an important role, considering the ease of access to information, promoting learning in different spaces, formats, and moments*" (T25, p. 9).

Finally, we highlight the need to discuss, in the educational field and, therefore, also in teaching, emerging and current themes that reflect the changes and challenges faced by contemporary society. In this sense, we can highlight the

importance of promoting discussions regarding the needs and interests of central issues that target more disadvantaged collectives, in all aspects of their ideological demands, which are present in the current scenario, one of which is education (Duarte & Santos, 2017, p. 63).

In this study, we can cite the discussion of works involving Women in Science (T10), Special Education (T1, T56), and Sexuality (T55), as examples of the attention that is beginning to be given to emerging themes that urgently require research attention.

In summary, the works originate from research developed in various institutions, predominantly UFFS and Unipampa, therefore, the corpus of analysis presented here also concentrates its production in the state of Rio Grande do Sul. The works were published in journals with a higher Qualis stratum, with the vast majority (59/71) in stratum A. Another aspect to be highlighted is that the knowledge of the teacher, the teaching identity, and professional development were little emphasized in the research, which seems to go against the predominant defenses in the field (Imbernón, 2010). The themes are varied, focusing on the general discussion about teacher training, but also centered on specific content and methodologies – which is directly related to the training model to be discussed next.

Training Models

As also advocated by Mizukami *et al.* (2002), in the course of a teaching career, it is crucial for the teacher to be aware that their training should not remain stagnant, limited only to their undergraduate degree. This professional must understand that training is not static and requires continuous improvement throughout their entire professional life. In this sense, the ongoing training of teachers assumes a central role and guides the entire teaching trajectory, making it essential to invest in public policies that promote the development of this level of training as well as the production of studies that discuss the importance and nuances that compose this context.

Therefore, based on the importance of the formative process for teacher training, we justify the need to focus on the understanding and analysis of the training models that are being developed and researched in the Brazilian context. To this end, we categorize the studies regarding the training models, defined based on the proposition by Piotrowski and Güllich (2021), constructed from the authors Nóvoa (1995), Maldaner (2003), Imbernón (2011), Carvalho and Gil-Pérez (2003), and Zanon (2003), namely: a) Permanent: constant training, highlighting the insufficiencies of training; b) Shared: collectively constituted by different levels of interaction among subjects (initial training teachers – basic education teachers – higher education teachers); c) Complementary: short-term courses with a well-defined objective (lectures, workshops, seminars, for example); and d) Ongoing: to

foster the development of reflective capacity about teaching practice, in order to understand and reflect on education and social reality.

To facilitate the discussion of the data, we constructed Table 4 below, which encompasses the models and the frequency identified in the analyzed studies.

Tablet 4
Training Models

Training Model	Frequency	Code of Works	Context Unit
Complementary	4 7:71	T1, T4, T6, T7, T9, T10, T11, T12, T14, T15, T16, T18, T19, T20, T21, T22, T23, T24, T25, T26, T28, T31, T32, T36, T37, T38, T39, T40, T43, T44, T46, T47, T48, T51, T52, T53, T54, T55, T57, T58, T59, T60, T61, T64, T68, T69, T70	"[...] the present work analyzed the data obtained during a continuing education meeting on HC held in 2016, with a duration of eight hours [...]" (T37, p. 123 [emphasis ours]).
Shared	1 9:71	T2, T3, T5, T8, T13, T30, T34, T35, T41, T42, T45, T49, T50, T56, T62, T65, T66, T67, T71	"The meetings of the Formative Cycles are monthly and include teachers in initial training, basic education teachers, and teacher trainers, following the principle of the formative triad of Zanon (2003)" (T3, p. 16 [emphasis ours]).
Continued	4 :71	T17, T29, T33, T63	"Formative activities (readings and discussions, among other activities) were proposed during the school's pedagogical coordination , a moment dedicated to planning and study by the teachers of the Early Years" (T33, p. 203 [our emphasis]).
All the training models defined as categories <i>a priori</i> were identified in this study, however, with significant differences in their frequencies.	1 :71	T27	Permanent "This investigation was developed with teachers from the early years of elementary education to offer a new perspective on lesson planning in Science that would contribute to the collective emancipation of these teachers in relation to their alienating practices (CAMIOTTI, 2020)" (T27, p. 110 [our emphasis]).
			According to Carvalho and Gil-Pérez (2003), there are various training needs among Science teachers, particularly highlighting deficiencies in teacher training systems.

The vast majority of the works (47:71) were categorized as having their training model complementary. This model is characterized by its short duration and by a format resembling lectures, workshops, and seminars, for example.

There is significant criticism of this training model, as "training is not built through accumulation (of courses, knowledge, or techniques), but rather through a process of critical reflexivity on practices and the (re)construction of a personal identity" (Nóvoa, 1995, p. 25). In this case, what occurs is exactly the opposite: a theme, a content, a methodology is identified, and something quick is carried out, directed at this central objective, which does not always resonate in reflections or in looking at one's own practice. In this sense, courses in the complementary model do

not carry the notion of continuous teacher training, as they are sporadic and of finite duration. Therefore, it is concerning that the vast majority of studies categorize their models in this type of training, as this falls short of discussing and promoting reflective processes and awareness of the actions and teaching identities of those involved.

This model generally has a clear and defined direction/objective, as we can see in the excerpt: *"the continuing education course for teachers took place over two days, totaling 16 hours of in-person activities [...]"* (T59, p. 603). Another example of this model can be observed in T26, which highlights that the objective was the production of didactic sequences based on a specific teaching methodology: *"the main objective of the continuing education course was to foster the professional development of basic education Science teachers by inserting them into a process of experiencing, elaborating, and developing didactic sequences (DS) based on the educational approach of QSC"* (T26, p. 146). Processes based on the shared training model start from processes where training is established based on reflection and investigation of the actions of the involved subjects. In this model, subjects at different career/training levels have the opportunity to develop collaborative partnerships (Maldaner, 2003; Zanon, 2003).

Thus, the trainings utilize different instruments and methods to guide reflection, in order to provide moments of shared discussion that may (re)signify the subjective practices of each teacher subject. As highlighted in: *"[...] promote social and cooperative integration among the different levels of education (trainer teacher; teacher in training (initial) and teacher of basic education (continuing education) combining teaching and research)"* (T8, p. 6). As highlighted in: *"[...] promote social and cooperative integration among the different levels of education (trainer teacher; teacher in training (initial) and teacher of basic education (continuing education) combining teaching and research)"* (T8, p. 6). As highlighted in: *"[...] promote social and cooperative integration among the different levels of education (trainer teacher; teacher in training (initial) and teacher of basic education (continuing education) combining teaching and research)"* (T8, p. 6).

In this study, the works classified in this subcategory (19:71) shared the reflection on their own practice and the triad of interaction among subjects as common and central characteristics, as we see: *"The ongoing training present in the investigated training group uses formative instruments that can facilitate the investigation process of one's own practice from both individual and collective teaching perspectives: writing in the logbook, formative dialogue, practice mirroring,*

experience reports, which, through the systematization of practices, generate a deeper understanding of the experiences we carry out in order to improve our own practice” (T66, p. 30).

Deepening the analysis, we consider it important to examine the theoretical currents adopted for the discussion of formative processes in the analyzed studies. We identified that the vast majority of the works (14:19) classified in the shared training model adopt action research (AR) or training-action research (FAR) as the guiding reference for the proposed and developed actions: T3, T5, T8, T35, T41, T42, T45, T50, T56, T62, T63, T65, T66, T71(14:19). Furthermore, another strong current identified in the studies was that of Historical-Cultural theory, with a frequency of 6:20 (T30, T41, T42, T49, T56, T65), with three of these studies sharing both highlighted references (T31, T56, and T65).

AR constitutes a dialogical, reflective, and critical conception, aimed at enabling the development of the self-reflective spiral that constitutes the subject and the processes of teaching and teacher training. In this understanding, AR “is a form of self-reflective inquiry in which participants in social situations seek to improve the rationality and justice of their own practices, their understandings of them, and the situations in which they take place” (Carr & Kemmis, 1988, p. 174 [own translation]). Alarcão (2010) discusses that experience-based learning and reflection-based training have many points in common; thus, AR can be referred to by the trinomial Investigation-Training-Action (ITA). According to Güllich (2013), when researching a situated context of training in Sciences (IFAC), this trinomial highlights the high formative value attributed to critical reflection. This same study developed the shared training process under the theoretical perspective of ITA and the Historical-Cultural approach. In this sense, we advocate for its use in the context of teacher training in Sciences, more specifically from the IFAC process (Güllich, 2013).

The training model identified as ongoing provides for the encouragement of the development of competencies, skills, and attitudes that favor long-term teacher development (Piotrowski & Güllich, 2021). In this study, this category was identified in four works (04:71), with the works that fit into this category having as a characteristic the planning of activities with a longer timeframe, from the perspective of continuing discussions, as we perceive in: *“the training course took place [...] from September 2013 to May 2014, lasted 90 hours, and involved the participation of 24 teachers in the area of Natural Sciences” (T29, p. 55).*

In this context, permanent training (1:71) emerges as a formative necessity to meet these demands and insufficiencies of training, being identified in: *“in this*

scenario, the proposal for ongoing and permanent training capable of meeting the real needs of teachers and promoting the overcoming of pedagogical practices based on the transmission of knowledge is essential to solve this issue" (T27, p. 107 [our emphasis]). In this sense, in this study, training aims to overcome a process identified by the authors as urgent in that context and has Freirean characteristics (Delizoicov; Delizoicov; Silva, 2020). We highlight, in this context, that the only work categorized as permanent has a theoretical discussion grounded in several studies from a Freirean perspective.

Based on the analysis of the data presented, we identified that the vast majority of formative processes do not have a basis in a critical perspective, assuming a predominantly practical perspective and being based on short-term courses. We perceive that there are still fragile formative processes promoted based on updates or isolated activities and without continuous reflection on teaching practice. Thus, the data present a fragility in the formative processes that were developed and researched, as analyzed in this study. Teacher training should be understood as a continuous process, starting from initial training and continuing in (re)construction throughout the entire career. Furthermore, it should develop with a shared perspective, in which different levels of interaction foster authorship and autonomy, the curriculum, and their own process of professional teacher development (Maldaner, 2003). Thus, teacher training requires a stance in defense of a collective and shared process, which can occur during the exercise of teaching in schools in the style of self-reflective learning communities (Alarcão, 2010; Güllich, 2013).

Teaching Conceptions

The teaching conceptions analyzed in this research were categorized a priori based on the theoretical framework proposed by Contreras (1994) and adapted by Rosa and Schnetzler (2003) for the investigative context of training and teaching in the field of Sciences. In this scenario, we classified the studies in this analysis corpus based on teaching conceptions from three levels: technical, practical, and critical/emancipatory (see Table 5).

Table 5
Frequency of Teaching Conceptions

Teaching Conception	Code of Works	Frequency	Context Unit
<i>Technical</i>	T4, T10, T11, T14, T15, T19, T21, T32, T34, T37, T43, T44, T46, T47, T48, T51, T53, T57, T58	19:71	"Continuing education can present itself as a way to enable new learnings , transforming elements of the experiences of the teachers themselves and presenting different methodologies and content transmitted by the course planners, seminars, journals and other materials used in training (T51, p. 499 [emphasis added])."
<i>Practical</i>	T1, T6, T7, T9, T17, T20, T22, T23, T24, T28, T31, T49, T52, T54, T59, T64, T68, T70	18:71	"Thus, it is essential to invest in educational and scientific practices in order to eliminate existing prejudices in humanity and raise awareness among the population about the role of science" (T20, p. 85 [emphasis added]).
<i>Critical/Emancipatory</i>	T2, T3, T5, T8, T12, T13, T16, T18, T25, T26, T27, T29, T30, T33, T35, T36, T38, T39, T40, T41, T42, T45, T50, T55, T56, T60, T61, T62, T63, T65, T66, T67, T69, T71	34:71	"[...] challenge the traditional path at the beginning of the career and allowed us to experience the collaboration , through co-teaching; the praxis , through collective reflection , theoretically oriented; the production of knowledge, through collaborative research and the development of affection " (T18, p. 15 [emphasis added]).

In this study, nineteen works (19:71) were identified as having the teaching conception of technical. Technical teaching encompasses the teacher in a technical role, who assumes a professional activity posture instrumentally, aiming to solve problems through the application of theories and techniques (Schön, 1983; Pérez-Gómez, 1992). In this training model, teachers do not have principles for developing techniques; they merely apply them, assuming a certain dependence on prior knowledge not developed by them, which limits their action (Barros; Queiros; Souza, 2019). The scenario encountered points to an important discussion: despite a growing movement of judgment against technicism and the overcoming of uncritical and traditional conceptions of teaching and learning (Bremm & Güllich, 2022), these conceptions are still present in current teacher training. In these cases, as can be perceived in the excerpts, the contents or techniques prevail in the educational process: *"it was assessed that the workshops presented an academic quality that valued knowledge and know-how [...]"* (T46, p. 448).

The conception of teaching practice understands that teacher training is based on learning from practice, for practice, and about practice, that is, it conceives the teacher as a practitioner (Contreras, 1994). According to Rosa and Schnetzler (2003), in this approach, knowledge is constructed and validated by all individuals involved in the context. This means that all participants play an active role in the process, representing an advancement over the strictly technical perspective. This

conception of teaching is evident in T52, which states that *“for this purpose, science classes should seek to enhance scientific education”* (p. 254).

In this study, 18 works were classified as practical (18:71). These works take into account a *“plural teaching that considers cultural, social, and environmental aspects in science education”* (T24, p. 86). As also exemplified in the excerpt: *“promoting the construction of cognitive, physical, and social knowledge”* (T22, p. 2670) and also in: *“Seeking to overcome the influence of Positivism, the continuing education program for teachers addressed curricular content in natural sciences articulated to socio-scientific, socio-historical, socio-cultural, local, and regional issues, especially socio-environmental issues”* (T20, p. 86). It is noted that, in these works, the reflection on one's own practice is considered, but it does not have a prominent place in this conception.

The critical and/or emancipatory approach in teaching plays an important role in continuing education courses, as it allows for professional development and, consequently, promotes teaching grounded in reflection (Contreras, 1994). This approach has a transformative character, and we agree with Imbernón (2011, p. 36), when he states that if practice becomes “a constant process of study, reflection, discussion, and experimentation, in collaboration and dialogue,” it will approach the critical/emancipatory trend.

In this study, thirty-three works from the *corpus* of analysis (33:71) had their teaching conceptions centered on this perspective, that is, they adopted the conception that *“the teacher is constituted throughout the professional career. In light of this need for continuous training, it is interesting to note the feasibility of valuing the teacher's thinking. Thus, it is not appropriate to impose pedagogical innovations; the teacher has autonomy in the decisions and incorporations they may make at the pedagogical level.”* (T71, p. 64). It is important to highlight that most works with a shared training model (17:19), permanent (1:1), and ongoing (3:4) are part of this conception of teaching (and training).

Moreover, some works with this teaching conception, which had their training in the complementary model (13:47), by providing stimulation to the emancipatory teaching conception, exceeded the limits of the proposed specific activities. One hypothesis is that, despite being short courses, they promoted reflective movements and encouraged a look at one's own action, as is the case with T69: *“regarding the course, it was possible to identify an **increase in reflections** from the teachers in both quantity and quality. At different times, they **questioned their own practice**. Since it was proposed in a **collaborative manner**, it allowed participants to dialogue*

with their peers and favored commitment to their own training" (p. 832 [emphasis added]).

In summary, we observe that training models that value teacher reflection, investigation of one's own practice, and discussion and consideration of context provide an understanding of teaching directed towards the process and not just a specific product or content. Furthermore, we observe that duration positively influences the teaching conception and the training itself.

The Ongoing Training in Sciences that We Aspire to

The production of results through the study for constructing the state of knowledge allows us to reach important considerations. The formative processes for teachers are still, for the most part, centered on quick actions and aim to discuss teaching methodologies and content – which is not wrong, but when carried out in isolation, they weaken the processes of reflection and the constitution of being a teacher (De-Alba-Fernández & Porlán, 2020). Moreover, we realize that the technical teaching conception and practice still resonate significantly in training, especially in types of complementary training. However, the potential of the critical perspective for teaching and training is evident, especially in the development of shared formative processes and/or those that promote a reflective, critical, and collective-based conception. This approach understands the importance of reflection, permeating the entire teaching process and the training of Science teachers.

Based on the *corpus* analyzed, we identified AI and IFAC as potential promoters of a formative process that encompasses collective participation in the discussion of practice and thus enables a (re)signification of action that is also individual and subjective, in addition to stimulating an emancipatory and autonomous conception – beyond the application of content and teaching methods within the four walls of the classroom. Emphasizing this importance, we highlight the need to expand research involving organized formative processes based on the self-reflective spiral and mediated by critical reflection in the context of initial and ongoing training of Science teachers (IFAC).

We also point out two other possibilities for future work focuses as research agendas involving formative processes in Sciences: the approach of emerging themes and the identity and professional development of teachers. The first focus considers that society has undergone constant changes in recent years; therefore, it is necessary to incorporate current discussions that sometimes exceed the limits of

traditional curricula in contemporary educational contexts, as they permeate the daily lives not only of students but of society as a whole, such as gender, sexuality, technologies, cultures, special education, and environmental issues, for example. The second focus refers to the process of becoming a teacher; the processes of identity constitution and professional development of Science teachers need to find spaces for discussion in formative contexts, as we believe these are the cradle of critical and formative (self)reflection.

In this sense, we propose that ongoing teacher training, based on investigation-training-action (IFA), can constitute a virtuous cycle in which teachers act as researchers of their own practices, enabling the transformation and improvement of teaching processes. This is, therefore, a collective and continuous movement of formation.

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