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ORIGINAL ARTICLE

In-service training for early-grade school teachers to develop interdisciplinary projects

A formação em serviço de professores dos anos iniciais para a construção de um projeto interdisciplinar

Daniele da Silva **Oliveira**[1] Thais Gimenez da Silva **Augusto**[2]

[1]São Paulo State University (UNESP), School of Agricultural and Veterinary Sciences, Inter-Unit Graduate Program in Teaching and Educational Processes, Jaboticabal, State of São Paulo, Brazil.
Corresponding Author: daniele.s.oliveira@unesp.br

[2]São Paulo State University (UNESP), School of Agricultural and Veterinary Sciences, Department of Economics, Administration, and Education, Jaboticabal, State of São Paulo, Brazil.

Translated by P. D. dharma.pedro@gmail.com

Abstract: This article reports the findings of a qualitative study that examined the continuing professional development of teachers engaged in designing an interdisciplinary project for the early elementary grades. Data were collected through semi-structured interviews with the participating teachers. Analysis of the interviews revealed that the project fostered collaborative professional development between subject-matter specialists and pedagogical coordinators and created conditions for professional learning attuned to the specific needs of both teachers and students within their actual school contexts. The development of the project contributed to greater teacher autonomy and more student-centered instructional practices, gradually displacing the traditional approaches that had previously dominated, while also promoting teachers' appropriation of interdisciplinary perspectives. At the same time, the findings underscore the need for further reflection on the meaningful internalization of interdisciplinary concepts and on the improvement of working conditions.
Keywords: elementary education; continuing teacher education; interdisciplinary education.

Resumo: Este artigo apresenta os resultados de uma pesquisa de caráter qualitativo, cujo objetivo foi analisar a formação continuada recebida por professoras envolvidas na construção de um projeto interdisciplinar para os anos iniciais do ensino fundamental. Os dados foram coletados por meio de entrevistas com as professoras participantes desse projeto. A análise dos dados mostrou reflexões referentes à implementação do projeto interdisciplinar, na medida em que proporcionou processos formativos em colaboração entre professores especialistas e pedagogos, bem como a possibilidade de formação voltada às particularidades dos professores e estudantes, ao contemplar o real ambiente de trabalho. O desenvolvimento do projeto proporcionou aumento da autonomia docente e ações pedagógicas mais centradas nos alunos, amenizando práticas tradicionais vigentes até então, bem como a apropriação de abordagens interdisciplinares, além de evidenciar questões a serem repensadas quanto à interiorização e ao aprofundamento de conceitos interdisciplinares e melhorias nas condições de trabalho.
Palavras-chave: ensino fundamental; formação continuada do professor; interdisciplinaridade; ensino interdisciplinar.

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Introduction

The school constitutes a privileged site for teacher education, as it is within this environment that tensions emerge and educational theories are confronted with practice (Nóvoa, 2007). In this study, we investigated a continuing professional development experience involving classroom teachers and subject-specialist teachers working in the early years of elementary education, together with the leadership team of a private school. Dissatisfied with a traditional model of teaching and with decontextualized, disciplinary practices, these educators undertook a process of rethinking and reshaping their pedagogical work.

These concerns prompted questions about the possibility of developing new ways of teaching, leading the group to recognize that Science, History, and Geography could be meaningfully integrated through a closer dialogue among the disciplines. This process culminated in the development of an interdisciplinary project for the 1st, 2nd, and 3rd grades of elementary school.

Thus, the classes in these subjects adopted a non-fragmented approach, bringing together the pedagogical teachers responsible for Science, History, and Geography in collaboration with the English and Science Laboratory teachers. The aim was to make the classes more engaging, less disciplinary, and, primarily, more closely connected to students' realities, while creating opportunities for them to assume an active role in their own learning process.

To develop a project centered on interdisciplinary practices and active methodologies, it was necessary to provide professional development for the teachers. These formative activities took place at the school itself and were intended to deepen theoretical understanding, foster the exchange of experiences, and support collective decision-making throughout the project. As Japiassu (1976) argues, opportunities for teachers from different fields to engage in dialogue should not be understood as mere exchanges of information. Rather, these encounters should involve the exchange of perspectives and critical reflections that break down the compartmentalization of *slices of knowledge* through communication among specialists, thereby reducing barriers and fostering mutual enrichment.

According to Pombo (2005, p. 13, own translation), interdisciplinarity exists only if "we are able to share our modest domain of knowledge, if we have the courage to abandon the comfort of our technical language and venture into a domain that belongs to everyone and of which no one is the exclusive owner".

Based on this issue, a qualitative study was conducted to investigate the professional development experience that took place at this school through semi-structured interviews with the teachers involved in the project. The purpose of this research was to analyze an in-service professional development experience undertaken in the development of an interdisciplinary project for the early grades of elementary school. In this context, the study examined professional development in the workplace involving specialist and generalist teachers, contributing to reflection on pedagogical practices.

Furthermore, the study investigated whether and how an interdisciplinary perspective can restructure teaching strategies. Accordingly, this article addresses the following research questions: (1) Did the teachers' professional development experience contribute to their pedagogical practices? (2) Were limitations stemming from their initial teacher education addressed through professional development? In what ways? (3) Did professional development grounded in interdisciplinary perspectives foster the restructuring of disciplinary approaches? How? (4) What were the implications of collaborative professional development in the workplace?

The focus of this analysis of teacher professional development stems from the importance of investigating a professional development experience developed within the school itself through a collective initiative to create an interdisciplinary project for the early grades of elementary school. This focus is particularly relevant given the limited number of academic studies addressing such experiences, especially those centered on interdisciplinary work.

Professional development and interdisciplinarity

In Brazil, we predominantly observe isolated, sporadic, and episodic models of continuing professional development that fail to address teachers' professional learning needs (Diniz-Pereira, 2019). These limitations are compounded by heavy teachers' workloads, which hinder their ability to devote time to sustained study, as well as by weaknesses in initial teacher preparation, which constrain professional development. They undermine the quality of teacher education and encourage reliance on traditional approaches to lesson planning and instruction. This makes it more difficult to articulate theory and practice, as argued by Demo (2019) and Lima and Santos (2017).

Thus, the educational context continues to be constrained by a set of outdated practices, underscoring the importance of rethinking established approaches to continuing professional development.

In view of this, it is necessary to recognize the school as a formative environment and to engage educators as active participants, as Nóvoa (1992) points out, in a process of knowledge production that takes the form of a participatory, interactive, and dynamic network of self-directed professional development. Beyond these aspects, the author emphasizes pathways toward autonomous thinking, fostering what he calls "participatory self-formation" and creating conditions for individuals to develop a critical and reflective understanding of their own professional development. Being engaged in such a process means becoming an autonomous and creative individual in relation to one's own projects and professional trajectories.

Beyond these propositions, Nóvoa (2019) crucially emphasizes the importance of teachers reflecting on personal and collective dimensions of the profession, as it is impossible to learn the craft without the support and collaboration of other educators. For the author, becoming a teacher requires individuals to engage in reflection both individually and collectively.

In turn, considering the context of this study, which investigates teaching practices in the early elementary school years, Augusto (2010) points to deficiencies in generalist teachers' subject-matter content preparation. He emphasizes the need for continuing professional development as a means of strengthening the teaching profession.

> It is also important to recognize that continuing professional development is necessary to address these deficiencies in specific content among the entire cohort of teachers currently qualified to teach in the early grades under existing preparation frameworks. To meet this demand, it would be necessary to offer medium- or long-term courses addressing specific subject-matter content in connection with pedagogical practice (Augusto, 2010, p. 276, own translation).

We understand that learning takes place around children lived experiences within an environment that provides opportunities for observation at this stage of schooling, which is the focus of this study. Fracalanza, Amaral, and Gouveia (1987, p. 66, own translation) characterize the early grades as a developmental stage marked by egocentrism and syncretism. Accordingly, "children's thinking is still deeply linked to personal experience and the child's direct engagement with the subject," and reasoning up to approximately eight years of age is predominantly tied to the concrete and to what children have experienced themselves. The authors further note that "learning must respect the stage of intellectual development at which the child currently finds themselves" (Fracalanza, Amaral; Gouveia, 1987, p. 66, own translation).

Given the unique conditions of this age group, pedagogical proposals centered on expository lessons are not appropriate. Thus, considering these characteristics and the learner's syncretic worldview, which makes it difficult for the child to perceive the world through separate perspectives, as commonly presented in individual disciplines or areas of knowledge, an interdisciplinary approach becomes necessary, recognizing that

> [...] for the child, the things in the environment are integrated rather than separated into physical, geological, and biological sciences, social studies, mathematics, communication and expression, or curricular areas. Dividing the curriculum into areas of study represents an analytical approach that may be premature, particularly for a second-grade child, who is generally still engaged in the process of learning to read and write (Fracalanza; Amaral; Gouveia, 1987, p. 68, own translation).

However, for teaching practices to meet the aforementioned recommendations, it is necessary to consider the gaps observed in the initial teacher preparation provided by Pedagogy Programs. According to Pimenta (2017), disciplinary approaches predominate, resulting in a fragmented treatment of school knowledge in the early grades, which, in the author's view, hinders teachers' ability to work from an interdisciplinary perspective. In this regard, Lenoir (1997, p. 14, own translation) argues that teacher education itself must become interdisciplinary, asserting that "it is not acceptable to adopt a compartmentalized approach to teacher education" because the generalist teacher is responsible for a group of students and is tasked with teaching a broad range of content. Thus, the generalist teacher must adopt integrative and meaningful approaches. Moreover, the authors recommend that teaching approaches be grounded in the everyday experiences of each student, in addition to interdisciplinary dimensions.

Against this backdrop, the present article draws on discussions that problematize and contribute to the field of in-service teacher education from an interdisciplinary perspective. Regarding interdisciplinarity, a disparity of meanings can be found in the literature; therefore, this study adopts Olga Pombo's propositions as its principal theoretical framework.

For her, interdisciplinarity is understood as any form of combination between two or more disciplines aimed at understanding an object of study through the convergence of distinct points of view toward the understanding of a common object. Depending on the specific context and the intended level of integration, interdisciplinarity can take many forms, including the "transposition of concepts, terminologies, types of discourse and argumentation, methodological and instrumental cooperation, transfer of content, problems, results, examples, applications, etc." (Pombo, 1994, p. 13, own translation).

Methodology

Given our intention to investigate an experience of continuing professional development, we adopted a qualitative research design. As Bogdan and Biklen (1994) note, qualitative inquiry encompasses research strategies focused on collecting descriptive data rich in detail about participants, settings, and conversations. The researcher's interest lies in the process rather than merely in outcomes or products, with particular attention to understanding phenomena in all their complexity and within their natural context.

The participants in the study were six teachers involved in an interdisciplinary project implemented at a partner school, teaching first, second, and third grades of elementary school. Three of the participants were generalist teachers with degrees in Pedagogy and, therefore, responsible for teaching multiple subject areas; two were subject-area specialists, one in English and the other in Biological Sciences; and the sixth was the coordinator (Teacher Educator), responsible for the teachers' professional development and for coordinating the project. She also holds a degree in Biological Sciences.

Of the six teachers, only five participated in the interviews, as one of them was the researcher herself. At key points during the data analysis, she offered perspectives on the project, providing valuable insights and explanations. To preserve the participants' anonymity, pseudonyms were used to identify them (P1, P2, P3, P4, and P5) when presenting their interview accounts throughout the article.

These teachers were selected based on their participation in professional development meetings related to the design and implementation of the interdisciplinary project. The school was selected due to its commitment to professional development among its teaching staff, and its focus on empowering teachers to do their work within an environment that values active agents in their own professional growth. Accordingly, the professional development process is grounded in the teachers' needs and existing knowledge, adopting a perspective of building upon their professional knowledge and experiences. It begins by identifying didactic, conceptual, and methodological needs and gaps, particularly those arising from the diversity and particularities of the students' realities.

The project in question was established at the partner school in 2018 and integrated with the professional development sessions. The present investigation, which is linked to the first author's master's research, focused on the period from 2021 to 2023, during which data were collected and analyzed while the project was still underway at the school.

In developing the project, one teacher from the group was selected to lead the professional development sessions as the *Teacher Educator*. Her role was to facilitate study meetings, seek support for addressing potential challenges, and share her subject-matter expertise with the generalist teachers. Her responsibilities included contacting the teachers involved in the project, scheduling meetings, distributing group tasks such as activity preparation, selecting readings (texts, websites, books, and curriculum guideline documents), leading the study sessions, and serving as a bridge between the generalist teachers and the subject-area specialists in English and the science laboratory.

These meetings took place either exclusively with the teachers involved in the project or during Collective Pedagogical Work Periods (in Portuguese: Aulas de Trabalho Pedagógico Coletivo, ATPC) with the entire teaching staff of the early elementary grades. Additionally, individual meetings were held between the Teacher Educator and the generalist teacher responsible for each class. Initially, the project-specific professional development meetings were held weekly for a period of two years, followed by biweekly meetings through the period investigated in this study.

The meetings involving the three generalist teachers, the Teacher Educator, and the subject-area specialists focused on defining content, selecting teaching methodologies, deepening theoretical understanding, and organizing how Science, History, and Geography topics would be addressed from interdisciplinary perspectives. They also developed activities and aligned them with the proposed curriculum for the early elementary grades, as well as providing opportunities to share challenges, suggestions, and frustrations, exchange experiences, and reflect on teaching practice.

The data collection instrument was a semi-structured interview based on a previously developed guide comprising 20 questions organized into three thematic axes: *teaching prior to the project*, *in-service continuing professional development*, and *implementation of interdisciplinary perspectives*.

The interviews were conducted during the first semester of 2022, individually with each teacher and the researcher, in a remote format using the Microsoft Teams® platform. This format was adopted to protect the participants during the COVID-19 pandemic. With the participants' consent, the interviews were recorded in both audio and video formats and subsequently transcribed in full for data analysis.

The data were collected in accordance with the standards and protocols required for research involving human subjects, following approval by the Research Ethics Committee (CAAE 53572921.0.0000.9029), as outlined in Opinion 5.239.248.

The qualitative content analysis followed the principles outlined by Flick (2013, p. 134, own translation), who defines content analysis as a "classic procedure for analyzing textual materials of any origin, ranging from media products to interview data". The method is an empirical procedure for the systematic and intersubjective description of messages. It remains faithful to their substantive and formal characteristics and relies on categories

constructed from theoretical models. According to Flick (2013, p. 134, own translation), "content analysis aims to classify the content of texts by assigning statements, sentences, or words to a system of categories".

In the following section, we present the analysis of the results obtained.

Teaching prior to the interdisciplinary project

The initial questions directed at the teachers participating in the study focused on the nature of teaching at school prior to the implementation of the interdisciplinary project. The interviewees characterized the instruction as being based on rote memorization, lectures, a lack of contextualization, and a disciplinary approach. They also reported a heavy reliance on textbooks. In essence, the practice was characterized as traditional, based on the transmission of knowledge, as noted by Nóvoa (2007), and on procedures involving "memorization, appeals to authority, and summary tests" (Demo, 2019, p. 56, own translation).

> [...] *there was no integration with other subjects; everything was taught separately* (P2).
>
> [...] *one textbook for each subject. One for Geography, one for Science, and one for History* (P3).
>
> [...] *it was a traditionalist, completely structuralist approach to teaching* [...] (P4).
>
> *That's how it was: rote learning. The teacher would explain and then ask the students to explain it back, all based on the textbook and teaching materials, and they would memorize everything and do it all from memory* (P5).

P3 stated that, before the project, the subjects of History, Geography, and Science were treated in isolation "[...] *each subject was taught separately*", in opposition to the interdisciplinary project, which aims to foster connections among these three disciplines. P1 also pointed out the presence of repetitive content that was often covered in both the first and second years, leaving students disengaged. In the teacher's view, the standardized curriculum of the textbook created a significant challenge, as it made it difficult to align instruction with the students' actual experiences.

> *When I got to the second grade, the children would say, 'Again? We're doing this again? The teacher already talked about it.' So, I felt the need for something that would capture the children's attention, something more interesting and meaningful to them. I could see from the books that the material was very far removed from their lives* (P1).

The accounts reveal patterns of disciplinary separation and the standardization of pedagogical practices associated with the use of the textbook as the primary teaching tool, which had to be followed in its entirety. This resulted in decontextualized teaching, leaving little room to incorporate the stories, circumstances, and prior knowledge that students brought to the classroom, as illustrated by P1's account: "[...] *the textbook meant working with whatever was in there*".

We recognize that the textbook, when used to support lesson planning, is convenient and practical, as it addresses topics aligned with the current curriculum and provides texts, images, and exercises. However, in the context of the interviewees, its use becomes an obstacle when it serves as the sole pedagogical tool, as students are often confronted

with an instructional resource that is imposed upon them and with which they have difficulty learning. Nóvoa (2007) and Zeichner (2003) regard standardized and uniform practices as limiting because they fail to address the particularities of students.

In this discussion, we emphasize that the textbook is an important resource, particularly in regions where a scarcity of instructional materials directly affects pedagogical work and student learning. Thus, the textbook is often the only available resource, particularly in the context of the reality of many Brazilian states. However, the context investigated here presents different circumstances, as it involves a private school in which families purchase the instructional materials and, consequently, there is an expectation that they will be used as prescribed. At times, this can reinforce their use as the sole or primary instructional tool. This can result in content-centered teaching and reinforce traditional, lecture-based practices.

According to Ovigli and Bertucci (2009) and Pimenta *et al*. (2017), the exclusive use of the textbook as a teaching resource for reading and activities — which will later be important for studying and completing assessments — is insufficient to foster meaningful student learning. The authors deliberately associate such practices with shortcomings in initial teacher education, drawing on research conducted in public and private Pedagogy programs in the state of São Paulo. Their findings reveal deficiencies in preparation in specific subject areas, given that the generalist teacher is trained to teach different subjects in the early years of elementary school.

Thus, the dissatisfaction with existing teaching practices prompted reflection on new possibilities for teaching. The aim was to develop active, inquiry-based, and dynamic methodologies that would foster student autonomy, in contrast to the traditional patterns that were in place at the time. As P5 describes: [the teaching] "*didn't really make much sense; it was more about memorizing for the test. With more active methodology and autonomy, even though they're young in the early grades, always encouraging them to question things and think critically, we were going to start trying to move beyond common sense*".

Consequently, the circumstances observed by the teaching staff and administrators led to the development of the interdisciplinary project, which sought ways to address the dissatisfaction with existing teaching practices while also responding to the requirements of the National Common Curricular Base (BNCC, in Portuguese), which was being implemented at the time and recommended:

> […] overcoming the radical disciplinary fragmentation of knowledge, encouraging its application to real life, recognizing the importance of context in giving meaning to what is learned, and promoting student agency in their learning and in the construction of their life project (Brasil, 2018, p. 9, own translation).

We emphasize that the dissatisfaction and proposals surrounding the development of the project involved analysis by both the teaching staff and administrators. However, one of the concerns highlighted was the excessive use of the textbook as a pedagogical practice, which, as indicated by the theoretical references consulted, is associated with teachers' initial preparation. At the same time, we identified that this issue also stems

from the context of private schooling, where parents' purchase of instructional materials generates an expectation that they will be used in their entirety.

One of the proposed solutions to address these challenges was to explain the objectives of the interdisciplinary project — which sought to integrate Science, History, and Geography together through an integrated instructional approach — to parents during a parent-teacher meeting prior to the following school year, thereby justifying the decision not to adhere fully to the textbook.

The analyses also revealed gaps in teachers' preparation to work from interdisciplinary perspectives, as evidenced by the following accounts:

> *Back when I was studying to become a teacher and later pursuing my degree in Pedagogy, nobody even talked about interdisciplinarity* (P1).
>
> *I was already doing some of these activities, but at the time I didn't know what I was doing, you know? I didn't know it had a name, or that the topic could be studied in greater depth, like we're doing now* (P3).

Most of the teachers reported that they did not receive specific training during their undergraduate studies to teach from an interdisciplinary perspective. One participant reported that she acquired theoretical and methodological knowledge about interdisciplinarity through short professional development courses offered, for example, by the Department of Education where she worked, highlighting the importance of continuing education in the development of teachers' professional knowledge. P3's account indicates that interdisciplinary approaches were already incorporated into her teaching practice, albeit without a deeper theoretical understanding of the concept.

In this regard, we consider the purpose of the project developed at the school under study and engage with the contributions of Fazenda (2011) and Pombo (1994), who reflect on weaknesses in teacher preparation that may constitute an obstacle to the implementation of interdisciplinarity in the school context.

Continuing education at school

In the context of the investigation, continuing professional development took place as an ongoing process. Teachers actively participated in their own professional development, in collaboration with a Teacher Educator who facilitated the meetings, identified their needs, selected topics for study, and assisted in the development of activities.

To understand the dynamics of the project, the interviewees were asked how the pedagogical work aimed at developing interdisciplinary practices was organized. Analysis of their responses indicates that the planning process was directly related to the professional development sessions experienced by the teachers. In this regard, the participants highlighted the support provided through these sessions, which included suggested readings, collective discussions, the study of specific texts on interdisciplinarity, analysis of the BNCC (National Common Curricular Base), selection of themes, and the development of activities to be carried out with students. The interviewees reported:

> "[...] *especially now that the BNCC has been introduced, some content has been revised; some topics used to be taught but are no longer included, while others have been added* [...] *she* [the Teacher Educator] *brings materials; we've already done studies, readings, supplementary work, and looked at the BNCC proposal* (P1).
>
> [...] *reading, studying, discussions* [...] *studying explanatory texts related to the project; sometimes the Teacher Educator suggests activities for us to work on* [...] *texts about contextualization, about how to better apply contextualization, so that's the stage we're at* (P2).
>
> [...] *materials they give me, plus materials for the children* [...] *we take the content that will be covered during the month and create related activities* (P3).
>
> [...] *choosing the next theme to be worked on* (P4).

The professional development stages were organized through individual schedules arranged between the Teacher Educator and the generalist teachers, using shared intervals between classes. Initially, the professional development sessions focused on developing familiarity with the Science, History, and Geography skills outlined in the BNCC, with the aim of identifying thematic convergences for interdisciplinary work. In parallel, the project sought to understand learning processes from an interdisciplinary perspective. To support these sessions, the Teacher Educator selected texts, articles, and case studies, fostering theoretical and practical discussions that guided both the teachers' pedagogical work and the development of student activities.

At each meeting, the objective was to deliberate on the methodology for integrating the curriculum for the three subjects. P1 recalled: "[...] *for an entire class period, we would sit down, talk, and study; she [the Teacher Educator] brought a lot of material on project development and interdisciplinarity among these three subjects* [...]". As the professional development stages progressed, the thematic scope expanded. Beginning in the second year of the project's implementation, the discussions incorporated active methodologies, forms of assessment, the teacher's role as a mediator in the teaching-learning process, and inquiry-based teaching.

As mentioned above, the professional development sessions included time for developing activities, during which the teachers consulted supporting materials, such as websites and textbooks. These activities prioritized group discussions, fostering a process of thinking and dialoguing, questioning, observing, formulating hypotheses, challenging ideas, making comparisons, and analyzing.

> [...] *material that discussed hypothesis generation, that whole framework aimed at helping students apply that content to practice, to everyday life, asking, "Why am I learning this? What is it for" I learned all of this; I gained knowledge about all of this during that professional development* (P1).

To illustrate this, we will discuss an activity conducted in the second grade on the theme of *family*, involving the subjects of History and Geography. To address this theme, the generalist teacher prompted reflections on family histories; guided students in observing photographs; suggested constructing a family tree highlighting the characteristics of family members; and developed record sheets. In the Science Laboratory classes, students studied animal families, parental care, and different family configurations, including those observed in seahorse reproduction, in which the male *becomes pregnant*, as well as hereditary traits passed on to offspring. The English teacher further contributed to

the theme by exploring vocabulary related to family members and proposing playful activities within the context and specificities of her subject.

Following this approach, the intention was to establish connections between similar themes across two subjects, complemented by an interdisciplinary approach involving English and the Science Laboratory. As Pombo (2008) observes, interdisciplinarity involves significant movement across disciplines, seeking the reciprocal and necessary integration required to overcome the boundaries imposed by disciplinary compartmentalization.

The professional development sessions discussed above were primarily attended by generalist teachers of the first, second, and third grades and the Teacher Educator. The English and Science Laboratory specialists participated in these meetings with the generalist teachers and the Teacher Educator less frequently, given the frequency of their classes with the different groups, which generally took place every two weeks or once a month.

At the beginning, the professional development sessions were held on a weekly basis. After two years, they became biweekly, as evidenced by P1's statement: "[...] *so it was weekly, then every 15 days*". The theoretical work developed for the project also extended into the ATPC meetings, in which the entire Elementary School 1 teaching staff participated, allowing teachers to appropriate the themes and restructure their own practices. The discussions at these meetings were grounded in the observations and developments emerging from the project in the first, second, and third grades.

In general, the teachers viewed the professional development sessions as important opportunities for sharing experiences and collectively developing strategies for addressing dissatisfaction with teaching and responding to emerging needs. When asked to evaluate the in-service professional development they had received, P2 stated: "[...] *I always say that this exchange of ideas, experiences, and materials, these readings, all of this enriches us.* [...] *especially because I didn't have this kind of training, so it was these courses and professional development opportunities that changed me, that shaped me.*"

The subsequent accounts provide further oportunities for reflection, sharing, and restructuring of practice.

> [...] *when we notice a new difficulty emerging, or have some ideas, we talk about it* (P1).
>
> [...] *discussing what worked or didn't work during the week* (P4).
>
> [...] *we exchange ideas about what was good, what works, what doesn't work, and what can be done* (P3).

In this sense, it is relevant to relate these observations to the questions guiding this research, particularly regarding their contributions to pedagogical practices. Thus, we highlight the potential for restructuring these practices based on studies addressing the needs identified by the group, as well as on systematic processes of reflection on their own practice, an approach recommended by Nóvoa (2019).

We also observed, in the interviewees' accounts, that the studies focused on understanding methodological and conceptual approaches. Given the in-service nature of this professional development, the teachers engaged in a dialogue between practice

and theory. As Nóvoa (2019) argues, the principles of teacher reflection are grounded in professional knowledge, from a theoretical and conceptual standpoint, since teaching is marked by conflicts, underscoring the importance of reflection grounded in theoretical concepts.

In this regard, Lima and Santos (2017, p. 76, own translation) argue that it is desirable for professional development activities should include assessments that can be discussed "in light of the collective reflections of the professional development group." The authors also highlight the influence of professional development activities as catalysts for opportunities to reflect on aspects of the teaching profession, as these activities are related to how teachers organize and develop their practice.

Therefore, the professional development described here was conducted specifically for a particular group, as part of a continuous process that considered their needs and the circumstances of their pedagogical practice. As Marcelo García (2009) argues, professional development can take different forms across diverse contexts; consequently, there is no single effective model for promoting professional development in all schools. Instead, individual educational institutions must assess their own needs, beliefs, and cultural practices to identify the most appropriate professional development approaches.

Another aspect worth emphasizing is the overarching framework guiding this professional development initiative. In the descriptions provided, the guiding principles for promoting teachers' professional development focus on their professional preparation and specific needs, enabling a broader view of knowledge, deeper understanding, and interconnections, while valuing the student within this process.

In this context, we highlight the commitment of the teacher-educator, who was responsible for leading and planning the professional development meetings. In her account, she states: "*I read a lot; I read less about it now. I read a lot at the beginning, especially during the first and second years — books, articles, case studies* [...]." Her account reveals an initial phase of intensive theoretical inquiry that underpinned the organization of the professional development process at the school. This stance reflects an understanding of teacher professional development as a continuous process constructed through dialogue between theoretical frameworks and the concrete demands of the school context. By drawing on studies, readings, and case analyses, the teacher-educator demonstrates an effort to ground collective discussions and enhance opportunities for reflection among the teachers.

From this perspective, professional development is constructed through an analysis of the school's own reality, valuing the experiences and challenges encountered in daily pedagogical practice. This approach enables teachers not only to receive external guidance but also to participate actively in the production of knowledge about their own practice. As a result, professional development processes are strengthened because they are more contextualized, reflective, and meaningful to teachers' professional growth.

Under these circumstances, we recognize the value of professional development opportunities embedded within the workplace itself, whose knowledge-building proposals respond directly to the needs observed in the actual teaching context and to the unique characteristics of each teacher. Such possibilities are difficult to achieve in courses offered

to large groups of teachers, which often provide limited space for discussing and exploring the particularities and contexts of individual students as well as for reflecting on classroom issues. This reflection can be used to identify more effective ways of reaching students.

Furthermore, the interviewees' statements reveal the rich opportunities created by the ongoing meetings, during which teachers reflected on their teaching practices and sought guidance for the project, while taking into account the realities of the classroom and their own areas of difficulty and need. Theachers' accounts also reflected positive views of this closer collaboration, as well as of the partnership between the generalist teachers and the subject-area specialists.

Nóvoa (1992) emphasizes networks of "participatory (self-)training," rooted in interaction and the exchange of experiences among teachers, thereby creating a space for mutual professional development. From this perspective, Zeichner (2003, p. 45, own translation) discusses the support derived from social interactions, noting that they are "important for helping us clarify what we believe and for giving us the courage to act in accordance with our convictions".

The document establishing the National Curricular Guidelines for Continuing Professional Development of Basic Education Teachers — Resolution CNE/CP No. 1, dated October 27, 2020, Article 7 — stipulates that, for continuing professional development to be effective, certain characteristics are necessary, including:

> IV – Extended duration of training — adults learn best when they have the opportunity to practice, reflect, and dialogue about their practice; consequently, short-term training is not effective. Continuous interaction between teachers and teacher-educators is necessary; thus, in-service professional development within the school is the most effective approach for improving pedagogical practice, as it provides the necessary support and continuity for sustained changes in teachers' professional practice [...] (Brasil, 2020, p. 5, own translation).

These premises are evident in the professional development experience under study, in which teachers engage in ongoing professional development through dynamic activities rather than passive listening, linking their own pedagogical practices to the conceptual and methodological elements they have learned. Regarding these implications, Marcelo García (2009) discusses professional development as a long-term process, characterized by an interactive relationship between prior knowledge and new learning. Given these aspects, we emphasize the important role of continuing professional development, recognizing that individuals actively construct themselves throughout their life trajectories; hence, the importance of continuity in professional development, as well as dialogue among teachers (Nóvoa, 1992).

Thus, we recognize the relevance of holding these meetings within the school itself as a formative environment, with teachers' experiences serving as a starting point for understanding their needs, as advocated by Bezara (2019) and Lima and Santos (2017). These authors consider continuing professional development linked to the actual school context to be particularly relevant, as it creates space for the specific needs of those involved and fosters collaborative action among teachers. Such collaboration enables transformations in teaching practice in response to changes in paradigms shaped by the

realities of the context, while it also establishes an environment conducive to dialogue between practice and theory and to critical reflection on teaching practice. Furthermore, we recognize the importance of this approach as a means of addressing weaknesses associated with initial teacher education.

Teacher education from interdisciplinary perspectives

As discussed, interdisciplinarity in the school context emerges as an important issue, given the need to educate individuals who are not alienated, but rather active and socially conscious members of society, particularly in light of its relevance to the age groups taught by the participants in this study.

Pombo (2005) discusses the limits imposed by disciplinarization, arguing that the boundaries delineating specialized knowledge into discrete subjects are insufficient to fully encompass certain phenomena. These established boundaries fail to provide in-depth perspectives on certain issues; therefore, it becomes necessary to move fluidly among different disciplines or to replace such compartmentalized perceptions with an interdisciplinary understanding.

By cross-referencing the author's arguments with the project's proposals, we identified efforts among the participants' descriptions to integrate the subjects of Science, History, Geography, and English, as well as interdisciplinary practices involving these subjects and Science Laboratory classes. Building on this experience of pedagogical restructuring, the interviewees were asked about the project's contributions against the backdrop of the dissatisfactions previously observed, given that the teaching practices had been characterized by the teachers as disciplinary, traditional, and decontextualized.

In their accounts, we observed more participatory classes and students who were enthusiastic, critical, reflective, and thoughtful, and capable of relating and connecting concepts to their everyday lives. Teachers attributed these changes to the new practices made possible by the project, particularly when compared to previous classes. As Zeichner (2003, p. 36, own translation) argues, it is necessary to "value students' lived experiences and current interpretations as the starting point for instruction".

The following excerpts from the interviewees illustrate the points raised above.

> [...] *to analyze, to be critical about it, to really think about the subject. [...] they participate; it's not just about reading a text and answering questions* (P1).
>
> [...] *it made them more critical, more reflective.* [...] *they can see what we're trying to say; they can make connections between concepts* [...] *I see that their way of thinking is different; they think more* (P2).
>
> [...] *they realized that the class only works if they participate* (P3).
>
> [...] *the ability to apply the content. They give many examples of practical, everyday things* (P4).
>
> *All* [the classes] *used to be very passive* [for the students]. *Now, in all of them, we try to get the students to do things, because they must do them. We try to put students in groups, create productive groupings, use some things that come from them* [...] l*et the students use more of their creativity through certain activity proposals. Before, things were more rigid; now, especially when we say, 'Let go, let them do it, let them go,' we propose something and they do it, and it even surprises us because they follow a path other than the one, we guided them toward, but it leads to better results. This has already been observed and discussed by the teachers* [...] (P5).

Thus, we consider that the professional development processes carried out alongside the project have contributed to expanding methodological knowledge and pedagogical approaches, leading to students who are more participatory, interested, and better able to contextualize their learning. In this sense, we found that the objective of this investigation, namely, to analyze gaps in initial teacher education, was addressed through the proposed professional development, which helped mitigate these gaps.

The findings from the work of Lima and Santos (2017), who point to significant contributions related to the professional development activities in which their research participants were involved. They noted an "[…] increased understanding of the processes of teaching and learning, and that new understandings were incorporated into their classroom experiences" (Lima; Santos, 2007, p. 75, own translation). According to the researchers, these professional development activities have led to changes in teachers' roles, creating opportunities for students to express themselves and ask questions, thereby valuing their active participation in their own learning.

Another aspect analyzed was the contributions observed by the interviewed teachers regarding the interdisciplinary approaches adopted. Prior to the implementation of the project, the teachers found it difficult to continually seek new possibilities to address subjects common to Geography, History, and Science.

The accounts indicate that students demonstrate a stronger understanding of the topics being studied when the subjects were not fragmented. Previously, students not only became tired but also confused because there were no connections among the subjects, even when addressing the same contexts. As P3 explained:

> *I mentioned at the beginning that, before, I had to work on the same topic across different subjects, dealing with different aspects. But not anymore! I take the same topic, and I do not need to tell the students, 'Now I am working on History, now I am working on Science, now I am working on Geography.' No! Now I am working with the whole. So, it becomes much easier to teach; you do not need to label things by subject* (P3).

Based on these observations, we emphasize Pombo's (1994) argument for combining disciplines in the pursuit of understanding a shared object of study. According to the author, interdisciplinarity does not imply the disappearance of discipline. Instead, they coexist within an integrated effort to interpret the world and its relationships.

Thus, we associate the possibility of developing interdisciplinary approaches to teaching, supported by professional development sessions held within the school itself, with the research objective of analyzing the restructuring of teachers' pedagogical practices resulting from these formative experiences.

Similarly, Lima and Santos (2017) identified contributions from continuing professional development among their research participants, particularly regarding the incorporation of pedagogical practices grounded in an integrative perspective.

The National Curriculum Guidelines for Basic Education (Brasil, 2010) specify that interdisciplinary work should be approached theoretically and methodically with an emphasis on the integration of different areas of knowledge through cooperation, exchange, openness to dialogue, and collaborative planning. The document also provides

guidelines for work involving cross-cutting themes and knowledge and learning networks. From this perspective, we present P4's account:

> *I realized that I really needed to win over the classroom teachers involved and try to find a language they could understand and that would lend me credibility. So, this became a learning experience for me. I translated my language and tried to understand theirs so that we could create possibilities for working together* [...] *Today I can say that we are able to communicate well, not perfectly, but well, and, as far as possible, we are able to establish a process that is worthwhile* (P4).

Pombo (2005) clarifies that interdisciplinarity does not lie solely in the cognitive domain, such as the ability to identify common mechanisms or to recognize articulating structures that may initially appear unrelated. Rather, this approach also involves an attitudinal dimension, characterized by "curiosity, openness of mind, a willingness to collaborate, cooperate, and work together" (Pombo, 2005, p. 13, own translation), since interdisciplinarity cannot be achieved without genuinely valuing what others have to say.

Along these lines, we highlight the developmental stage of students in the early elementary grades, which is the focus of this research, considering their cognitive and psychological development, as well as the needs and specific characteristics of this age group. At this stage of schooling, students require a more holistic understanding of the world, one that extends far beyond content acquisition. It is desirable to foster the development of these students as social subjects, which, according to Cruz and Batista Neto (2012), this can be achieved through the development of interdisciplinary practices.

Based on the excerpts aforementioned and considering the nature of interactions among teachers in schools and the preparation of generalist teachers to transcend the boundaries of disciplinarization, we can reflect on the value of continuing professional development opportunities and knowledge-sharing within the school, particularly in interdisciplinary and methodological domains. This analysis relates to one of the research questions guiding this study. It is essential to consider the potential of sustaining such initiatives and extending them to other educational institutions.

Nevertheless, we recognize that, despite these contributions, certain contradictions within the group became apparent regarding their understanding of the foundations and concepts of interdisciplinarity, as well as some misconceptions about the approach. The teaching staff demonstrated an initial level of understanding that requires further study, development, and internalization of its theoretical and methodological foundations, in addition to issues that warrant reassessment within the school itself.

Drawing on these findings, we consider it essential that teachers be fully engaged in the proposed activities, including study, planning, and the ongoing cultivation of interpersonal relationships within the group. Accordingly, we recognize the importance of the initial steps taken to establish in-service professional development programs for teachers, as well as the need to extend such initiatives. We understand that knowledge sharing, reflection on lived realities and on one's own practice, combined with sustained actions, were carried out in ways that effectively characterized them as meaningful formative activities capable of generating changes in teaching, as noted by Nóvoa (1992).

The introduction of the project linked to professional development has led to progress, changes, and a shift in mindset among the teachers. Nevertheless, some statements suggest the need to deepen pedagogical knowledge in order to effectively change conceptions about teaching, and get more support and encouragement provided by the school. Regarding issues involving school policies, the National Guidelines for Continuing Teacher Education state:

> V. Systemic coherence – Teacher education is most effective when it is articulated with and coherent with the broader policies of school networks, teachers' professional development needs, pedagogical projects, curricula, instructional support materials, assessment systems, career plans, and salary progression. It is important to consider, at all times, the most recent evidence and research related to teacher education, as well as guidelines from the federal government, specialized professional associations, and innovations in the educational field. It is also worth noting that, when it comes to teacher education, systemic coherence extends to the preparation of teacher educators or faculty members in teacher education programs, whose qualifications are required by law to be at the graduate level. Teaching at this level, guided by these criteria, can provide future teachers with learning experiences analogous to those that Basic Education teachers are expected to provide to their students (Brasil, 2020, p. 5, own translation).

In this regard, we understand that the reformulation of pedagogical practices linked to periods of professional development grounded in interdisciplinary perspectives was significant because it incorporated the positive aspects discussed above. However, as indicated in Art. 7 of CNE/CP Resolution Nº 1 of October 27, 2020 (Brasil, 2020), other dimensions are essential for considering effective continuing professional development that can meet the demands for quality teaching in Basic Education.

Final remarks

We consider the professional development experience investigated from an interdisciplinary perspective to have been enriching because it sought ways to address the dissatisfactions and weaknesses identified by the group regarding their initial teacher education, in response to the emerging needs of the school context and changes in teaching strategies. Despite the need for further conceptual development, we emphasize the importance of sustained professional development in the face of the challenges emerging in contemporary society and the demands of the classroom as an uncertain and conflict-laden environment. We argue that professional development processes must remain flexible, recognizing that the practice of teaching requires the ongoing evaluation of methods and practices, as well as reflection on the act of teaching itself.

Significantly, we advocate for continuing professional development to primarily take place within the school itself, through an active, collaborative, and shared approach involving different areas of specialization. Furthermore, interdisciplinary pedagogical perspectives should be valued, as should the professional development required to support them. This will ensure that future generations are equipped to live in and contribute to a responsible society that is constantly changing and marked by social, environmental, technological, and ethical challenges, as well as the profound inequalities that surround us.

Conflicts of interest

The authors have no conflicts of interest to declare.

Authors' Contributions

Daniela da Silva Oliveira: Conceptualization (lead); Data curation (lead); Formal analysis (lead); Funding acquisition (lead); Investigation (lead); Methodology (lead); Project administration (lead); Resources (lead); Software (lead); Supervision (lead); Validation (lead); Visualization (lead); Writing - original draft (lead); Writing - review & editing (lead).

Thais Gimenez da Silva Augusto: Conceptualization (supporting); Data curation (supporting); Formal analysis (supporting); Funding acquisition (supporting); Investigation (supporting); Methodology (supporting); Project administration (supporting); Resources (supporting); Software (supporting); Supervision (equal); Validation (supporting); Visualization (supporting); Writing - original draft (supporting); Writing - review & editing (supporting).

Data Availability Statement

All data supporting the research findings are included in the text of this article.

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