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Pedagogical content knowledge and environmental themes: a study with early elementary teachers

Ana Lúcia dos Santos
analuciabiomed@yahoo.com.br
orcid.org/0009-0007-2140-9082
Universidade Federal de Alfenas (UNIFAL–MG), Alfenas, Minas Gerais, Brasil

Elaine Angelina Colagrande
elaine.colagrande@unifal-mg.edu.br
orcid.org/0000-0003-3307-3524
Universidade Federal de Alfenas (UNIFAL–MG), Alfenas, Minas Gerais, Brasil

ABSTRACT

This article, part of a master's research project involving five elementary school teachers, presents the results of an investigation into the pedagogical content knowledge related to environmental issues and their conceptions of Environmental Education. The qualitative research employed Pamela Grossman's PCK model and the field of Environmental Education as its theoretical framework, utilizing semi-structured interviews as one of the data collection instruments. The analysis of the responses, conducted through content analysis, demonstrated that the teachers drew upon different knowledge bases when addressing environmental issues, with pedagogical and contextual knowledge being the most recurrent, suggesting an initial understanding of teaching this content. Regarding conceptions of Environmental Education, the results indicated an affinity with conservationist and pragmatic trends. The results highlighted the importance of deepening knowledge about environmental issues and pedagogical innovation in addressing these themes. Furthermore, they emphasized the importance of formative practices that foster a critical and integrated understanding of Environmental Education within the school context, aiming to broaden both content knowledge and the development of contextualized pedagogical strategies to address contemporary socio-environmental challenges.

KEYWORDS: Environmental Education; Early Years of Elementary School; Pedagogical Content Knowledge; Teacher Training; Pedagogical Practices.

Conhecimento pedagógico do conteúdo e temáticas ambientais: estudo com professoras dos anos iniciais do ensino fundamental

RESUMO

Este artigo, parte de uma pesquisa de mestrado que envolveu cinco professoras dos anos iniciais do ensino fundamental, apresenta os resultados de uma investigação sobre o conhecimento pedagógico do conteúdo relacionado a temáticas ambientais e concepções sobre Educação Ambiental dessas professoras. A pesquisa, de abordagem qualitativa, utilizou como referencial teórico o modelo de PCK, de Pamella Grossman, e o campo da Educação Ambiental, tendo as entrevistas semiestruturadas como um dos instrumentos de coleta de dados. O tratamento das respostas, realizado por análise de conteúdo, demonstrou que as professoras mobilizaram diferentes bases do conhecimento ao abordar as temáticas ambientais, sendo que o conhecimento pedagógico e o do contexto foram os mais recorrentes, o que sugere compreensão inicial sobre o ensino desse conteúdo. No que se refere às concepções de Educação Ambiental, os resultados indicaram aproximação às tendências conservacionistas e pragmáticas. Os resultados evidenciaram a importância do aprofundamento no conhecimento sobre questões ambientais e da inovação pedagógica na abordagem dessas temáticas. Além disso, indicaram a relevância de práticas formativas que favoreçam uma compreensão crítica e integrada da Educação Ambiental no contexto escolar, de modo a ampliar tanto o conhecimento do conteúdo quanto o desenvolvimento de estratégias pedagógicas contextualizadas frente aos desafios socioambientais contemporâneos.

PALAVRAS-CHAVE: Educação Ambiental; Anos Iniciais do Ensino Fundamental; Conhecimento Pedagógico do Conteúdo; Formação Docente; Práticas Pedagógicas.

INTRODUCTION

The theme presented in this article aligns with discussions that have intensified over the past few years regarding the universal right to an ecologically balanced and preserved environment for future generations (Fonseca, 2007). In this context, given the mandatory inclusion of Environmental Education in educational curricula, from basic education to higher education, established by Law No. 9,795/99, which establishes the National Environmental Education Policy, its consolidation has been the subject of various debates and reflections due to the need for a comprehensive approach that encompasses the different aspects of contemporary environmental issues.

In the current context of Environmental Education in Brazil, a phase marked by convergences and divergences is observed, indicating a process of theoretical and methodological maturation, highlighting its nature as a social practice and a political action, therefore requiring a clear stance on environmental and social issues (Peneluc, Pinheiro & Moradillo 2018). In this sense, Resolution No. 2 of June 15, 2012 (Brazil, 2012), which established the National Curriculum Guidelines for Environmental Education, emphasizes that this should constitute an essential and permanent component of national education, articulating itself at all levels and modalities of teaching. It is up to the institutions to incorporate it in an integrated way into their institutional and pedagogical projects.

Considering this context and the set of socio-environmental challenges that demand reflection and action, it becomes relevant to develop research that investigates the bases of the professional knowledge of teachers in the early years of elementary school with regard to environmental issues. This level of basic education is particularly significant for its formative role in early childhood, a fact that justifies the interest in investigating the pedagogical content knowledge of these teachers, as well as their conceptions of Environmental Education.

Pedagogical Content Knowledge (PCK) is a construct developed by the American psychologist Lee Shulman (1986). According to the author, PCK is a specific construct for teachers developed from the connection formed by general pedagogical knowledge and specific content. It can be conceived or constructed from initial teacher training, but becomes more accessible and organized from the wisdom acquired from practice throughout their professional career.

In the context of early childhood education, Quidigno, Fochesato, Camargo, and Zimer (2024) point out that the inclusion of Natural Sciences faces obstacles arising mainly from insufficient teacher training, which hinders the development of a robust PCK. To address this deficiency, it is essential to improve teacher training, create appropriate teaching materials, encourage studies, and establish environments for exchange among educators, aiming for more effective and relevant teaching. In addition, effective teaching of Natural Sciences in Early Childhood Education, supported by a solid PCK, can favor the development of new knowledge and active participation in learning, helping to form more conscious individuals who can deal with the demands of a constantly changing society. (Quidigno, Fochesato, Camargo & Zimer, 2024).

In light of the introductory considerations, this article, part of a master's research project involving five teachers from the early years of elementary school,

presents the results of an investigation into the pedagogical knowledge of these participants regarding content related to environmental themes and initial conceptions about Environmental Education. The research is thus justified by the fact that few studies have sought to analyze PCK related to Environmental Education at this level of education.

THEORETICAL FRAMEWORK

A BRIEF CONTEXT ON ENVIRONMENTAL EDUCATION IN BRAZIL

Environmental education implies education for conservation, for responsible consumption, and for solidarity in the equitable distribution within each society, both current and future societies (Sauvé, 2005). Therefore, study and research in this area are important for the development of critical citizens aware of their role in this context.

Azevedo, Alexandrino, Da Silva, and Riondet-Costa (2017) highlight, in particular, Law No. 9,795/99, regulated by Decree No. 4,281/02, which deals exclusively with Environmental Education and establishes the National Environmental Education Policy (PNEA). Recently, Law 14.926/2024 amended Law 9795/99, and indicated, in its article 1, the need to "ensure attention to climate change, biodiversity protection and risks and vulnerability to socio-environmental disasters," a context that should be present in basic and higher education (Brazil, 2024).

The PNEA advocates that Environmental Education be a permanent part of national education, and should be present, in an articulated manner, at all levels and modalities of education, in both formal and non-formal settings. Furthermore, the Law describes Environmental Education as the process through which individuals and communities build social values, knowledge, skills, attitudes, and competencies aimed at environmental conservation.

Luccas and Bonotto (2020) state that, in seeking alternatives to deal with the socio-environmental crisis, it is necessary to improve how people relate to the environment, as well as to understand in depth the social, cultural, and economic aspects that sustain it and that demand transformation. The goal is to create a sustainable society that promotes justice and well-being for all living beings, and Environmental Education can contribute to this process.

The National Curriculum Guidelines for Environmental Education (CNE Resolution No. 2/2012) emphasize the relevance of specific training in Environmental Education in undergraduate and graduate programs, employing integrated and interdisciplinary approaches. In addition, they establish the inclusion of the socio-environmental dimension in teacher training programs, highlighting the cultural and ethnic diversity of Brazil. Furthermore, they point to the need for constant improvement of teachers and the encouragement of research and the use of pedagogical instruments that improve pedagogical practice and environmental citizenship.

Environmental Education emerged in the 20th century as a response to the environmental crisis, and was established by the need for humankind to adopt a

worldview that, like social practice, would reduce environmental impacts. However, it was found that the complexity of Environmental Education involved multidimensional pedagogical aspects, encompassing the relationships established between the individual, society, and nature (Layrargues & Lima, 2014). Layrargues and Lima (2014), in their study, point out that, in the trajectory of Brazilian Environmental Education, it is possible to perceive:

> [...] an initial moment of searching for a universal conceptual definition, common to all those involved in this educational praxis, which, in a subsequent moment, tends to be abandoned due to the growing perception of the diversity of views from the plurality of actors who shared the same universe of activities and knowledge. The realization of this internal multiplicity of the field naturally led to new efforts to differentiate this universe of knowledge, practices, and pedagogical, epistemological, and political positions that interpreted the relationships between education, society, the natural and built environment, and sustainability. (Layrargues & Lima, 2014, p.26, translation by authors).

The authors indicate that Environmental Education is a complex and diverse field. Initially, there was an attempt to formulate a single concept that encompassed all this diversity, but this proved unfeasible. The different understandings that emerged were attempts to establish an interpretative and political hegemony on the subject. Over time, this internal diversity became more evident, and perspectives on Environmental Education became more attentive and differentiated (Layrargues & Lima, 2014).

Lima (2004) states that Environmental Education, in addition to being part of the educational process, which is inherently political, also has political conflict at its origin. According to the author, we are all responsible for environmental degradation. However, we are not equally responsible: there is unequal responsibility for environmental degradation, with certain countries, social classes, and productive sectors causing more damage. Since the 1980s, conventional Environmental Education has been influenced by companies and the notion of sustainable development. It is crucial to recognize this hierarchy of responsibility when seeking solutions to the socio-environmental crisis (Lima, 2004).

Carvalho (2004) proposed understanding socio-environmental problems in their multiple facets and a change in the habits of using natural resources towards practices that are more just and sustainable, highlighting the relevance of cultivating an ecological stance and connecting the school to the community to deal with environmental issues. He also emphasizes the need to promote meaningful learning processes, in addition to the educator's role as a facilitator and organizer of initiatives that favor new knowledge.

Similar to Carvalho (2004), Guimarães, Queiroz, and Plácido (2014) indicate that awareness is essential in Environmental Education, since it strengthens the feeling of belonging and drives the adoption of conscious practices. However, this awareness needs to be accompanied by reflection and action in order to deepen its approaches, always considering socio-environmental complexity.

Initially, the direction of Environmental Education was conservationist, with practices of human awareness for nature conservation and ecological awareness. This approach was based on the idea that if people knew more about nature, they would love it and, consequently, protect it (Layrargues & Lima, 2014).

Layrargues and Lima (2014) point out that the self-reflection of Environmental Education may have caused a change in this approach, making the conservationist perspective cease to be predominant. Thus, two other perspectives were presented: the critical perspective, as an alternative capable of counteracting the conservationist one, and the pragmatic perspective.

In this way, the study by Layrargues and Lima (2014) presents Environmental Education in three macro-trends as political-pedagogical models: conservationist, pragmatic, and critical. According to the authors, the conservationist macro-trend is the most traditional and is based on the idea that Environmental Education should promote the preservation of nature. This trend emphasizes the importance of environmental awareness, individual behavioral change, and the appreciation of the affective dimension in relation to nature.

The pragmatic macrotrend, in turn, emphasizes the importance of education for sustainable consumption, energy efficiency, and pollution reduction, in a vision of solving environmental problems that is appropriate to the current market model. The critical macrotrend, finally, seeks to promote social transformation, highlighting the importance of education for environmental citizenship, socio-environmental justice, and social equality (Layrargues & Lima, 2014).

Dias and Megid Neto (2020) corroborate the previous studies when they state that, regardless of the term used, educational practices associated with Environmental Education approaches tend to focus on actions aimed at transmitting ecologically correct knowledge, promoting awareness, and appropriate behavioral changes both in the school community and in society in general, which indicates that there are still challenges to be overcome for Environmental Education to be addressed and incorporated more broadly in the school context.

It is possible to reflect, from the brief context presented, that there are different ways of understanding Environmental Education. In this sense, the present study chose not to adopt a specific trend in Environmental Education for the analysis and discussion of data. The focus was on identifying the initial conceptions of Environmental Education held by the participating teachers, respecting the diversity of perspectives presented by them.

ENVIRONMENTAL EDUCATION AND TEACHING IN BASIC EDUCATION

The role of the teacher is fundamental in the development and mediation of educational proposals that involve environmental issues and that can have real meaning for students. Therefore, it becomes essential to analyze how teacher training prepares future professionals for new demands in the Environmental Education process (Almeida, Silva, Santos, & Oliveira, 2021).

According to Nunes Neto (2019), the pedagogical practices developed in Environmental Education point to the need for constant reflection regarding the actions of the teacher in the teaching and learning process. In this sense, it is necessary to look at teacher training, both initial and continuing, to present the fundamentals and purposes of Environmental Education.

The work of Santos (2012), for example, indicates that, in general, the courses are focused on the theoretical and/or practical training of education professionals, bringing little connection with other fundamentals essential to the success of the development of Environmental Education inside and outside the school environment. This results in a worrying gap, since Environmental Education plays a crucial role in the formation of conscious and responsible citizens, capable of facing constantly changing environmental challenges. Carvalho and Bonotto (2024) point out that the articulation between theory and practice in teacher training is not established through immediate solutions or ready-made models, as it is a process that requires careful attention so that this integration is effectively consolidated, highlighting the need for continuous and contextualized training paths.

Given the progress of Environmental Education in basic education, teachers are faced with demands that they meet with difficulty, and to which undergraduate courses contribute little. The distancing of teachers from Environmental Education is justified by factors ranging from work situations that stifle innovation and greater dedication to the realization that they are not prepared to contribute effectively to this field (Teixeira, 2014).

However, the teacher can be a facilitator for environmental awareness through the activities they plan and conduct in school spaces. In the context of Early Childhood Education, Bonotto and Carvalho (2016) highlight that, just as play and guided learning contribute to the development of children's interpersonal relationship skills, children can and should be exposed to environmental awareness and problematization in the school context from the earliest years, participating and establishing connections.

This integrated, experience-based approach, highlighted by Bonotto and Carvalho (2016), aligns with Souza's (2018) perspective. For this author, it is essential to understand that Environmental Education demands constant and interdisciplinary integration in schools, encompassing different subjects. This approach should be carried out through projects, with the purpose of fostering changes in customs and working together with the community, since, by participating in school projects, the community can act in defense of these projects (Souza, 2018).

In this context, Nunes Neto and Kaminski (2021) agree that Environmental Education in schools goes beyond simply creating artistic activities with recyclable materials. These classes must be effective, expanding the activities to be conducted, seeking to awaken the environmental awareness capacity of all those involved.

Souto (2018), in turn, considers the enormous potential of Environmental Education as an agent of awareness, making it essential to include it in both formal and informal education. It is thus understood as a possibility to guide present and future generations towards the transformation of contemporary paradigms. In this way, it allows for a change from the traditional view of human/nature development to an integrative approach, breaking with the fragmentation of knowledge and opening space for the development of interdisciplinary, multidisciplinary, transdisciplinary, and pluridisciplinary proposals (Souto, 2018).

When discussing the relevance of Environmental Education from the early years, Borges, Costa, Oliveira, and Gontijo (2019) emphasize the transformation of

students and teachers into agents of environmental awareness through the development of practical skills and knowledge. In this perspective, considering Pedagogical Content Knowledge (PCK) as a unique knowledge of the teacher, Shulman (1986) highlights the importance of transformative education, focusing on the student, understanding their individualities, and the educational contexts. Understanding the PCK of teachers in the early years of elementary school regarding environmental themes can, therefore, foster reflections on teaching practice and the development of Environmental Education at this level of education.

PEDAGOGICAL CONTENT KNOWLEDGE

Pedagogical Content Knowledge is a construct whose expression was developed by Lee S. Shulman in 1986. In his study, Shulman defends a model of teacher knowledge that takes into account the need for a professional knowledge base grounded in content. PCK is the acronym for Pedagogical Content Knowledge, a knowledge specific to the teacher, formed throughout their professional career (Shulman, 1986).

The American researcher considers the teacher's knowledge through three dimensions: Subject Knowledge, Curriculum Knowledge, and Pedagogical Content Knowledge (PCK), and explains that the latter is unique to the teacher, which makes it different from a technician in the field. In the context presented, for example, a professional such as an engineer may be skilled in calculus and not have the pedagogical knowledge to teach mathematics (Shulman, 1986).

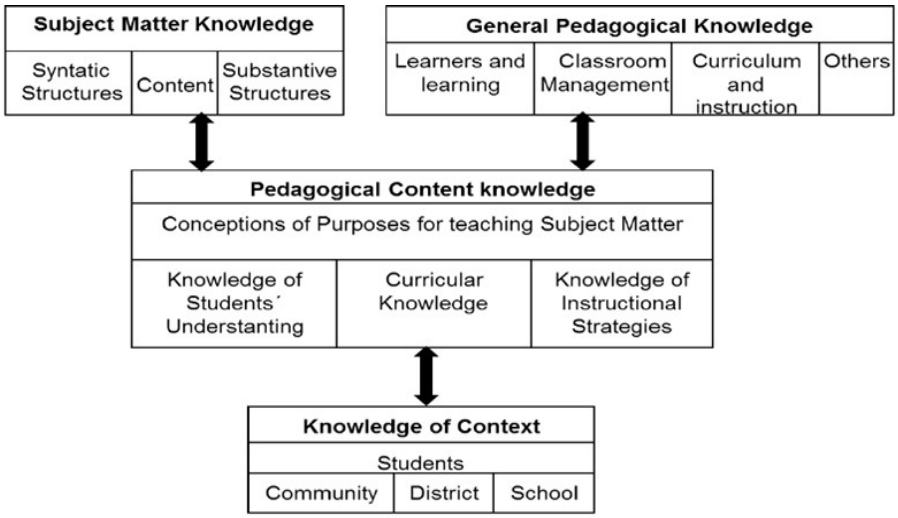
Pamella Grossman, in her book *The Making of a Teacher - Teacher Knowledge & Teacher Education*, published in 1990, indicates that knowledge is a set of four types of knowledge, three of which are independent: pedagogical knowledge, subject knowledge, and contextual knowledge. The author emphasizes the importance of the context of the teaching environment, such as available resources, classroom size, the location of the school, and whether or not the students are in a vulnerable situation.

The product that connects the three types of knowledge is pedagogical content knowledge (PCK), which is specific to the teacher.

Grossman (1990) states that the term Subject Knowledge encompasses not only knowledge of a specific content, but also PCK, which is the knowledge constituted by knowledge of students' understanding, knowledge of the curriculum, and knowledge of instructional strategies. All this knowledge that constitutes PCK is subordinate to the conceptions of the purposes for teaching a subject. Figure 1 illustrates the model proposed by the author:

Figure 1

Model of teacher knowledge, proposed by Grossman (1990).



Source: Grossman, 1990, p. 5.

The research reported in this article was developed using the PCK model proposed by Grossman and represented in Figure 1 as a theoretical framework. The author categorizes the knowledge bases into four titles: general pedagogical knowledge, subject knowledge, content pedagogical knowledge, and context knowledge.

Grossman (1990) explains that general pedagogical knowledge includes beliefs about student learning and skills related to teaching, classroom management, educational objectives, knowledge, and time of academic learning, waiting time, and teaching in small groups. It also encompasses knowledge and beliefs about the objectives and purposes of education. This component formed the basis of the analysis of how teachers justify their didactic choices when addressing Environmental Education.

Regarding subject knowledge, Grossman (1990) highlights that this knowledge encompasses a deep understanding of the main concepts and structures of a discipline and its content, including its paradigms and assessment and validation practices. No matter how skilled someone may be at teaching, the quality of teaching depends on understanding the subject matter, both in choosing appropriate learning and in developing plans that do not alter the nature of the subject (Grossman, 1990). Thus, making this dimension explicit allows us to connect the teachers' statements to the central elements of the PCK model.

Regarding pedagogical content knowledge (PCK), the same author describes the combination of general pedagogical knowledge with specific subject knowledge, which goes beyond simply mastering the subject matter. It encompasses the ability to understand how the content should be taught effectively, so that the teacher must be able to develop ways to better represent the knowledge in the practice of transposition, making analogies, presenting illustrations, providing examples, explanations, and more powerful demonstrations, thus dealing with ways of representing and formulating the subject that make it understandable to others. Pedagogical content knowledge

also includes understanding what makes learning specific topics easy or difficult, as well as the conceptions and prejudices that students of different ages and backgrounds bring with them to learning the most frequently taught topics (Grossman, 1990). This knowledge base helped identify how teachers mobilize knowledge to address environmental issues in their pedagogical practices.

For context knowledge, Grossman (1990) emphasizes that teachers need to base their teaching on an understanding of the specific contexts in which they work, thus adapting their general knowledge to the particularities of the students' school contexts. Context knowledge includes knowledge of the region where teachers work, considering opportunities, expectations, and constraints; knowledge of the school environment, including school "culture," departmental guidelines, and other contextual factors at the school level that affect teaching; and knowledge about students and their communities, that is, their backgrounds, families, strengths, weaknesses, and specific interests (Grossman, 1990). This knowledge base underpinned the analysis of how the social context influences teachers' approaches to environmental issues.

By integrating different types of knowledge, teachers can develop a more effective pedagogical practice, suited to the needs of students. According to Grossman (1990), pedagogical content understanding is the element that distinguishes the subject matter expert from the experienced teacher, since the qualified teacher not only masters the content, but also knows how to teach it in a way that students can understand. In light of the above, Grossman's model proved to be an appropriate reference to guide this research discussed herein.

METHODS

THE RESEARCH CONTEXT

This qualitative research, of a descriptive nature, is configured as a case study, which, according to Gil (2022), implies an intense and complete examination of one or some objects, to enable a full and precise understanding of them. In the context of this study, this approach was taken in relation to a group of teachers and is justified by the need for an in-depth investigation into their pedagogical content knowledge (PCK), considering their practices and perceptions in a specific educational environment. As Clemente and Santos (2012) point out, the case study allows for an analytical reflection on the researched context.

Maria Flor School (fictitious name assigned to the school), the institution where the research was developed, is in the south of the state of Minas Gerais and began its activities in 1987. The school unit offers only Elementary Education to its students, in the following modalities: Initial Years of Elementary Education, Full-Time Project, and Regular Supplementary Education - in the Youth & Adult Education (EJA) modality. In its Political Pedagogical Project, there is an emphasis on working with and addressing environmental issues, considering the school context and reality, to promote children's awareness of environmental preservation.

For participation in the research, 28 teachers from the school were invited. The inclusion criteria for participation considered a Bachelor's degree in Pedagogy and experience in the early years of Elementary School as the basic training; exclusion criteria included not having a Bachelor's degree in Pedagogy, not working in the early years of Elementary School, or not agreeing to participate in the study.

The invitation was made in person, at a pedagogical work meeting, which is attended weekly by all professionals in the pedagogical sector. Five teachers from the school agreed to participate in the research and signed the Consent Form. To preserve their identities, the participants were identified by pseudonyms chosen by them: Agate, Amethyst, Jade, Ruby, and Tourmaline.

The research was approved by the Research Ethics Committee (CEP) of University XX, under number CAAE 65373622.7.0000.5142, and its commencement only occurred after approval by this Committee. The data collection phase with the participating professors took place between June and December 2023.

METHODOLOGY

As an initial step in the research, it was understood, based on Laville and Dionne (1999), that it would be fundamental to engage in a careful reading of the scientific literature involving Environmental Education and the early years of elementary school, as well as the pedagogical content knowledge, as presented in the theoretical framework. This prior review of existing literature was considered necessary to support understanding, providing a solid base of theoretical knowledge, thus allowing for the understanding of relevant concepts, theories, and practices, essential for effectively addressing issues related to environmental themes in the specific context.

To identify the pedagogical content knowledge (PCK) and the teachers' initial conceptions of Environmental Education, semi-structured interviews were used as one of the data collection instruments, allowing for more detailed access to the participants' knowledge, representations, and beliefs (Laville & Dionne, 1999). This format provided flexibility in conducting the questions with the teachers, allowing for adaptations as needed. The interview questions were formulated with the intention of identifying the four components of PCK in Grossman's model (1990): content knowledge, context knowledge, general pedagogical knowledge, and content pedagogical knowledge.

The interviews, audio-recorded with the participants' permission, were conducted at the school, without interfering with the teaching routine. The instrument's questions aimed to obtain evidence of which knowledge bases, considering the model proposed by Grossman (1990), are mobilized when listing environmental themes and answering the questions, as well as identifying possible conceptions of Environmental Education.

The responses were recorded and faithfully transcribed, including the expressions used by the interviewees, as well as seeking to reproduce their marks of subjectivity, the emotions demonstrated, the laughter, and the hesitations, as suggested by Laville and Dionne (1999). These authors emphasize the importance of capturing the richness of verbal and contextual data in qualitative research. The

transcription allowed for greater precision in the search for the content of the messages, making it possible to identify the units of analysis considering the knowledge bases proposed in Grossman's model (1990).

DATA ANALYSIS

The procedures for analyzing the data produced in this research considered the complexity of the elements of a personal, relational, and contextual nature. Thus, for the observation of these data, content analysis was chosen, according to the methodological framework of Laville and Dionne (1999). After careful reading of the materials, followed by a descriptive-interpretative movement, comparable discursive excerpts (words, phrases, paragraphs) with the same semantic content were organized (Laville & Dionne, 1999). The excerpts are composed of the units of analysis, understood as significant “excerpts” of the discourse capable of revealing elements of the phenomenon studied, according to Laville and Dionne (1999).

For the analysis of the interviews, an initial reading was carried out to organize the materials produced and to gain a deep understanding of the data content. Next, the pre-analyzed material was systematized, with careful reading of the transcribed texts, separation, and identification of the units of analysis. At this stage, a deeper look was taken at the teachers' reflections on environmental issues. The categorization of the identified units of analysis followed the indicators provided for in the four dimensions of Grossman's PCK (1990): general pedagogical knowledge, subject knowledge, pedagogical content knowledge, and context knowledge.

In the last part of the analysis, efforts were concentrated on the treatment and interpretation of the data to find patterns and significant understandings. At this stage, the raw results of the semi-structured interview were analyzed considering Grossman's model (1990) and the work of Layrargues and Lima (2014), seeking to establish a dialogue between the theoretical framework on the knowledge bases and conceptions of Environmental Education. This interpretative stage grouped the units of analysis, allowing for the identification of common points, divergences, and contradictions in the teachers' statements.

RESULTS AND DISCUSSION

The results were presented considering two areas: the identification of the teachers' knowledge bases in addressing environmental issues in their teaching practice and their initial conceptions of Environmental Education. Although these areas are presented separately in this section, the discussion sought to establish connections between them. Table 1 summarizes the results for the first five questions of the interview. The objective was to create a profile of the participants, considering that these elements can directly influence their pedagogical practices. Understanding the initial profile was fundamental to contextualizing the subsequent analyses, since these characteristics influence the teachers’ PCK.

Table 1

Responses to the initial questions of the semi-structured interview

Pseudonym	Age	Years in teaching	Grade level	Certificate in specialization	Course on E.E.	Other degree
Agate	48	10	5º	No	No	No
Amethyst	40	8	2º	Yes	No	No
Jade	37	15	3º	Yes	No	No
Ruby	51	14	4º	Yes	No	No
Tourmaline	38	11	1º	Yes	No	No

Source: the author, based on research data (2024).

As can be seen in Table 1, at the time of data collection, the teachers were between 38 and 51 years old. Their teaching experience ranged from 8 to 15 years. All participants indicated a degree in Pedagogy, and only Agate did not indicate a specialization. The teachers were also asked if they would like to participate in training courses in the area of Environmental Education, considering that none of them had taken courses in this area. All answered affirmatively, but some highlighted the lack of incentives from institutions and the lack of time to undertake such courses, an important factor regarding the importance of ongoing teacher training. These initial elements helped to understand the depth of the responses, since the lack of specific training in Environmental Education may justify some limitations observed in the application of knowledge on the subject. In this sense, continuing teacher training, especially in the context of public education, is pointed out as an alternative so that the school, as an educational space, can develop practices aligned with the purposes of critical and transformative Environmental Education (Carvalho & Bonotto, 2024).

IDENTIFICATION OF KNOWLEDGE BASES

Table 2 presents the questions from the semi-structured interview developed for this study.

Table 2

Questions from the semi-structured interview

Script
1 – Which pseudonym will you be using in the research?
2 – Besides pedagogy, do you have another degree?
3 – Did you attend graduate school? Which level? Specialization ( ) Master's degree ( ) Doctorate ( )
4 – How long have you been teaching?
5 – Have you been attended any course in environmental education? If yes, which one? Describe:

6 - What influences your teaching practices?
7 – How do you plan your lessons? (Which knowledge areas)
8 - Regarding the planning of teaching environmental themes, what pedagogical aspects do you consider relevant?
9 - Describe activities you have developed on environmental themes.
10 - When are environmental themes present in your classes? Comment.
11 – In your own words, what is environmental education?

Source: the author (2023).

The analysis of the interview data was carried out based on Grossman's model (1990). As previously pointed out, the author, in her model of professional knowledge for teaching, highlights the importance of four domains: pedagogical content knowledge, general pedagogical knowledge, subject knowledge, and context knowledge. Conceptions of Environmental Education were also analyzed, using the work of Layrargues and Lima (2014) as a reference.

Excerpts from the responses were used, and within these excerpts, specific passages were selected and highlighted as units of analysis, aiming for a better interpretation of the data. The units of analysis were selected based on passages that evidenced the mobilization of teaching knowledge, prioritizing segments that revealed actions, beliefs, or justifications related to environmental themes.

Table 3 presents excerpts from the responses to question 6: "What do you consider to possess and exert influence on your teaching practice?"

Table 3

Excerpts from the interview for question 6.

Pseudonym	Excerpts analyzes
Agate	*"[...]appropriate material [...] better results from the work developed."*
Amethyst	***"**students' **prior knowledge** and the **teaching methods", "The preparation** of what will be **worked on,** how it will be used **to conduct the class."***
Jade	*"[...] students' **cultural and social background** [...] everything that involves **the students**."*
Ruby	*"[...]**affective bond**, right? The ties, the proximity [...] **facilitate teaching and learning** and the resources, right, [...]technology, which I think is very important, because children have a lot of interest in **technological resources**[...] because I work in a school in a poor neighborhood, lower middle class parents, mostly working class. This is one of the main factors [...]and the **teaching methodologies** that I use."*
Tourmaline	*"[...]**students' prior knowledge** [...] and the social context. Also the **place** where they live, that they are **poorer** or have **more difficulties**[...], really knowing **what their life is like**, at home, in the neighborhood. **I know these children well** [...]**recycling, caring** for the environment and **not wasting** too much water." **Training courses** [...]."*

Source: the author, based on research data (2024).

The analysis of the responses revealed different factors that influence teaching practice, in addition to a common concern with adapting teaching to the needs and context in which students are inserted, as well as the use of appropriate materials. The teachers highlighted the importance of understanding students' prior knowledge, considering their cultural backgrounds, and also the importance of affectivity and the use of technologies.

These responses point to the knowledge of educational contexts that teachers need to develop in order to base their teaching on an understanding of the specific contexts in which they work, thus adjusting their general knowledge to the particularities of the students' school contexts (Grossman, 1990). In this sense, Shulman (1987) also emphasizes that teacher knowledge should encompass an understanding of educational contexts and the cultural and community characteristics that shape the school environment. By highlighting these contextual elements, the study highlights a relevant contribution to teacher training: the importance of articulating contextual knowledge with the demands of Environmental Education.

Table 4 shows excerpts from the responses to question 7: "What do you use to plan your teaching activities (knowledge bases)?"

Table 4

Excerpts from the interview for question 7

Pseudonym	Excerpts analyzes
Agate	*"**Planning**, right? **Brazilian National Common Curriculum, YouTube**, Google, [...]."*
Amethyst	*"**Internet** research, **Brazilian National Common Curriculum**, in **books**, the students' level of knowledge."*
Jade	***"Books, internet, Brazilian National Common Curriculum, the exchange** of information with other professionals."*
Ruby	*"The **school curriculum** [...] **textbook**, all my practice carried out in the classroom is according to the material that **the department sends**, it's by semester [...] **textbook**, it is **a guide** for my practice."*
Tourmaline	*"The **Brazilian National Common Curriculum**, right, updated, and the **Minas Gerais Curriculum**, [...] **internet** [...] to be able to work better in a **playful way** with the children. When I went to college, I thought **there was too much theory**; I learned it in **practice**. So it didn't help much, it's more **on a daily basis**, right, in the **classroom**."*

Source: the author, based on research data (2024).

The question presented in Table 4 aimed to examine the knowledge bases of the subject, knowledge of contexts, and general pedagogical knowledge, in light of Grossman's model (1990). The analysis of the responses points to the use of multiple resources to plan activities, as the teachers highlighted the search for different ways to approach the topics for teaching, also demonstrating knowledge of the curriculum by using guiding documents, such as the Brazilian National Common Curriculum, the Minas Gerais Curriculum, and the textbook. According to Pacheco (2005), the curriculum should be structured considering the learning processes, interests, values, and attitudes of the students. The data suggest that the teachers reflected in this regard. The explicitness of these curricular choices allowed us to understand how each teacher articulates prescriptive guidelines with

planning decisions, revealing nuances of the mobilization of both content knowledge and general pedagogical knowledge.

Regarding knowledge of contexts, when considering the use of the material that the Department of Education sends to teachers, the students' knowledge, the exchange of information with colleagues, and the adaptation of practices to the realities of the class, the teachers seem to consider an integrated approach, which aims to adjust their teaching to the specific needs and characteristics of their students. This practice reflects an understanding of the importance of adapting pedagogical strategies to educational contexts, an essential skill for effective teaching. For Grossman (1990), as discussed, knowledge of the school context encompasses everything from knowledge of the school environment, through departmental guidelines, to knowledge of who the students are and their communities of origin. By analyzing these choices, the research shows how the teachers of the early years, participants in the research, articulate curricular references with the sociocultural context of the school, in the sense indicated by the author.

The responses to Table 4 also reveal general pedagogical knowledge, as the teachers state that they integrate digital resources and playful methods as an effort to teach engagingly, in line with Grossman (1990), who highlights the fact that this knowledge involves skills related to teaching, classroom management, and educational objectives. For this question, there was no direct mention of environmental themes by the teachers.

Table 5 illustrates excerpts from the responses to question 8: "Regarding the planning of teaching environmental themes, what pedagogical aspects do you consider relevant?" The question sought to directly address environmental themes.

Table 5

Excerpts from the interview for question 8.

Pseudonym	Excerpts analyzes
Agate	*"[...] research, right, in practice, right, on environmental **conservation and awareness** [...]. Students can take this **beyond school.**"*
Amethyst	*"**Internet research**, [...] **get their attention and engage** students with more enthusiasm and dedication."*
Jade	*"**All aspects involved** in the evolution of student learning [...] **The cultural background** also enriches this **exchange between teacher and student**, which is very good."*
Ruby	*"[...] **the student, so that he feels part of the environment**, right? That this theme becomes part of his daily life [...] that he is a fundamental piece [...] **interdisciplinarity** [...] and not just be worked on in science class."*
Tourmaline	*"[...] **the importance of water for life, recycling**, waste, and environmental conservation. For their own future, because it's not something **that will end overnight, but little by little**."*

Source: the author, based on research data (2024).

The objective of the question was to investigate the bases of pedagogical content knowledge (PCK), general pedagogical knowledge, subject knowledge, and context knowledge, in addition to verifying possible conceptions of Environmental Education among the teachers. The responses suggest the combined use of specific pedagogical knowledge, content knowledge, and context knowledge to plan the teaching of environmental themes. Each teacher revealed that they use strategies to make learning meaningful, integrating practical, cultural, and everyday aspects into the teaching process, suggesting that they present pedagogical content knowledge in development. These strategies indicate that, although there are differences in the responses, the teachers share an initial articulation between environmental knowledge and pedagogical choices.

From Grossman's (1990) perspective, Agate demonstrated knowledge of the subject by mentioning environmental conservation; however, she did not detail her understanding of it, which suggests a conservationist perspective on Environmental Education (Layrargues & Lima, 2014). Research and practice are active pedagogical methodologies, and "taking knowledge outside of school," as the teacher highlighted, is close to understanding educational contexts, which Shulman (1986) emphasizes as relevant for an education that promotes change, focusing on the student and taking into account their particularities.

The units of analysis highlighted in the excerpt from Amethyst's response, "Internet research," "attracting attention and engaging students with more enthusiasm and dedication," refer to knowledge of educational objectives, which seek to motivate and engage students. The use of pedagogical strategies is essential for the construction of learning. With regard to the principles and strategies of teaching, as well as classroom management and administration resources, the points suggest general pedagogical knowledge, which involves understanding learning processes, teaching approaches, and assessment methods (Shulman, 1987). In her response, the interviewee did not mention elements that are directly related to conceptions of Environmental Education.

Jade's response, by mentioning aspects of learning development, indicates points related to educational objectives that are included in general pedagogical knowledge, which also encompasses knowledge and conceptions about the objectives and purposes of education (Grossman, 1990). In this aspect, it is essential to understand the reasons that make education fundamental, in addition to understanding its objectives and the values underlying learning. The knowledge base should address both the objectives of education and the techniques and approaches employed in the teaching process. By valuing cultural background and the interaction between teacher and student, Jade demonstrates knowledge of educational contexts. Grossman (1990), in this sense, highlights the importance of teachers' understanding the local context to adapt their pedagogical practices. In the interviewee's response, it was not possible to identify conceptions of Environmental Education. Even so, the emphasis that Jade places on the students' cultural background allowed us to consider her statement as important for understanding how sociocultural contexts are present in her planning.

The highlighted excerpts from Ruby's interview, "that the student feels part of the environment, a fundamental piece, making interdisciplinarity a part of their life and not just in science class," suggest the educational objective of meaningfully integrating environmental issues into students' daily lives. The goal is for students

to feel connected to and responsible for the environment, fostering a richer and more contextualized understanding of the topic, although possible conceptions of Environmental Education are not explicitly stated in the response.

The mention of the importance of the topic being part of students' daily lives reflects a consideration of the context. This implies adapting teaching to the environment and the daily experiences of students, making learning relevant and meaningful to them. The idea of not limiting teaching to the content of science class, but of incorporating interdisciplinarity, although this incorporation is not clear in the response, suggests a general pedagogical knowledge, involving the use of approaches that integrate different disciplines to enrich students' understanding, applying knowledge more comprehensively, and approaching Grossman's (1990) concepts.

Tourmaline's speech, which discusses the importance of water, recycling, waste, and environmental conservation, reflects educational objectives aimed at raising students' environmental awareness. The intention seemed to be to sensitize them to the importance of sustainable practices, such as water conservation and recycling, and to the need to avoid waste, which suggests that she knows the subject, as systematized by Grossman (1990). In her response, it is possible to note a pragmatic Environmental Education perspective (Layrargues & Lima, 2014) when she highlights practices aimed at solving environmental problems.

Question 9, whose answers are shown in Table 6, was formulated to assess pedagogical content knowledge, general pedagogical knowledge, and subject knowledge. This question also sought, directly, as did question 8, the teachers' understanding of the approach to environmental issues.

Table 6

Answers to question 9: Describe activities you have developed on environmental topics.

Pseudonym	Excerpts analyzes
Agate	*"**Texts**, right? **Informative** with interpretation, we have a **debate**, right? **Text productions**."*
Amethyst	*"**Preservation** of the environment in which we live, **care for the animals** that are part of the environment in which we live, and **recycling**."*
Jade	*"[...] **commemorative dates** are more important and **effective learning** [...] in **science class** for us to improve, but they **are present in everyday life**, for example, we **arrive** in the classroom, we already **address** some environmental theme, something they saw on the street, for example, it's already a moment that is present in the class, right? [...] What I'm telling you is that **children have a very important background** [...]. So it ends up **being present not only in a specific subject**."*
Ruby	*"[...] **recycling**, which is a child **being aware that the materials** they use, **the milk carton they discard, the medicine box**, all of that can be **reused and recycled**, whether for **making toys or for reusing them** in the various daily activities of the students." [...]**planting trees** makes the school **greener and more flowery**, and[...] avoids **wasting food and water**, right?*
Tourmaline	***"Those things I already mentioned."***

Source: the author, based on research data (2024).

By promoting debates, the combination of various elements, such as preservation, animal care, recycling, and knowledge about specific environmental practices indicated by the teachers, denotes an understanding of educational objectives and general pedagogical knowledge. Furthermore, the relationship between the environment, the student, and their cultural background suggests an understanding of the contexts. This set of elements contributed to understanding, in the analysis, how the teachers articulate environmental practices in daily school life.

The responses of Amethyst, Jade, and Ruby, who explicitly cite situations involving Environmental Education, suggest conservationist and pragmatic perspectives (Layrargues & Lima, 2014) when addressing environmental preservation, the promotion of environmental activities on commemorative dates, and discussions about the possibility of reusing or recycling materials, without highlighting the importance of reflecting on possible social causes in the generation of environmental problems, certainly adapting the discussion to the students' educational level. Agate and Tourmaline did not directly mention environmental themes.

Table 7 presents excerpts from the responses to question 10: “When are environmental themes present in your classes? Comment.”

Table 7

Excerpts from the interview for Question 10.

Pseudonym	Excerpts analyzes
Agate	*"**In all classes, in a cross-curricular and interdisciplinary** way, right? I can use it in Science, right, in Geography, in Portuguese, in Mathematics, Arts, so, in all subjects, **you can fit it in some way in which moments we have environmental issues**."*
Amethyst	***"In all subjects, according to the environment in which it arises or directly related."***
Jade	*"The theme of environmental education **is a very broad theme**, right? So, for us, it is **a process in which the individual builds their social values, knowledge** and especially attitudes geared towards environmental conservation and also, thinking about **children, we develop with children responsible actions and attitudes** towards environmental problems, right, such as water waste, burning, deforestation."*
Ruby	*"In **June**, especially at the beginning of the month, when **World Environment Day is celebrated**, we do several activities for students to reflect on what the environment is, how we can contribute to it, right?" Furthermore, sometimes the Department of Education requests an extracurricular project where we address this topic.”*
Tourmaline	*“Oh, **it’s practically every class**, that’s how we work.”*

Source: the author, based on research data (2024).

The analysis of the teachers' responses (Table 7) shows that they combine general and specific pedagogical knowledge with knowledge of the subject. Agate and Tourmaline report that they address Environmental Education in all classes, although it is not explicit in their responses how this approach takes place. The responses of Tourmaline and Amethyst, presented in a generalized way, do not

allow inferences about possible knowledge bases mobilized or about possible conceptions of Environmental Education. Some teachers claim to address the environmental theme continuously, but without detailing or showing how this occurs in pedagogical practice.

Jade emphasizes the ethical and social dimension of Environmental Education by highlighting the construction of values and social attitudes. This approach is close to a critical conception of Environmental Education, as it mentions social values, attitudes, and responsibilities that seek to form conscious and participatory citizens (Loureiro, 2003). On the other hand, Ruby mentions commemorative dates, such as World Environment Day, which highlights a punctual practice, an action that is close to the conservationist conception, described by Layrargues and Lima (2014) as an approach focused on the preservation of nature.

In general, the teachers demonstrated flexibility in integrating environmental themes in a cross-cutting and interdisciplinary way, although they did not delve into how this form of integration occurs. This approach reflects pedagogical content knowledge (PCK), described by Grossman (1990), which combines general pedagogical knowledge with subject knowledge, going beyond simple mastery of the subject matter.

CONCEPTS OF ENVIRONMENTAL EDUCATION

In seeking to understand the possible conceptions of Environmental Education held by the participating teachers, in addition to the results discussed in questions 8, 9, and 10, which addressed activities with environmental themes, question 11 of the interview was also used, which directly asked: "In your opinion, what is Environmental Education?" Table 8 presents the teachers' responses. The highlighted sections correspond to the units of analysis.

Table 8

Excerpts from the interview for Question 11

Pseudonym	Excerpts analyzes
Agate	*"It is an educational action that leads to **environmental knowledge**. It can contribute in various ways, presenting **good recycling practices**, reducing **the causes of global warming**, and especially the study of water, which is the basis of all life on our Planet Earth, contributing to its **preservation**."*
Amethyst	*"For me, Environmental Education is about **skills** related to the environment, so we **can maintain the preservation** of the environment."*
Jade	*"It is a process that the individual **builds little by little**, developing their **social and cultural values**, always focused on this **regulation and conservation** of a healthier environment, always doing their part, **not just waiting for the government.**"*
Ruby	*"Environmental Education is a type of **education** where we pass on to individuals and our students **ways to care for the environment** in which they are **inserted**. We end up **preparing our children** to **become critical and conscious citizens** of the environment in which they are inserted."*
Tourmaline	*"For me, Environmental Education is a **process responsible** for forming **individuals concerned** with **environmental issues** and who **seek the conservation and preservation of natural resources** and sustainability."*

Source: the author, based on research data (2024).

Agate's response, while highlighting the importance of preserving natural resources, suggests a pragmatic approach, as emphasized by Layaragues and Lima (2014) when they highlight objective resolution as a central aspect of pragmatic Environmental Education. Furthermore, Layaragues and Lima (2014) indicate that the pragmatic conception, by valuing quick and tangible solutions, often focuses on solving specific problems, such as the management of urban and industrial waste and conscious consumption, without necessarily considering the complex underlying social and political interrelationships. Thus, the pragmatic approach to Environmental Education sees environmental problems as a consequence of the advancement of science and technology. It emphasizes changing individual behavior, believing that everyone should take care of natural resources (Longo & Bonotto, 2024). An important point highlighted by the professor was her understanding that Environmental Education is an educational action towards environmental knowledge, which is constituted by the integration of science, ethical knowledge, social practices, and traditional knowledge (LEFF, 2015).

Amethyst adopted a perspective more focused on environmental preservation in her response and demonstrated an affinity for a conservationist conception, since in this perspective, the focus is on acquiring skills that promote the conservation and preservation of the environment (Carvalho, 2004).

Jade broadens the discussion by including the development of social and cultural values in her response, but, in the context of environmental education trends, there seems to be a pragmatic perspective when she emphasizes "always doing your part and not waiting for the government." This conception values individual, practical, and immediate action, as highlighted by Layaragues & Lima (2014). Although her response mentions the development of social and cultural values, the political and social transformation, an aspect of the critical conception of Environmental Education, is not explicitly addressed, suggesting the importance of formative processes that broaden critical reflection on the environmental dimension and its educational implications (Longo & Bonotto, 2024).

Unlike Jade, Ruby focused on the formation of critical and conscious citizens, a vision that presents characteristics of critical Environmental Education, as defined by Carvalho (2004), although she indicated it superficially in her response, without deepening this discussion. The emphasis on forming critical and conscious citizens reflects an approach that seeks social change; however, the teacher did not make evident in her response possibilities for provoking such changes. In this sense, Dias and Megid Neto (2020) point out that most pedagogical practices in Environmental Education are still limited to transmitting knowledge and encouraging individual changes in behavior, without promoting questioning about the political, cultural, and economic aspects that shape socio-environmental problems.

Tourmaline highlighted Environmental Education as a process of individual formation, an important condition for promoting positive changes regarding socio-environmental issues. In her response, she indicated the importance of training people who are concerned about the conservation of natural resources and sustainability but did not elaborate on how this training process can occur. In the overall context, Tourmaline's response suggests an approximation to the conservationist conception described by Carvalho (2004), which focuses on the importance of protecting the environment and conserving its natural resources.

The responses of participants Agate, Amethyst, Jade, Ruby, and Tourmaline to the questions that dealt with environmental themes (8, 9, and 10) and to question 11, specifically, which directly asked about Environmental Education, revealed a diversity of viewpoints and interpretations. For question 11, Agate and Jade demonstrated a pragmatic approach, prioritizing immediate solutions and individual actions, without delving into the political and structural dimensions of environmental problems, consistent with the pragmatic perspective described by Layrargues and Lima (2014).

Amethyst and Tourmaline, in turn, presented a conservationist vision, emphasizing the importance of preserving natural resources and raising environmental awareness, a perspective that aligns with the concept of conservationist Environmental Education described by Layrargues and Lima (2014), for whom this trend prioritizes awakening a sensitivity focused on the care and preservation of nature. Ruby approached the critical conception, highlighting the need to train critical and conscious citizens, although without detailing concrete strategies for social change. This understanding aligns with the perspective that critical Environmental Education seeks to train individuals capable of recognizing and intervening in socio-environmental issues, guided by principles of environmental justice (Carvalho, 2004). This perspective was also discussed by Dias and Megid Neto (2020), when they point out that Environmental Education, from a non-conservationist perspective, understands environmental problems as a result of the relationships between society and the environment and of political factors, considering EE a political act aimed at social transformation and questioning the capitalist model. This diversity of conceptions highlights how Environmental Education can be interpreted in different ways, influencing how it is approached in the school context.

Although there is a consensus among the participants about the relevance of Environmental Education, their responses represented only a general and initial conception of this field. As indicated by Longo and Bonotto (2024), in their study involving continuing teacher education, more in-depth changes in conceptions involving Environmental Education require continuous training processes that allow for a broader perspective on this field and the development of more critical and transformative practices in the school context.

It is understood that, to deepen the knowledge about their conceptions, it would be necessary to monitor the practices of the participating teachers, an action that could not be carried out in this study.

The objective of this topic was not to present a classification of trends, but rather to reflect on the understanding of the field and the actions proposed by the teachers for the development of Environmental Education practices, a reflection that contributes to the context of teacher training.

CONCLUSION

This study aimed to investigate the pedagogical content knowledge on environmental issues held by elementary school teachers participating in the research, as well as to identify their initial conceptions of Environmental Education.

When investigating the knowledge bases on environmental issues, according to the adopted PCK framework, the results suggest that, although they did not always explicitly state the four components of PCK individually, their statements revealed the presence of three independent types of knowledge: pedagogical knowledge, subject matter knowledge, and contextual knowledge. The most prominent types of knowledge were pedagogical knowledge and contextual knowledge.

The teachers' initial conceptions of Environmental Education were close to conservationist and pragmatic trends, reflecting the complexity in the field and highlighting the need for a diversified and inclusive approach in the training of environmental educators. Such pluralism is essential to meet the different demands and contexts in which Environmental Education is embedded. There was a consensus among the teachers about the importance of Environmental Education, which highlights the relevance of including environmental themes continuously in school curricula and providing opportunities for continuing education that broaden understanding of the area and deepen teachers' PCK on environmental themes.

This study sought to contribute to the understanding of the needs and skills of early years educators in addressing issues related to environmental themes, highlighting the relevance of comprehensive and continuous training that assists teaching practices. As a possibility for future research, considering the scarcity of studies on PCK and environmental themes at the educational level taken as a focus, a participatory research approach or a longitudinal study is suggested, including the observation of classes and pedagogical activities with environmental themes, which would allow for a more in-depth analysis of teachers' practices; and, possibly, from this analysis, the obtaining of important elements that can be integrated into future teacher training actions (initial and continuing) involving PCK and the field of Environmental Education.

NOTES

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