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What do studies in the field of science education developed in postgraduate programs in Paraná reveal?

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ABSTRACT

To guide the continuous development of the academic field, it is essential to understand the landscape of research in Science Education, as there are themes that lack sufficient investigation. In this context, it is also necessary to focus on postgraduate programs, where studies are conducted to support and characterize this field of knowledge. Thus, our inquiries led us to the following research problem: What is the panorama of research in Science Education within the graduate programs in Paraná? What are the main trends, challenges, and gaps identified? The objective of this study is to highlight emerging trends and contributions in Science Education research within the graduate programs in Paraná. We conducted a state-of-the-art study using theses and dissertations produced in graduate programs evaluated in the Teaching Area and the core area of Science and Mathematics Teaching as our corpus. Data were analyzed using IRAMUTEQ® software to identify and describe the main aspects of the investigations. The results revealed a diversity of topics, notably issues related to textbooks, epistemic practices and reflections, critical perspectives on scientific and social concepts, citizenship promotion, environmental education, and teacher training. However, gaps were identified in areas such as teaching methodologies, inclusion and diversity, curriculum, assessment, and the history of science. These gaps present opportunities for further research to expand and deepen understanding in these fields.

KEYWORDS: Science and Mathematics Teaching Area; postgraduate programs; Paraná; Research.

O que mostram as pesquisas na linha de ensino de ciências desenvolvidas em programas de pós-graduação do Paraná?

RESUMO

Para orientar o desenvolvimento contínuo do meio acadêmico, é fundamental compreender o cenário das pesquisas no ensino de Ciências, já que existem temáticas que carecem de investigações. Nesse sentido, é necessário direcionar o foco também para os programas de pós-graduação, onde são desenvolvidos estudos que embasam e caracterizam essa área do conhecimento. Assim, nossos questionamentos nos conduziram ao seguinte problema de pesquisa: Qual é o panorama das pesquisas em ensino de Ciências nos programas de pós-graduação do Paraná? Quais são as principais tendências, desafios e lacunas identificadas? O objetivo deste estudo é destacar as emergentes tendências e contribuições nas pesquisas sobre o ensino de Ciências nos programas de pós-graduação do Paraná. Realizamos uma pesquisa de estado do conhecimento, utilizando como *corpus* as teses e dissertações produzidas nos programas de pós-graduação, avaliados na Área de Ensino e na área básica de Ensino de Ciências e Matemática. Os dados foram analisados com o suporte do *software* IRAMUTEQ® para identificar e descrever os principais aspectos da investigação. Os resultados revelaram uma diversidade de assuntos, com destaque para questões relacionadas ao livro didático, práticas e reflexões epistêmicas, criticidade sobre conceitos científicos e sociais, promoção da cidadania, educação ambiental e formação de professores. No entanto, identificaram-se lacunas relacionadas a diversidade de metodologias de ensino, inclusão e diversidade, currículo, avaliação e história da ciência. Essas lacunas podem ser objeto de novas investigações buscando expandir e aprofundar o entendimento nesses campos.

PALAVRAS-CHAVE: Área de Ensino de Ciências e Matemática; Programas de pós-graduação; Paraná; Pesquisa.

INTRODUCTION

The quality of Science Education plays a fundamental role in shaping critical and reflective individuals capable of acting as conscious citizens in society. Understanding the research landscape allows us to identify emerging trends, the most relevant themes, and existing gaps. Based on this premise, it becomes possible to encourage new studies addressing crucial questions and filling gaps identified by the scientific community. This understanding drives continuous development in the academic field, strengthening research in the area.

Research in Science Education in Brazil is relatively recent. Its origins are marked by a movement toward improving the teaching of exact sciences, also known as hard sciences, in both universities and schools, driven by the need to reassess traditional teaching methods (Lavarda & Pereira, 2019). Currently, the research community has access to a vast body of work, established and published through various dissemination channels (Nardi, 2022). This demonstrates that studies conducted in Science Education have already produced a significant amount of knowledge.

Examining this landscape allows us to identify research priorities and the progress achieved. In this context, the older *Stricto sensu* graduate programs in Paraná play a prominent role. Many studies have already been conducted, and their contributions to the training of researchers and educators are evident. The state of Paraná, located in southern Brazil, stands out for its academic and scientific relevance, hosting graduate programs with over two decades of consolidation in the field. These programs' importance in training researchers and educators motivates an exploration of ongoing investigations in the field of Science Education. Research conducted by various authors over the last decades allows us to understand the possibilities and challenges in teaching and learning Science (Catarino & Reis, 2021).

It is essential to highlight the pioneering role of two programs in Paraná: the Graduate Program in Science and Mathematics Education (PECEM) at the State University of Londrina (UEL), approved in 2001 by CAPES (Coordination for the Improvement of Higher Education Personnel), and the Graduate Program in Science and Mathematics Education (PCM) at the State University of Maringá (UEM), established in 2004. Over the years, these programs, along with others created later, have met the growing demand for qualified professionals. Their creation reflects the commitment of Paraná's higher education institutions to advancing Science Education and fostering research in various contexts.

Despite the dissemination and accessibility of work in various academic spheres, a gap remains in understanding what has been investigated in Paraná's older *Stricto sensu* graduate programs. Therefore, the central questions of this study are: What is the research panorama in Science Education within these contexts? What paths have these studies followed, with an emphasis on the addressed themes and gaps to be explored? The general objective is to highlight emerging trends and contributions in Science Education research conducted within Paraná's graduate programs.

THE FIELD OF SCIENCE AND MATHEMATICS EDUCATION

The establishment of Area 46 in Brazil, dedicated to Science and Mathematics Education, is highly relevant to understanding the academic context. Its origins trace back to the 1940s and 1950s, driven by the mobilization of researchers in fields such as Natural Sciences and Education. Scientists, specialized groups, and institutions shared concerns about teaching and learning within their respective domains. Collaborative efforts, consistent funding, and researcher engagement strengthened and propelled continuous growth in Brazil.

The official creation of the Science and Mathematics Education Area by CAPES in August 2000 was a milestone. From 1998 to 2001, the triennial evaluation highlighted the historical aspects of established courses and quality criteria, with committees comprising researchers from various disciplines (CAPES, 2001). In 2002, the first evaluation led to the approval of graduate programs and the definition of guidelines for professional and academic master's degrees (CAPES, 2002). Subsequent triennial evaluations and the National Graduate Plan in 2004 further solidified the area's identity, emphasizing integrating researchers from core fields and expanding publications. During 2007–2009, evaluations showed growth in the number of programs, albeit concentrated in the Southeast and South. To address regional disparities, initiatives were implemented to foster integration and partnerships (CAPES, 2009).

Over recent decades, the Science and Mathematics Education field has experienced significant evolution and consolidation, confronting numerous challenges and limitations. A restructuring by CAPES in 2010 expanded Area 46 into the Teaching Area, a critical development following intense debates among researchers and associations. The creation of thematic panels, including one for Science and Mathematics Education, aimed to preserve the original identity (CAPES, 2010). Monitoring seminars played a crucial role in discussions and consolidating the area, emphasizing its multidisciplinary nature and promoting interdisciplinarity, as reflected in the 2013 triennial evaluation (CAPES, 2013).

Due to its interdisciplinary nature, this field of activity within CAPES seeks to integrate knowledge and strengthen the interdependence between disciplines. In an increasingly complex and diverse global context, interdisciplinarity plays a strategic role by connecting different areas of knowledge, fostering the development of new concepts, methodologies, and approaches. From this perspective, the Teaching Area develops its postgraduate project with an interdisciplinary approach, emphasizing: a faculty with expertise in various fields of knowledge; curricular proposals that prioritize the integration of disciplines; the expansion of research addressing educational processes from an interdisciplinary perspective; and the investigation of educational processes and products with a focus on interdisciplinarity (CAPES, 2019).

During the 2017–2020 quadrennium, the emphasis on interdisciplinarity became an increasingly discussed topic due to its strategic relevance in fostering connections across various fields of knowledge. This approach bridges theory and practice, philosophy and science, and science and technology, among others. It proposes a model of knowledge production based on the sharing of theories and methodologies between converging areas, resulting in the creation of new concepts and pedagogical practices (CAPES, 2023).

A pivotal moment in this process was the COVID-19 pandemic, which profoundly impacted the field of education. Restrictions on movement, social distancing, and the abrupt shift to online learning posed unique challenges, complicating in-person data collection and limiting the budget available for research. Adapting research and teaching methods, along with efforts to safeguard mental health and well-being, became crucial. The most significant impacts of the pandemic are expected to be reflected in the current quadrennium (2021–2024), presenting researchers with challenges and opportunities to explore new issues and rethink methodological approaches (CAPES, 2023).

Research and the training of professionals have played a crucial role in enhancing the quality of science and mathematics education. Despite progress, persistent challenges demand studies capable of contributing to quality education. Additionally, the field faces struggles for increased funding, recognition, autonomy, and participation in CAPES-related initiatives for education, as highlighted by Agostini and Massi (2023). The presented context underscores the consolidation and relevance of research, emphasizing the importance of understanding national developments to analyze postgraduate programs in Paraná, the state serving as the reference for this study.

To understand the scenario, it is essential to identify the institutions hosting postgraduate programs. Based on data from the Sucupira platform, academic programs emphasizing science education were selected. In Paraná, seven programs were identified: Science Education and Mathematics Education at the State University of Londrina (UEL), established in 2002 in Londrina; Education for Science and Mathematics at the State University of Maringá (UEM), established in 2004 in Maringá; Science and Mathematics Education at the Federal University of Paraná (UFPR), established in 2010 in Curitiba; Science and Technology Education at the Federal University of Technology–Paraná (UTFPR), established in 2011 in Ponta Grossa; Science Education and Mathematics Education at the State University of Western Paraná (UNIOESTE), established in 2017 in Cascavel; Science and Mathematics Education at the State University of Ponta Grossa (UEPG), established in 2017 in Ponta Grossa; and Science Education, Mathematics Education, and Educational Technologies at the Federal University of Paraná (UFPR), established in 2021 in Palotina.

Our focus was directed toward the oldest programs, PECEM and PCM, pioneers in researcher training. Additional information was gathered from their respective institutional websites, revealing that PECEM and PCM were initiated by faculty from various departments, such as Physics, Mathematics, Biology, History, and Philosophy. These faculty members were already involved in teacher and researcher training. Responding to CAPES' demands and the need to address local realities, these programs were created to meet specific needs, offering high-quality training, promoting research in diverse aspects of science and mathematics education, and contributing to educational improvements through inter-, multi-, and transdisciplinary projects.

The increased production of theses and dissertations reflects efforts dedicated to advancing research. With the growing volume of publications, revisiting existing knowledge becomes necessary to guide future investigations in Brazil (Teixeira and Megid Neto, 2012). To disseminate academic production, researchers began identifying and analyzing studies to understand their predominant characteristics,

map gaps, identify directions, and examine existing publications (Romanowski and Ens, 2006). These studies, known as "State of the Art" or "State of Knowledge," aim to understand how knowledge has been constructed in specific sectors over time and across different contexts, including theses, dissertations, journal articles, and presentations at academic events (Ferreira, 2002).

Mapping this panorama makes it possible to identify knowledge gaps, guide future investigations, and contribute to advancing science education at both national and international levels. Ultimately, this field stands out for its importance in the educational, scientific, and technological development of the region. Understanding the research conducted helps foster scientific production and train qualified professionals.

RESEARCH METHODOLOGY

The research adopted both qualitative and quantitative methods, considering the necessity for collaboration between the two. The mixed-methods approach integrates both forms of data simultaneously, combining them in a way that makes them complementary, with each contributing to the development of the other, without prioritizing one modality exclusively. This approach is applied according to the proposed objectives and can be incorporated at different stages of a study, structuring the procedures based on philosophical and theoretical propositions aligned with the methods guiding the research (Creswell & Clark, 2013).

The qualitative approach aims to understand, describe, and explain social phenomena from various perspectives, such as individual and collective experiences, analyses of developing interactions and communications, and investigations of documents or common patterns in experiences and integrations (Flick, 2009). Meanwhile, the quantitative approach contributed significantly to this study, allowing data to be quantified in generally large samples representative of the target population. This enables results to be interpreted as a comprehensive snapshot of that population. The quantitative approach uses mathematical language to describe the causes of phenomena, relationships between variables, and other aspects (Fonseca, 2002). The combination of qualitative and quantitative approaches enriches the research, enabling the acquisition of more complete information than would be possible through either approach alone.

In this context, we propose conducting a scientific "State of Knowledge" research. This methodology allows for establishing clear criteria for selecting and searching materials that comprise the corpus, including the collection of cataloged theses and dissertations, retrieval of materials from libraries, organization of reports, systematization of syntheses, and drafting of preliminary conclusions (Romanowski & Ens, 2006). According to Ferreira (2002), the main challenge in "State of Knowledge" research is mapping and discussing academic production, aiming to understand which aspects and dimensions have been emphasized or prioritized over time and across different contexts.

To achieve this, we present an overview of the works that comprised the research corpus, using the Thesis and Dissertation Library of the universities hosting the programs as the basis for the search. We listed the postgraduate programs in Paraná, highlighting Education as an evaluation area and Science and

Mathematics Education as the basic area. The following filters were applied: program status (active), modality (academic), region (South), and state (Paraná). The search covered the entire period since the creation of the postgraduate programs, considering theses and dissertations defended throughout their trajectory.

We adopted exclusion criteria to refine the search, disregarding: private universities and institutions that do not have stricto sensu postgraduate programs focused on Science Education in the academic modality. After completing the initial selection steps, we accessed the institutional websites of the universities and searched for theses and dissertations, filtering those related to the programs and the Science Education field.

Given the significant number of theses and dissertations obtained during the selection process, the need to use software to assist in organizing and analyzing the data was identified, as well as supporting the interpretation of the research results.

The use of software in research is particularly relevant in studies involving large quantities and diverse types of data, enabling researchers to make informed decisions and facilitate the conduction of their investigations. Such software offers specific capabilities and should be chosen according to the methodological context of the research (Silva *et al.,* 2021).

In this research, we used IRAMUTEQ® (Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires), a free software offering various analytical possibilities. Among the analyses conducted, Similitude Analysis and Descending Hierarchical Classification (DHC) stand out, which helped in processing and interpreting the data. Based on the results of these analyses, it was possible to create groups that allowed for the representation and discussion of the constructed analyses.

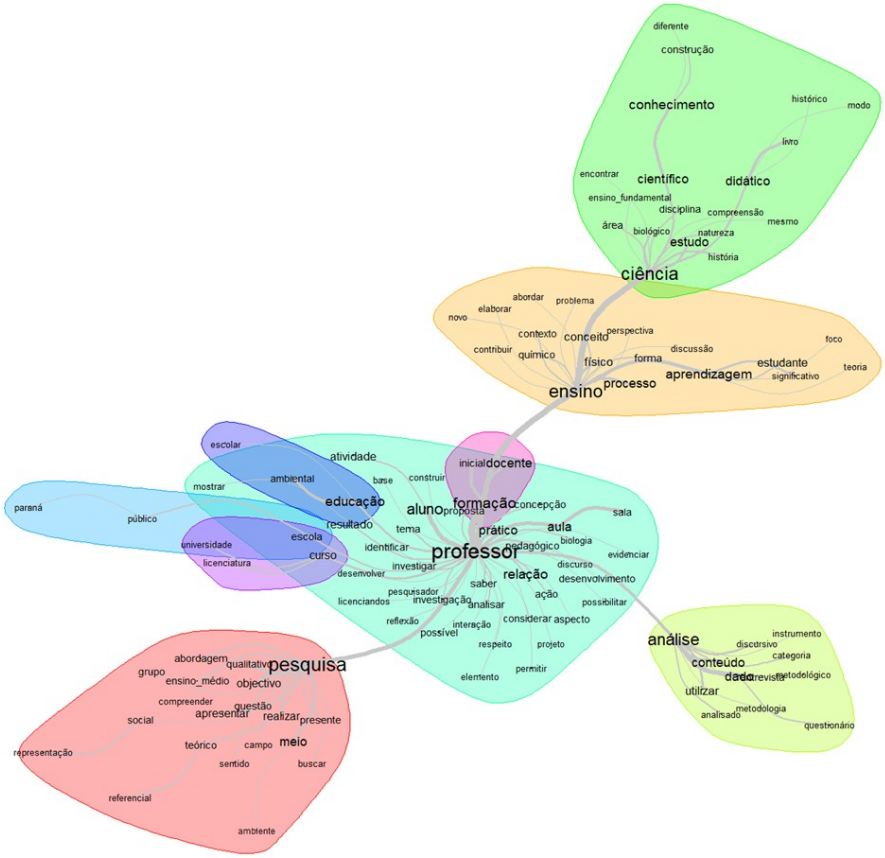
RESULTS AND DISCUSSIONS

For our analysis, we compiled a corpus of 354 theses and dissertations from the two PPGs selected for this study. The focus was directed towards the Science Teaching/Education track in works defended since the inception of both programs. The analyses performed using IRAMUTEQ® were essential in identifying the key aspects of the research. This approach provided a broader understanding of the research landscape in Science Teaching/Education within the PCM and PECEM programs, highlighting nuances and emerging perspectives.

In the analysis of theses and dissertations, the similarity analysis process allowed us to identify the patterns and central cores present in the analyzed corpus. Additionally, it enabled the identification of co-occurrences between words and their connectivity, represented by the similarity graph, where the central words stand out, and their connections, represented by thickness, indicate the intensity of the existing relationships. Furthermore, a more refined approach to identifying underlying themes and trends was possible. By examining the connections between keywords and central cores, we detected semantic patterns and implicit relationships that may not be immediately evident in a superficial analysis. Thus, we interpreted the representation as shown in Figure 1. In this context, we used colors to highlight the central words and connective groups.

Figure 1

Similitude Analysis of the theses and dissertations



Source: Prepared by the author (2024).

This analysis highlights the intrinsic and significant connection between the concepts of "teacher," "teaching," "science," and "research." These elements not only intertwine but also branch out, establishing complex relationships that enrich the context in which they are embedded. The visual representation of these interactions, obtained through the similitude graph, reveals potential connections between the words, providing a broader perspective. Terms such as "teaching," "teacher," "science," "analysis," and "research" emerge as central, underscoring the importance of the teacher's role and their close relationship with the teaching process, pedagogical practice, and scientific research. The thickness of the connecting lines between these terms indicates the intensity of these relationships, with the link between "teaching" and "science" being particularly striking. This connection highlights the interdisciplinary aspects of science teaching and research, with the student playing a central role as the subject of investigations.

Interpreting these analyses reveals that the research reflects a multifaceted and interdisciplinary approach in the field of Science Teaching/Education. The strong connection between these concepts demonstrates the importance of integrating these elements and contextualizing the studies. This trend suggests that researchers are seeking a broader and more holistic understanding of the educational process, recognizing the centrality of the teacher's role and their

interaction with teaching, pedagogical practice, and research. Furthermore, it indicates a concern with promoting a more active, meaningful education focused on the practical application of knowledge in different contexts.

The words "analysis" and "research" revealed an intrinsic relationship with the foundational elements of a research methodology. This association suggests the consolidation of an emerging methodological group that stands out as a crucial component in the development of investigations. The significant presence of these terms' points to a growing trend in adopting rigorous methodological approaches, denoting the scientific maturity of the analyzed research. These aspects indicate that methodological issues have frequently been emphasized in the abstracts of theses and dissertations, aligning with subsequent stages of analysis.

Subsequently, we proceeded to create a table highlighting the representative words and organized the discussion groups, aiming to provide a more detailed interpretation of each class that emerged through the CHD analysis performed by the software. To select these words, we considered those with the lowest margin of error and the highest χ2 (chi-square) values. These words are essentially the most significant in terms of statistical analysis, offering insights into the analyzed texts. We then used this information to compose Table 1, where we emphasized the words that served as the basis for forming the discussion groups. This selection was guided by the context of each class and statistical references, allowing for a comprehensive and well-founded analysis of the data.

Table 1

Word Classes and Formation of Discussion Groups

Classes	Representative Words	Discussion Group
5	Data; Analysis; Interview; Questionnaire; Paraná; Qualitative; Collection; University; Londrina; Maringá; Textual; Bardin; Course; Undergraduate; Semi-structured; Instrument; Discursive; Procedure; Transcription; Documentary; Initiation; PIBID.	1. Methodological Indications in Theses and Dissertations Abstracts
4	Book; Argument; Historical; Concept; HIV; Energy; Image; History; Analogy; Force; Metaphor; AIDS; Work; Kuhn; Texts; Epistemological; Textbook; Mechanism; Heat; Bachelard; Episode; Didactic; Matter; Cigoli; Faraday; Article; Journal; Renaissance; Distortion; Language; Artificial; Darwin; PNLD.	2. Epistemological Elements and Didactic Concepts in Science
1,2,3	Education; Environmental; Society; Critical; Sexuality; Socio-environmental; Formative; Sexual Educational; Thematic; Citizen; Theme; Training; Project; Political; Participative; Quality; Formation; Initial; Area; Physical; Science; Teaching; Mathematics; Modern; Contemporary; Curricular; Philosophy; Astrobiology; Fiction; Learning; Student; Interaction; Process; Activity; Meaning; Participation; Knowledge; Enable; Knowing; Expose; Classroom; Practical; Experience.	3. Themes and Approaches in Science Teaching

Source: Prepared by the author (2024).

The analysis of the three discussion groups reveals a distinct set of aspects and issues, reflecting the diversity and complexity of the research conducted within the analyzed graduate programs. The first group is related to research methodologies, highlighting elements that suggest the development of data collection and analysis techniques, as well as aspects linked to predominant methodological approaches. The second group emphasizes key terms that suggest a connection to education and the production of educational materials, specific scientific concepts, and philosophers and epistemologists of science whose ideas are frequently discussed in the context of science education. Finally, the third group highlights issues related to the theory and practice of teaching, as well as contemporary themes and educational policies. Specific topics of interest within the field are addressed, such as environmental education, teacher training, and sociocultural aspects of science teaching.

METHODOLOGICAL INDICATIONS IN ABSTRACTS OF THESES AND DISSERTATIONS

The words identified in the discussion group "Methodological Indications in Abstracts of Theses and Dissertations" highlight the methodological approaches adopted in the analyzed research. Terms such as "Data," "Analysis," "Interview," "Questionnaire," and "Collection" suggest a diversity of research methods, encompassing both quantitative and qualitative approaches. The mention of "Paraná" and "Qualitative" indicates a particular focus on qualitative methods contextualized within the studied region. Additionally, the presence of terms such as "University," "Londrina," and "Maringá" points to a specific association with academic institutions and geographic contexts relevant to the research in question. The inclusion of words like "Course," "Teaching Degree," and "PIBID" underscores an interest in investigations related to teacher training and pedagogical practices. Finally, terms such as "Bardin," "Semi-structured," and "Transcription" suggest a special attention to methodological procedures and data analysis techniques commonly employed in qualitative researches.

Within this discussion group, the word "Data" stood out as the most relevant. Data are essential, representing the process through which information is collected to address research questions and objectives. A variety of techniques and instruments are employed to this end. To better understand the concept of "data," we investigated the origin of the word, derived from the Latin *datum*, meaning "gift," "offering," or "something acknowledged and used as a basis for calculations." Data constitute a widely understood phenomenon in which researchers are immersed (Sayão & Sales, 2019). Tools such as the abacus played a significant role in aiding data calculations and, along with the development of writing, greatly expanded human capacity to record experiences and events over time.

Analyzing the profiles contextualizing the word "data," we observed the use of various techniques for data collection. Among these techniques are surveys, interviews, field journals, observation, document analysis, textbook analysis, lesson plans, classroom observation, and participation in continuing education activities, among others. Particularly notable are the techniques of "Interviews" and "Questionnaires," due to their relevance in the research context. Interviews, in particular, are one of the primary strategies for obtaining data in different types of scientific research. In qualitative research, the most employed data collection

techniques include interviews, observations, journals, and document analysis. According to Lüdke and André (2018), several of these techniques can be combined, as in the case of interviews, questionnaires, and forms.

The prominence of "Interview" and "Questionnaire" as predominant data collection techniques reinforces this premise. According to Gil (2021), the interview is widely used in the social sciences, characterized as a form of social interaction aimed at obtaining relevant data for the investigation, in addition to being flexible in its development.

On the other hand, the questionnaire, also according to Gil (2021), is defined as an investigative technique that uses structured questions to gather information. In most research exploring phenomena related to social, technological, and human interaction, questionnaires play diverse and important roles, including orientation, theoretical grounding, and methodological criteria. The effectiveness of data collection, aligned with the researcher's objectives, often depends on the quality of the questionnaire designed (Coelho *et al.,* 2020).

Considering the various alternatives for data production and collection, the need for data processing and analysis becomes evident. In this context, examining the profiles associated with the word "Data" reveals an intrinsic relationship with the term "Analysis," which emerged with significant expressiveness and relevance. This relationship led us to investigate text patterns, identifying a considerable number of abstracts discussing the data analysis process. The "Analysis" approach is frequently associated with Content Analysis (CA), proposed by Bardin (2016), and Discursive Textual Analysis (DTA), as presented by Moraes and Galiazzi (2016). These methodologies stand out as indispensable tools for processing data in qualitative research.

In research, it is crucial to adequately handle the collected material. According to Merriam (1998), this process can be divided into phases of organization, classification, and the actual analysis. The author emphasizes that it is essential for researchers to have a clear worldview, which implies defining how the sample will be collected and analyzed, considering aspects of validity, reliability, and ethics. For Flick (2009), research demands scientific rigor to legitimize the generated data, highlighting that the processes of collection and analysis are recursive, dynamic, and intuitive. Regarding data analysis and interpretation, Gil (2021) notes that, although conceptually distinct, these processes are often interconnected. The analysis organizes and synthesizes data to answer the research problem, while interpretation seeks to attribute meaning to the answers.

In the contextualized analysis of words, Discursive Textual Analysis (DTA), proposed by Moraes and Galiazzi (2016), stands out as a methodology that aims to understand the discourses present in the collected data. This approach goes beyond explicit content, identifying underlying meanings and discursive structures within the material. Essential for qualitative research, DTA assists in textual analysis, transitioning from the empirical to theoretical abstraction through the researcher's interpretation. It values the research subjects and their modes of expression, recognizing the diversity of participants and their collective networks of meanings. Hermeneutic interpretation is central to this process, enabling the researcher to understand, describe, and interpret the studied phenomena. The

researcher's interpretations enrich the analysis, allowing for multiple approaches and perspectives.

Content Analysis (CA) also emerged as a widely used methodology in the examined research. This approach seeks to explore and understand the content expressed in the collected information, classifying the material into themes or categories to facilitate discourse interpretation. Applicable to various sources and types of data, CA allows for comprehensive and in-depth analysis. Depending on the theoretical perspective and the researcher's intent, CA may adopt concepts of statistical semantics or seek inferences to identify the objective characteristics of messages. Bardin (2016) highlights the importance of methodological rigor and overcoming uncertainties to achieve a profound understanding of the analyzed content.

In addition to these methodologies, the word "qualitative" emerged as one of the most significant, reflecting the predominance of this approach in the analyzed research. The uniqueness of a theme investigated by different researchers is a valuable resource, as individual perspectives and theoretical frameworks confer a unique identity and meaning to the study. Proximity to the research object and careful consideration of social and historical issues enable relevant academic contributions.

The expressive presence of the word "Paraná" reflects the location of the analyzed research programs, establishing the state as an important hub of academic production. This association reinforces specific methodological characteristics and highlights regional relevance. The concentration of studies in this area contributes to the coherence of the analyzed corpus, enriching the understanding of the investigated phenomena and promoting local scientific development.

Finally, the methodological analysis, the predominance of qualitative approaches, and the influence of the regional context demonstrate the importance and dynamism of this field of study. The interaction among researchers, the diversity of theoretical and methodological perspectives, and the commitment to advancing knowledge consolidate the academic sphere, reinforcing its relevance as an instrument for understanding and intervening in education.

EPISTEMOLOGICAL ELEMENTS AND DIDACTIC CONCEPTS IN SCIENCE

The discussion group emerged from the analysis of the profiles in Class 4 of representative words in the investigated *corpus*, as shown in Table 2. The identified words encompass themes, concepts, and theoretical frameworks that permeate the studies. Terms such as "Book," "Argument," "Historical," "Concept," "Energy," and "Image" suggest a diversity of aspects related to the teaching and learning process in Science. Furthermore, the presence of terms like "Epistemological," "Textbook," "Metaphor," and "Episode" reflects a particular interest in reflecting on theoretical and methodological foundations. References to authors such as Kuhn, Bachelard, and Darwin indicate a critical and contextualized approach, while terms like "HIV," "AIDS," and "PNLD" point to contemporary issues and policies related to Science education.

The term "book," associated with the textbook, highlights the relevance of academic and didactic literature as a source of knowledge. Studies that analyze and

evaluate textbooks contribute to a critical understanding of these materials, considering their quality, adequacy, and effectiveness. With the prevalence of the Textbook driven by the establishment of the National Textbook Program (PNLD), it is evident that the textbook assumes a key role as a predominant pedagogical resource in teaching practice. In this context, it is essential to promote investigations into Science textbooks, as they serve as intermediaries in the transmission of scientific knowledge. As highlighted by Borges *et al.* (2022), textbooks are commonly used in the school environment. Despite technological advancements, they remain a highly significant pedagogical tool both in the daily classroom routine and in research on teaching practices. This relevance endures due to the textbook's substantial representation as part of school material culture, which is intrinsically linked to the educational setting.

In this way, we understand that research on textbooks has been extensively conducted, as this term appears with significant quantitative presence and expressiveness. In Basic Education, the textbook is perceived as a key element for school identity, primarily employed through teacher mediation. Teachers, when reflecting on knowledge, consider both the content and the manner in which it is presented. Thus, teachers not only utilize textbooks but also demonstrate skill in combining their elements in different arrangements, contributing to achieving the desired outcome: the learning of specific topics in scientific, technological, and social fields (Borges *et al.,* 2022).

Given the importance attributed to textbooks, it becomes imperative to conduct studies dedicated to their analysis and improvement. A critical analysis of these materials can help identify gaps, biases, and possible distortions in the content conveyed. Furthermore, continuous research on these materials ensures they remain aligned with the latest scientific discoveries, thus maintaining their relevance and significance for student education. Terms like "article," "journal," and "PNLD" highlight the importance of scientific production and the selection of educational materials in both education and research on science teaching.

The terms "argument" and "concept" point to the importance of argumentation and the construction of solid concepts in the scientific learning process. In Science education, the search for new pathways to learning is reinforced by the significance of argumentation for the field’s development. The practice of argumentation in the classroom emerges as a crucial contemporary demand, faced by educators across various levels of education and fields of knowledge (Borges & Lima, 2022). Thus, this perspective should provide students with opportunities to understand and explore the discursive and argumentative dimensions of scientific concepts. In this sense, the word "concept" is prominent, as it is closely related to the didactics of science and the construction of scientific knowledge.

Scientific concepts are essential for understanding and organizing knowledge. The notable presence of concepts such as "energy," "force," "heat," and "matter" indicates fundamental principles in physics and chemistry, while "HIV" and "AIDS" suggest the inclusion of contemporary and interdisciplinary topics. These concepts are constructed and refined over time through investigations, observations, and experiments, which lead to new knowledge about specific phenomena. Therefore, the relationship between the term "concept" and the process of "argumentation" lies in the fact that scientific

concepts are fundamental to building scientific knowledge, while argumentation is essential for evaluating and articulating this knowledge, enabling its understanding and application across various scientific and social contexts.

These terms intersect with "history" and "historical," which refer to the historical contextualization of science, the historical bias of concepts, theories, and epistemologies, and their influence on teaching. Emphasis is placed on authors such as “Kuhn, Bachelard, Cigoli, Faraday, and Darwin,” who appear frequently and suggest an epistemological and historical approach to science. These elements highlight the paths taken and point to possibilities for new studies. They make a relevant contribution to research, ranging from the use of textbooks to the analysis of concepts and epistemic practices. By addressing specific issues such as the adequacy of educational materials used in the classroom, the contribution to consolidating the field in both its theoretical and practical aspects become evident.

TOPICS AND APPROACHES IN SCIENCE EDUCATION

The significant terms identified in discussion group 3 reflect the predominant approaches in research conducted within the analyzed postgraduate programs. Terms such as "Environmental Education," "Society," "Initial Training," "Science," "Teaching," "Learning," and "Student" indicate an interest in promoting a contextualized and relevant education that addresses contemporary demands. Additionally, the presence of terms like "Critical," "Participatory," "Political," and "Philosophy" highlights a reflective and critical approach to social, political, and epistemological issues. The inclusion of terms such as "Classroom," "Practical Activity," and "Experience" underscores the importance of practice and concrete experience in the teaching and learning process.

These focal points in the state of Paraná play a fundamental role in understanding and improving pedagogical practices, contributing to teacher education and the enhancement of science teaching. Furthermore, the environmental focus reflects a growing concern for the environment, as evidenced by representative terms such as "socioenvironmental" and "environmental education." Socioenvironmental research emphasizes the interaction between social and environmental dimensions, seeking integrated solutions to challenges faced by the environment and local communities.

Currently, Environmental Education (EE) has been the subject of various studies, resulting in increasing scientific output within educational institutions. These studies address a wide range of topics, such as conceptions, representations, and perceptions of environmental issues. They also include discussions about the relationships between Education, Environmental Education, and Society, as well as other issues related to educational contexts, both formal and non-formal, covering the foundations of Environmental Education (Silva & Rink, 2021). These investigations are important because they significantly contribute to the advancement of academic knowledge and the contextualization of environmental topics within school settings.

Research related to society and citizenship also plays a crucial role in understanding the social challenges experienced by involved stakeholders. Expressive terms like "Citizen" and "Society" emphasize the need to promote active participation of individuals in building a more just and inclusive society. This approach allows for the analysis of existing social and educational structures,

identifying inequalities and fostering actions to overcome them. Terms such as "Critical," "Participatory," and "Educational" reinforce the importance of practices that not only encourage reflection but also drive transformative actions, preparing citizens to actively contribute to the construction of a democratic society.

Research on sexuality and sexual education is essential for addressing topics related to diversity. Words like "Sexuality" and "Sexual" represent studies that contribute to understanding sexual health and gender issues. This subject, encompassing areas such as education, health, human rights, and public policies, demands ongoing discussions, as sexuality permeates various aspects of daily life.

TRENDS AND ASSUMPTIONS IN SCIENCE TEACHING IN THE STATE OF PARANÁ

The formative focus of research aims to provide meaningful and transformative learning opportunities for both students and teachers, promoting personal and professional development. This process directly impacts the initial teacher training, equipping educators with pedagogical skills and knowledge of best teaching practices. Through formative approaches, teachers are challenged to critically reflect on their educational practices while building a professional identity and fostering a commitment to continuous improvement in teaching.

The observed methodological indications reinforce a prevailing trend in education: the use of qualitative approaches and discourse analyses. These methodologies stand out for their ability to capture the complexity of educational phenomena and for valuing research participants within their social and historical contexts. Recent studies, such as those by Júnior and Batista (2023), highlight the relevance of these approaches in studying education and Science teaching, enabling in-depth and comprehensive analyses of the challenges and pedagogical practices in the field.

The analysis of central terms reveals an interconnection between Science teaching, epistemological reflection, and pedagogical practices. Terms such as "Textbook," "Argument," "Energy," and "Concept" underscore the importance of understanding Science teaching not merely as the transmission of content but as a space for constructing knowledge supported by theoretical approaches. It is essential to consider the diverse perspectives discussed in the literature, which lead to reflections on the teacher's role. This role goes beyond textbook use, as educators are capable of integrating various components of these materials into varied configurations, contributing to the learning of scientific, technological, and social content (Borges *et al.,* 2022).

Reflections on the functions of textbooks, as discussed by Borges, Pereira, and Moreira (2022), demonstrate that, while these materials are considered essential in teaching practice, their use has increasingly been integrated with other methodologies. This integration suggests a pursuit of more dynamic and interactive approaches that favor knowledge construction through argumentation. These studies reinforce the need to revisit the criteria for textbook development, aligning them not only with formal standards but also with the practical demands of the classroom. Thus, textbooks, when mediated by teachers, demonstrate their capacity to promote the learning of scientific, technological, and social topics. Moreover, our research emphasizes the importance of epistemology and the history of science as essential components for contextualizing and deepening knowledge in Science teaching.

There is a predominance of approaches that connect Science teaching to social and environmental issues, indicating that research conducted in the state of Paraná seeks to promote education that transcends theory. These pedagogical practices also consider the impact on social and ecological issues. Studies such as Mello's (2017) demonstrate that Environmental Education, when incorporated into the curriculum, enables students to critically reflect on contemporary challenges and the role of science in solving these problems. These elements contribute to the development of citizenship, encouraging students to consider their social and political responsibilities in the world.

In summary, research on Science teaching in the state of Paraná reveals significant trends influencing both teacher training and pedagogical practices. Furthermore, it highlights concerns with contemporary social and environmental issues, pointing toward a more dynamic, interactive, and contextualized approach to Science education.

CONCLUSIONS

The relevance of research in the field of Science teaching in Paraná is crucial to motivate and drive new investigations in the area. Highlighting the contributions of studies conducted in the state is essential to demonstrate the strengthening of research and to identify its distinctive characteristics. Furthermore, the analysis of methodological aspects allows for an understanding of how these studies have been conducted in historical, philosophical, and epistemological terms. It is observed that the investigations exhibit a "plural" configuration, encompassing various themes that reflect the complexity and diversity of the educational reality in a multifaceted approach.

Although there is significant circulation of studies, it is necessary to deepen knowledge about themes, gaps, evolutions, and trends present in the theses and dissertations of the analyzed programs. By analyzing what emerges, we can identify themes in which there is a greater concentration of interest, as well as those that have been less explored. This deeper understanding allows researchers and practitioners to identify gaps in knowledge and prioritize investigations in fields that require greater attention and investigation. Based on the information provided, it is clear that the IRAMUTEQ® software played a crucial role in conducting our research, enabling the exploration of the textual corpus, identifying patterns, paths and semantic relationships between the elements studied.

The results highlighted the interconnection of concepts such as "teacher," "teaching," "science," and "research," reinforcing the importance of integrating these elements into the educational context. Furthermore, the recurrence of terms like "analysis" and "research" indicates the consolidation of robust methodological approaches, evidencing a commitment to quality in data collection, interpretation, and application. These conclusions underline the relevance of an approach that values the intersection between teaching practice, research, and methodological analysis.

Finally, we conclude the research landscape emphasizes the role of textbooks, the promotion of epistemic reflections, and critical thinking about scientific and social concepts within the academic environment. The intersection between

argumentation, concept construction, and historical understanding of science reflects an interdisciplinary approach to Science teaching. Moreover, topics such as citizenship, environmental education, and teacher training emerge as central concerns, highlighting the impact of research on the personal and professional development of educators and the construction of a more just and sustainable society.

We understand that the gaps lie in the need for a deeper understanding of areas of lesser interest or those that were not significant in the IRAMUTEQ® analyses. It is important to emphasize that the absence of certain topics in the results does not mean that there is no research on these subjects, but rather that their representation is smaller compared to the more prominent topics identified by the software. We recognize that some specific areas require greater attention, such as the diversity of teaching methodologies that promote learning, including technological approaches and active teaching methodologies, as well as the promotion of inclusion and diversity, curriculum design, assessment, development and use of teaching resources, understanding the history of science, promotion of scientific literacy, science communication, methodological research issues, among other relevant topics.

It is worth highlighting that, although the research is plural and multifaceted within the studied programs, it is a construct in constant evolution and adaptation to the real needs of both the academic and school environments. Therefore, it is essential for researchers to remain attentive to emerging demands and in constant dialogue with educational practice to ensure that their investigations effectively contribute to the advancement and improvement of science education.

NOTES

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REFERENCES

Agostini, G., & Massi, L. (2023). A área 46 na Capes: origem, mudanças e consolidação como "ensino" no campo acadêmico-científico. *Investigações em Ensino de Ciências*, 28(2), 65-91. https://doi.org/10.22600/1518-8795.ienci2023v28n2p65

Bardin, L. (2016). *Análise de Conteúdo.* São Paulo: Edições 70.

Borges, L. L., Pereira, M. V., & Moreira, M. C. A. (2022). Qualidade e uso do livro didático de ciências na visão de professores da educação básica que cursam pós-graduação. *ACTIO, Docência em Ciências*, 7(1), 1-17.

Borges, T. D. B., & Lima, V. M. do R. (2022). Indicadores qualitativos da argumentação dialógica: Um olhar sobre a educação pela pesquisa no ensino de ciências. *ACTIO, Docência em Ciências*, 7(3), 1-29. https://doi.org/10.3895/actio.v7n3.14719

Catarino, G. F. de C., & Reis, J. C. de O. (2021). A pesquisa em ensino de ciências e a educação científica em tempos de pandemia: reflexões sobre natureza da ciência e interdisciplinaridade. *Ciência & Educação* (Bauru), 27, e21033. https://doi.org/10.1590/1516-731320210033

Coelho, J. A. P. M., Souza, G. H. S., & Albuquerque, J. (2020). Desenvolvimento de questionários e aplicação na pesquisa em Informática na Educação. In P. A. Jaques, S. Siqueira, I. Bittencourt, & M. Pimentel (Eds.), *Metodologia de Pesquisa Científica em Informática na Educação: Abordagem Quantitativa* (Série Metodologia de Pesquisa em Informática na Educação, Vol. 2). Sociedade Brasileira de Computação.

Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. (2002). *Infocapes.* Brasília, DF.

Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. (2009). *Documento de área: ensino de Ciências e Matemática* 2007/2009. Brasília, DF.

Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. (2010). *Relatório da avaliação trienal: ensino de Ciências e Matemática.* Brasília, DF.

Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. (2013). *Avaliação trienal 2013: documento de área* 2013. Brasília, DF.

Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. (2019). *Documento de Área*. Brasília, DF.

Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. (2023). *Relatório do Seminário de Meio Termo*. Brasília, DF.

Ferreira, N. S. A. (2002). As pesquisas denominadas 'Estado da Arte'. *Educação & Sociedade*, 23(79), 257-272. https://doi.org/10.1590/S0101-73302002000300013

Flick, U. (2009). *Desenho da pesquisa qualitativa.* Porto Alegre: Artmed.

Fonseca, J. J. S. da. (2002). *Metodologia da pesquisa científica.* Fortaleza: UEC.

Gil, A. C. (2021). *Como elaborar projetos de pesquisa* (6th ed.). São Paulo: Atlas.

Júnior, Carlos Alberto de Oliveira Magalhães; Batista, Michel Corci (Org.). *Metodologia da pesquisa em educação e ensino de ciências*. 2. ed. Ponta Grossa, PR: Atena, 2023.

Lavarda, P. B. P., & Silva, T. C. F. (2019). Um levantamento histórico das pesquisas sobre linguagem no ensino de ciências no Brasil. *ACTIO Docência em Ciências*, 4(1), 1-2. https://doi.org/10.3895/actio.v4n1.7707

Lüdke, M., & André, M. E. D. A. (2018). *Pesquisa em Educação: abordagens qualitativas*. Rio de Janeiro, RJ: E.P.U.

Mello, Lucelia Granja. A importância da Educação Ambiental no ambiente escolar. *EcoDebate.* 2017.

Merriam, S. B. (1998). Qualitative research and case study applications in education. São Francisco (CA): Jossey-Bass.

Moraes, R., & Galiazzi, M. do C. (2016). Análise textual discursiva. Ijuí: Editora Unijuí.

Nardi, R. (2022). A pesquisa em ensino de ciências e a sala de aula. *Experiências em Ensino de Ciências*, 17(1).

Sayão, L. F., & Sales, L. F. (2019). O fim da teoria: o confronto entre a pesquisa orientada por dados e a pesquisa orientada por hipóteses. *Liinc em Revista,* 15(1), 16-26. https://doi.org/10.18617/liinc.v15i1.4688

Silva, P. G. N. da, Ramon, R., Cappelin, A., Tieppo, S. M., Grave, F. M., & Krug, C. B. S. (2021). A utilização de softwares de análise de dados qualitativos: um mapeamento de teses em Educação Matemática. *Amazônia - Revista de Educação em Ciências e Matemática*, 17(38), 209-226. http://dx.doi.org/10.18542/amazrecm.v17i38.9619

Silva, D. S, & Rink J. (2021). Contextos educacionais e temas de estudos presentes em relatos de pesquisas em Educação Ambiental divulgados em periódicos nacionais. *Pesquisa em Educação Ambiental*, 16(2). https://doi.org/10.18675/2177-580X.2021-15078

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