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## Research on paleontology teaching: ascientometric analysis of Brazilian theses and dissertations

*Pesquisas sobre ensino de paleontologia: uma análise cientométrica das teses e dissertações brasileiras*

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**Abstract:** This study conducted a scientometric analysis of Brazilian theses and dissertations on paleontology teaching (2000–2024), using data from the BDTD and CAPES platforms. A predominance of master's dissertations (91.6%) and a concentration of studies focused on basic education (95.8%) were identified, with no research focused on higher education. A modest growth in scientific production was observed from 2018 onward, especially in the South (50.0%) and Southeast (20.8%) regions. Most works are linked to graduate programs in science education, with few specifically dedicated to paleontology teaching. There is a notable shortage of paleontologists involved in the development of innovative educational strategies. Furthermore, a lack of standardization in keyword selection was evidenced, along with a predominance of practice-oriented studies (66.7%) focused on pedagogical interventions, limited use of active learning methodologies, and reliance on traditional teaching approaches. The findings reveal structural and theoretical challenges that limit the advancement of paleontology teaching in Brazil.

**Keywords:** scientometrics, education in paleontology, science teaching, state of the art, state of knowledge.

**Resumo:** Esta pesquisa realizou uma análise cientométrica das teses e dissertações brasileiras sobre o ensino de paleontologia (2000–2024), com base nas plataformas BDTD e CAPES. Identificou-se o predomínio de dissertações (91,6%) e a concentração das produções na Educação Básica (95,8%), com ausência de estudos voltados à Educação Superior. Observou-se crescimento discreto das pesquisas a partir de 2018, com destaque para as regiões Sul (50,0%) e Sudeste (20,8%). A maioria dos trabalhos está vinculada a programas de pós-graduação em Educação em Ciências, com poucos voltados especificamente ao ensino de paleontologia. Notou-se escassez de paleontólogos atuando no desenvolvimento de estratégias educacionais inovadoras. Além disso, constatou-se falta de padronização das palavras-chave, predominância de estudos de natureza “prática”



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(66,7%) sobre intervenções pedagógicas, uso limitado de metodologias ativas e predomínio de abordagens pedagógicas tradicionais. Os resultados evidenciam desafios estruturais e teóricos que limitam o fortalecimento do ensino de paleontologia no Brasil.

**Palavras-chave:** cientometria, educação em paleontologia, ensino de ciências, estado da arte, estado do conhecimento.

## Introduction

Paleontology investigates the organisms that have inhabited the Earth throughout geological time, with fossils and their diverse applications as its main objects of analysis (Cassab, 2010). It is a science that integrates knowledge from the biological and geological fields to understand the origin, evolution, diversity, and extinction of living beings, as well as the environmental and climatic transformations that have shaped the planet.

In the educational context, the teaching of this discipline is highly relevant since, as a historical science, it promotes the production and dissemination of biogeoscientific knowledge of the history of life on Earth. Moreover, it provides a foundation for interpreting paleoenvironmental conditions and understanding changes in the Earth's surface, in the planet's developmental cycles, in the evolutionary trajectory of its inhabitants, and in the composition of current biodiversity (Cassab, 2010; Schwanke & Silva, 2010).

Despite its importance, there is confusion in science education literature regarding the terms “education in paleontology” and “paleontology teaching”, which are often used interchangeably although they have distinct meanings. *Education in paleontology* is an interdisciplinary area at the intersection between paleontology and education, dedicated to investigating teaching-learning processes and to the development of methods, resources, and pedagogical practices that promote the understanding and teaching of this science (Antonini et al., 2022; Novais et al., 2015)

This area investigates how paleontological knowledge can be shared, explored, and collaboratively constructed in different contexts—formal (schools, universities) and non-formal (museums, parks, and field activities)—fostering a broad and integrated understanding of the history of life on Earth. In Brazil, this field has gained visibility—especially since the 2000s—with the growth of initiatives involving schools, museums, educational projects, and science communication activities (Schwanke & Silva, 2010). An important milestone in this process was the publication of the e-book *Paleontology in the classroom* (Soares, 2015), which brought together

contributions from specialists and made didactic materials and activities available for basic education, thereby strengthening pedagogical practices.

In turn, *paleontology teaching* refers specifically to pedagogical practices aimed at mediating and fostering the construction of paleontological knowledge in diverse educational contexts—both formal and non-formal—and across different levels of education, from basic education to higher education (Antonini et al., 2022; Novais et al., 2015). This practice involves applying didactic-pedagogical methodologies and strategies for teaching paleontological concepts, hypotheses, and theories. However, its development has been hindered by the lack of a consolidated theoretical foundation originating from the field of education. Constructivist and socio-constructivist theories, such as those proposed by Piaget (1998) and Vygotsky (2007), as well as the contributions of Ausubel (1963) and Dewey (1959), are still scarcely incorporated into paleontology teaching. This gap limits the development of more robust, targeted pedagogical practices capable of enabling deeper, more meaningful learning.

Although national curriculum documents recommend its inclusion (Alves & Lippi, 2021; Borsonelli & Rodrigues, 2019), paleontology teaching still faces implementation challenges, especially due to a lack of connection with a well-defined theoretical framework to guide teachers (Martello, 2023). Without a consolidated educational theoretical reference, it becomes more difficult to develop coherent pedagogical practices, which can result in technical, fragmented, or unengaging instruction, thereby compromising its educational potential.

In higher education, paleontology teaching expands through scientific investigations and advanced research on paleontological topics (Schwanke & Silva, 2010). Graduate programs offer a favorable environment for the production of new knowledge and the development of innovative, rigorous methodologies capable of enhancing both educational processes and research itself.

As Schwanke and Silva (2010) highlight, museums and universities have been the main venues for the production and dissemination of paleontological knowledge. However, strengthening education in paleontology at the graduate level can not only expand the theoretical and methodological foundation of this science but also foster the training of professionals capable of addressing challenges related to its inclusion in educational curricula, thereby promoting a more effective integration between research and teaching.

In light of this scenario, it is essential to understand how paleontology teaching has been addressed in Brazilian academic research. Although there is a perception

that most studies focus on basic education, until now, there has been no comprehensive survey mapping and characterizing the *stricto sensu* productions on the subject. Therefore, the present study seeks to fill this gap by investigating theses and dissertations produced between 2000 and 2024, identifying the educational contexts addressed, the authors' intentions, the methodologies employed, and the existing gaps—including the scarcity of research focused on higher education—thus contributing to a broad and well-founded view of the current landscape of the field.

The research question guiding this study is: How has paleontology teaching been addressed in Brazilian theses and dissertations produced between 2000 and 2024? To answer this question, the present study aims to carry out a scientometric analysis of Brazilian theses and dissertations on paleontology teaching, produced between 2000 and 2024, to map the topics addressed, identifying trends and gaps—such as the absence of studies focused on higher education—and understanding the evolution of knowledge in the field.

## **Materials and Methods**

### **Study Characterization**

The research presented in this study is quantitative in nature, employing statistical methods and techniques for data measurement and analysis (Rodrigues et al., 2021). Scientometrics was adopted as a quantitative analysis tool, with data processed through descriptive statistics, enabling inferences from simple representations (Barros & Langhi, 2023). It is worth emphasizing that scientometric studies go beyond mere statistical description of science, offering a broad approach in which information is compared, analyzed, and interpreted (Kundlatsch et al., 2019). These studies are used to identify patterns in scientific activity from academic production, encompassing journals, articles, and *stricto sensu* productions (Codato et al., 2020; Moraes & Giroldo, 2014), as well as the circulation and consumption of scientific production.

Therefore, this methodology aimed to map and synthesize secondary data related to academic productions on paleontology teaching presented in theses and dissertations developed in graduate programs (GP) in Brazil. Hohemberger (2018) highlights that this type of mapping is relevant to the field of education in paleontology, as this grouping of works allows for identifying and making inferences about contributions to teaching at different educational levels. Thus, we

understand that studies with this focus (Hohemberger et al., 2018, 2019, 2023) are fundamental for a broader understanding of the current situation regarding the research subject.

### **Initial Selection Criteria**

The research on *stricto sensu* scientific production was conducted in December 2024, based on a comprehensive investigation across the following data platforms: the Brazilian Digital Library of Theses and Dissertations (BDTD) and the Theses and Dissertations Catalog (CAPES). These platforms were selected because they offer distinct, complementary datasets aligned with the objectives of this study.

The inclusion criteria for data collection were as follows:

- a) Period: Selected studies were published between the years 2000 and 2024;
- b) Keywords related to the central theme of the investigation, specifically “paleontology teaching.” This temporal scope was chosen because it reflects the paradigmatic shift that occurred during the transition to the new millennium, marked by the promotion and encouragement of the Brazilian Paleontology Society (BPS) for the publication of works in official outlets related to paleontology teaching and the preservation of collections (Paleodest, 2002a, 2024). This period also encompasses calls for projects aimed at initiatives promoting education in paleontology to various segments of civil society (Paleodest, 2002b).

Furthermore, the adoption of this temporal framework is aligned with the study by Wendt (2024), who proposes a diachronic analysis divided into three historical periods to understand the development of paleontology in Brazil: Period I (1940–1969), Period II (1970–1999), and Period III (2000–2024). Period III marks a moment of greater expansion compared to the previous periods, as well as significant diversification in Brazilian paleontology and its associated studies (Hohemberger et al., 2023; Wendt, 2024).

Specifically regarding Period III, the choice is also justified by the expansion phase of the postgraduate system in Brazil. In 2000, the total number of postgraduate degree holders was 11,669 (among master’s and professional master’s) and 8,801 (doctoral studies). By 2023, these figures had risen to 47,188 (among master’s and professional master’s) and 52,895 (doctoral studies) (CAPES, 2024). This growth reflects a significant increase in the number of postgraduate graduates in recent decades, who are qualified to contribute to various fields of Brazilian research.

## **Data Collection Protocol**

Initially, in the CAPES Catalog, the descriptors “paleontology” and “teaching” were entered into the search field. In this study, “keywords,” “terms,” and “descriptors” are used interchangeably as synonyms. To retrieve works containing both words simultaneously, the logical operator “AND” was applied between them. It was not necessary to limit the search period (2000–2024), as all retrieved works were produced after the turn of the millennium, totaling 34 dissertations and five theses.

The search on the BDTD platform was conducted using the advanced search option. In the search fields, the descriptors were organized as follows: “paleontology” in the first line and “teaching” in the second line, both with the research delimitation set to “subject,” since the platform’s search refinement options were non-functional (Hohemberger et al., 2023). The period considered was 2000–2024. In the search matching field, the option “all terms” was selected in order to increase search sensitivity and retrieve documents containing both words.

For comparative purposes, the previously described strategies were employed by combining the descriptors “paleontology” and “higher education” and/or “paleontology” and “higher education”. No works were found in the CAPES Catalog for either combination of descriptors. Likewise, no records were found for these combinations in the BDTD. It became evident that the strategy using these descriptors was ineffective, as no results were obtained.

## **Study Selection**

After the search on both platforms, a total of 49 national works were identified: six theses and 43 dissertations. Of these, ten productions were found to be duplicates across both databases and were therefore excluded. Thus, 39 valid studies remained. The research then proceeded to the next stage, consisting of a selection based on previously defined conceptual criteria. It is worth noting that in the Brazilian academic context, the term “dissertation” refers to the work required for a master’s degree, whereas “thesis” refers to the work required for a doctoral degree, which contrasts with usage in the United States.

The selection of studies took place in two stages: 1) an initial screening of metadata based on reading the “titles” and “abstracts” of theses and dissertations to

identify relevant studies; 2) application of exclusion criteria, discarding works whose central focus was not the “paleontology teaching”. When the metadata was insufficient for a clear decision, the full texts were read to confirm or deny inclusion.

For example, publications addressing broader or tangential geoscientific issues were excluded, such as the relationship between society and environmental education, heritage education (geological, geomorphological, and cultural heritage), education in science museums, evolution, ecology, wildfires, water resources, the history of geosciences, astronomy, archaeology, ancient history, the curation of black memories, and statistics, as well as pure research on paleofaunas and paleoenvironmental studies.

The filtering revealed that another 16 productions did not meet the study’s objective, meaning they did not specifically address paleontology teaching. Thus, the final corpus for analysis consisted of 24 works, whose data are organized in Table 1.

**Table 1**

*Research corpus composed of dissertations and theses on paleontology teaching, found in the databases during the period 2000 to 2024 (n=24). Search conducted on December 31, 2024.*

Year	Title	Education alContext	TypeofAca demicWor k	Graduate Program (GP)	Evaluati onArea (CAPE S)	Author	Reposit ory Link
2008	Heritage education of the paleontological sites of the Santa Maria formation - RS: memories of the city study involving elementary school students	Basic Education	Master’s Dissertation	GP in Education (UFSM)	Education	José Alberto da Silva Martins	<a href="https://repositorio.ufsm.br/handle/1/6821">https://repositorio.ufsm.br/handle/1/6821</a>
2008	Paleontology and geography: A theoretical and methodological approach based on the paleontological sites located in the urban area of Ponta Grossa – PR	Basic Education	Master’s Dissertation	GP in Territory Management: Society and Nature (UEPG)	Geography	Suzana de Fátima Camargo Ferreira da Cruz	<a href="https://tede2.uuepg.br/jsui/handle/prefix/505">https://tede2.uuepg.br/jsui/handle/prefix/505</a>

2011	Paleontology as a tool for environmental education in a high school in the municipality of João Pessoa – PB	Basic Education	Master's Dissertation	GP in Development and Environment (UFPB)	Environmental Sciences	Marcio Luiz Freire de Albuquerque	<a href="https://sigaa.ufpb.br/sigaa/public/programa/defesas.jsf?lc=pt_BR&amp;id=1878">https://sigaa.ufpb.br/sigaa/public/programa/defesas.jsf?lc=pt_BR&amp;id=1878</a>
2014	Paleontology and palynology in teacher education: Perspectives and strategies for teaching science and biology in basic education	Basic Education	Master's Dissertation	GP in Science and Mathematics Teaching (ULBRA)	Teaching	Suelen Bomfim Nobre	<a href="http://www.ppgecim.ulbra.br/teses/index.php/ppgecim/article/view/201">http://www.ppgecim.ulbra.br/teses/index.php/ppgecim/article/view/201</a>
2017	Learning science in elementary education from the perspective of complexity theory: In(ter)ventions on a journey through the Paleolithic period	Basic Education	Master's Dissertation	Professional Master's Graduate Program (PMGP) in Science Teaching (UNIPAMPA)	Teaching	Graciela Marques Suterio	<a href="https://dspace.unipampa.edu.br/handle/riui/2980">https://dspace.unipampa.edu.br/handle/riui/2980</a>
2018	Patrimonial education in paleontology in the central region of RS: Building a booklet for high school students	Educação Básica	Master's Dissertation	GP in Cultural Heritage (UFSM)	Interdisciplinary	Cleusa Maria Pasetto Stochero	<a href="https://repositorio.ufsm.br/handle/1/16623">https://repositorio.ufsm.br/handle/1/16623</a>
2018	The use of fossils as a reference for the approach of paleontology in science teaching	Basic Education	Master's Dissertation	GP in Science Education: Chemistry of Life and Health (UFSM)	Teaching	Rômulo Hohemberger	<a href="https://repositorio.ufsm.br/handle/1/16091">https://repositorio.ufsm.br/handle/1/16091</a>
2019	Paleontology as a teaching tool for high school students	Basic Education	Master's Dissertation	PMGP in Biology Teaching in the National Network (PROFBO/UFPB)	Sciences and Humanities for Basic Education	Marlon William Nizer	<a href="https://acervodigital.ufpb.br/handle/1884/64194">https://acervodigital.ufpb.br/handle/1884/64194</a>
2019	Paleontological and geological workshops: A teaching tool for elementary education	Basic Education	Master's Dissertation	PMGP in Science Teaching (UEG)	Teaching	Rosely Vaz Bernardes Silva	<a href="https://www.bdtd.ueg.br/handle/tede/140">https://www.bdtd.ueg.br/handle/tede/140</a>

2020	Paleontology in science education: A proposal for continuing education for teachers	Basic Education	Master's Dissertation	GP in Teaching and Formative Processes (UNESP)	Teaching	William Franklin Sampaio	<a href="https://repositorio.unesp.br/items/f4e49a52-9d57-43d5-bb72-b572d90abc58">https://repositorio.unesp.br/items/f4e49a52-9d57-43d5-bb72-b572d90abc58</a>
2020	Learning with the dinosaurs: analysis of the exhibition "Dinosaurs (?) in IG"	Basic Education	Master's Dissertation	GP in Teaching and History of Earth Sciences (UNICAMP)	Teaching	Rafael Araújo Ribeiro	<a href="https://repositorio.unicamp.br/Arquivo/Detail/1129435">https://repositorio.unicamp.br/Arquivo/Detail/1129435</a>
2020	Contributions of geoscience education to the geoconservation of the Araripe Geopark: An approach using the paleobotanical record via educational games	Basic Education	Master's Dissertation	GP in Teaching and History of Earth Sciences (UNICAMP)	Teaching	Luis Henrique Marins Nogueira Nunes	<a href="https://repositorio.unicamp.br/Arquivo/Detail/1157205">https://repositorio.unicamp.br/Arquivo/Detail/1157205</a>
2020	Geology and paleontology guidebook for biology field classes in the Apodi-RN region	Basic Education	Master's Dissertation	PMGP in Biology Teaching in the National Network (PROFBI O/UERN)	Sciences and Humanities for Basic Education	Annabelle Mayara Soares Alvarez	<a href="https://sigaa.uern.br/sigaa/public/programa/section/extra.jsf?lc=pt_BR&amp;id=1057&amp;extra=5736152">https://sigaa.uern.br/sigaa/public/programa/section/extra.jsf?lc=pt_BR&amp;id=1057&amp;extra=5736152</a>
2020	Geosciences in early childhood education: Developing teaching material	Early childhood education	Master's Dissertation	GP in Teaching and History of Earth Sciences (UNICAMP)	Teaching	Beatriz Beloto Jose do Nascimento	<a href="https://repositorio.unicamp.br/Arquivo/Detail/1161643">https://repositorio.unicamp.br/Arquivo/Detail/1161643</a>
2020	Challenges and opportunities of paleontology in basic education: A proposal for a paradidactic book for the teacher	Basic Education	Master's Dissertation	PMGP in Science Teaching (UEG)	Teaching	Malena Marília Martins Gatinho	<a href="https://www.bdtd.ueg.br/handle/tede/797">https://www.bdtd.ueg.br/handle/tede/797</a>

2022	Continuing education for science teachers during the COVID-19 pandemic: Investigations through a paleontology teaching workshop	Basic Education	Master's Dissertation	GP in Science Education: Chemistry of Life and Health (UFRGS)	Teaching	Gabriel Dipicoli Brasil	<a href="https://lume.ufrgs.br/handle/10183/247054">https://lume.ufrgs.br/handle/10183/247054</a>
2022	Paleontology in science education based on curriculum documents and textbooks	Basic Education	Master's Dissertation	GP in Science Teaching (UFFS)	Teaching	Carolina Farias da Costa	<a href="https://repositorio.ufes.br/handle/prefix/6471">https://repositorio.ufes.br/handle/prefix/6471</a>
2022	Investigative teaching in paleontology: The use of educational materials in the construction of scientific knowledge	Basic Education	Master's Dissertation	PMGP in Science and Mathematics Teaching (UERR)	Teaching	Joicy Compagnon Mariano	<a href="https://producoes.uerr.edu.br/en-sino-investigativo-em-paleontologia-o-uso-de-materiais-didaticos-na-construcao-do-conhecimento-cientifico/">https://producoes.uerr.edu.br/en-sino-investigativo-em-paleontologia-o-uso-de-materiais-didaticos-na-construcao-do-conhecimento-cientifico/</a>
2023	Paleontology and the classroom: The local context as a link in teacher training	Basic Education	Doctoral Thesis	GP in Science Education: Chemistry of Life and Health (UFES)	Teaching	Rômulo Hohemberger	<a href="https://repositorio.ufes.br/handle/10183/247054">https://repositorio.ufes.br/handle/10183/247054</a>
2023	Paleonapp: An educational application aimed at teaching and learning paleontology in high school	Basic Education	Master's Dissertation	PMGP in Science and Mathematics Teaching (UFC)	Teaching	Weleson Portela de Aguiar	<a href="https://repositorio.ufc.br/handle/riufc/75883">https://repositorio.ufc.br/handle/riufc/75883</a>

2023	Modeling the length of the <i>Pycnonemosaurus nevesi</i> from the Tibia: A proposal for teaching mathematics	Basic Education	Master's Dissertation	GP in Teaching of Natural Sciences and Mathematics (UFMT)	Teaching	Patrick Godoi	<a href="https://sucupira-legado.capes.gov.br/sucupira/public/consultas/coleta/trabalhoConclusao/viewTrabalhoConclusao.jsf?popup=true&amp;id_trabalho=14371830">https://sucupira-legado.capes.gov.br/sucupira/public/consultas/coleta/trabalhoConclusao/viewTrabalhoConclusao.jsf?popup=true&amp;id_trabalho=14371830</a>
2023	The importance of fossils for teaching evolution: A proposal of a didactic sequence promoting knowledge of the Brazilian paleofauna	Basic Education	Master's Dissertation	PMGP in Biology Teaching in the National Network (PROFBI O/UFMG)	Sciences and Humanities for Basic Education	Júlio Antônio Alvarenga Santos	<a href="https://repositorio.ufmg.br/handle/1843/77741">https://repositorio.ufmg.br/handle/1843/77741</a>
2024	Paleontology in science education: An investigation of teachers and students at a public school in Uruguaiana, RS	Basic Education	Master's Dissertation	GP in Science Education: Chemistry of Life and Health (UFSM)	Teaching	Bruno Peruzzi Peres	<a href="https://sucupira-legado.capes.gov.br/sucupira/public/consultas/coleta/trabalhoConclusao/viewTrabalhoConclusao.jsf?popup=true&amp;id_trabalho=15220197">https://sucupira-legado.capes.gov.br/sucupira/public/consultas/coleta/trabalhoConclusao/viewTrabalhoConclusao.jsf?popup=true&amp;id_trabalho=15220197</a>
2024	Paleontology teaching: Strategies for scientific literacy in the early years	Basic Education	Doctoral Thesis	GP in Science Education: Chemistry of Life and Health (UFSM)	Teaching	Ruben Alexandre Boelter	<a href="https://repositorio.ufsm.br/handle/1/32998">https://repositorio.ufsm.br/handle/1/32998</a>

## Identification, Organization, and Visualization of Keywords

Data collection was carried out by identifying and extracting the keywords (in Portuguese) directly from the PDF files of each selected academic production. Subsequently, a simple count of the occurrence of these terms was performed. The data were organized in a spreadsheet in Microsoft Excel, resulting in a simple table listing the descriptors and their respective frequencies.

For content analysis, the Word Cloud (WC) graphical method was employed, generated using the online platform Word Art® (<https://wordart.com/>). This technique has recently been adopted in paleontology education studies (Hohemberger et al., 2019, 2021) as an effective tool for textual analysis, as it enables the intuitive interconnection and visual representation of a set of terms.

The WC provides a visual representation of the frequency of extracted terms, highlighting the most recurrent and relevant ones in the analyzed data (Santana & Salcedo, 2022). Through this approach, an image is generated that reflects the repetition and importance of concepts present in the texts, enabling the reader to quickly identify the central themes without reading the entire documents (Kalmukov, 2021; Silva et al., 2021). The visualization of WC facilitates the understanding and communication of results, aiding in the interpretation of the academic production investigated in this study (Figure 6).

## Characterization of the Objectives of Academic Productions

In this study, one of the analyzed aspects was the nature of the objectives of the academic productions on paleontology teaching, with the purpose of identifying whether each work would be classified as “theoretical” or “practical.” For this classification, the proposals by Hohemberger (2019) and Hohemberger et al. (2023) was followed, which clearly defines these categories in the context of research on paleontology teaching.

Works classified as *theoretical* are those that do not involve direct pedagogical intervention. They include studies based on data surveys and analysis, creation of didactic and supplementary materials, and evaluation and analysis of textbooks and curriculum documents, without the application of methods or activities in the classroom (Hohemberger, 2019; Hohemberger et al., 2023).

On the other hand, works classified as *practical* involve effective pedagogical interventions carried out in educational settings where active interactions between

teachers and students take place. This group includes actions such as lectures, the implementation of active methodologies and innovative techniques, the use of educational games, didactic workshops, field trips, and museum visits aimed at fostering problematization of the educational reality (Hohemberger, 2019; Hohemberger et al., 2023).

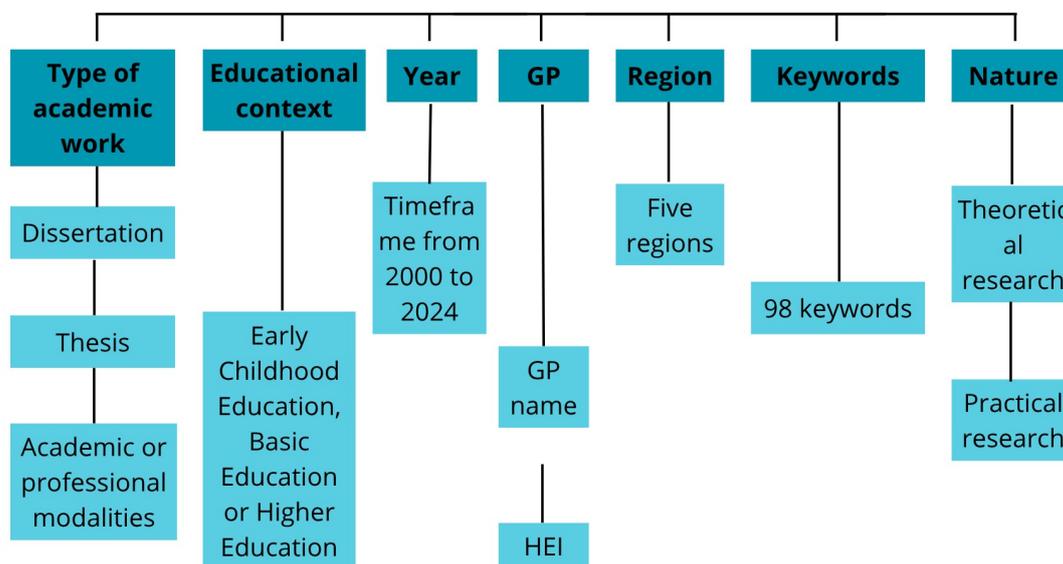
The categorization of the works according to these criteria enabled a detailed analysis of the predominance of the approaches adopted in the literature, as presented in Table 2 of this study.

## Overall Data Organization and Analysis

For the general analysis of the data collected from the academic productions, an analytical matrix (Figure 1) was used, adapted from Coutinho et al. (2012). The scientometric indicators included in the matrix were compiled in a Microsoft® Excel spreadsheet.

**Figure 1**

*Analytical Matrix of the Research*



Abbreviations: GP, graduate program; HEI, higher education institution.

## Results and Discussion

The scientometric analysis was structured in two stages. The first presents a quantitative characterization of the *stricto sensu* academic productions, addressing

aspects such as the number of studies, educational context, year of defense, graduate programs, and institutional origin (geographic regions). The second stage focuses on the conceptual characterization of the research, analyzing its objectives and conclusions.

### **Quantitative Characterization of the Productions**

The survey conducted indicated that 24 works were published between 2000 and 2024, of which two are doctoral theses (8.3%) and 22 are master's dissertations (91.6%). Among the dissertations, 16 (66.7%) belong to the academic modality and eight (33.3%) to the professional modality. This number highlights the need for expanded research, as the scarcity of dissertations—and especially of doctoral theses—on the subject has significant implications, potentially compromising the development of the field of education in paleontology.

Although it is a relatively young field of knowledge (Costa & Scheid, 2024), the lack of postgraduate research on paleontology teaching is concerning. This suggests a low valuation or recognition of education in paleontology as an autonomous area at the interface between education and paleontology, which may delay the advancement of pedagogical and didactic knowledge in this area.

The limited academic production compromises field validation and strengthening, as fewer studies result in less theoretical, methodological, and practical development. Furthermore, the lack of representativeness of these studies within the general scientific knowledge produced in the country, along with the low appreciation of the knowledge generated by this research field, leads to discouragement and further restricts the formation of a significant number of specialized researchers (Alves et al., 2023). This negatively impacts the development of new pedagogical strategies and resources for teaching the discipline and slows progress in expanding job market opportunities in the country.

The low number of *stricto sensu* publications in the area of education in paleontology can be explained by several factors, as noted by Hohemberger et al. (2023). Among these are the high level of complexity involved in earning advanced degrees, the reduced number of professionals working in this field, and the limited number of researchers trained in this research area. Additionally, the time required to conduct high-quality scientific research also contributes to this limitation.

Another relevant factor is that most paleontology graduate programs (PPGs) lack specific research lines focused on teaching (Hohemberger et al., 2023),

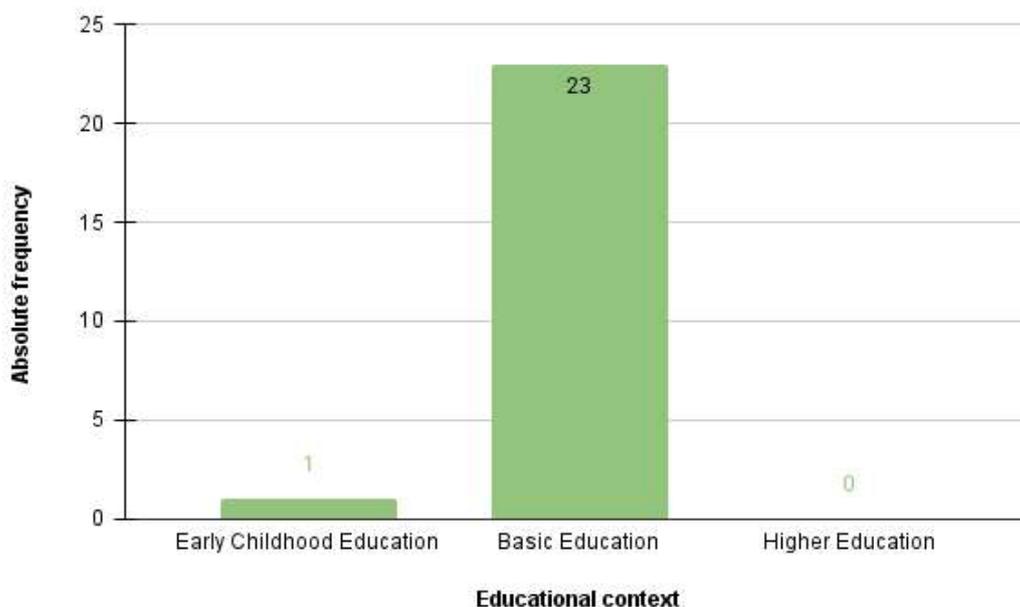
leading many studies to be disseminated as results of academic works or extension projects, further restricting the quantity of research in the field.

On the other hand, it is important to consider that the study by Hohemberger et al. (2023) identified some works in a similar time frame (2005–2020) that did not appear in the results of this research, possibly due to different filtering strategies. Similarly, some works in our research were not identified in the aforementioned study, which demonstrates that the records obtained in both studies cannot be considered fully representative of all *stricto sensu* productions and should be viewed only as approximations of reality.

Regarding the Brazilian educational context, we observed that the vast majority (95.8%) of the productions focus on basic education (Figure 2), distributed among elementary school (41.7%), high school (33.3%), and both stages of basic education (20.8%).

**Figure 2**

*Distribution of stricto sensu scientific production on education in paleontology by educational context (n=24), 2000–2024.*



The lack of research on paleontology teaching in Brazilian higher education is a significant challenge to the development of the field. Without studies investigating the best pedagogical practices for the learning of paleontological content, there is a shortage of evidence on effective methodologies and the specific needs of undergraduate students. This is particularly concerning given that paleontology is part of the curriculum in various undergraduate programs, such as Geography,

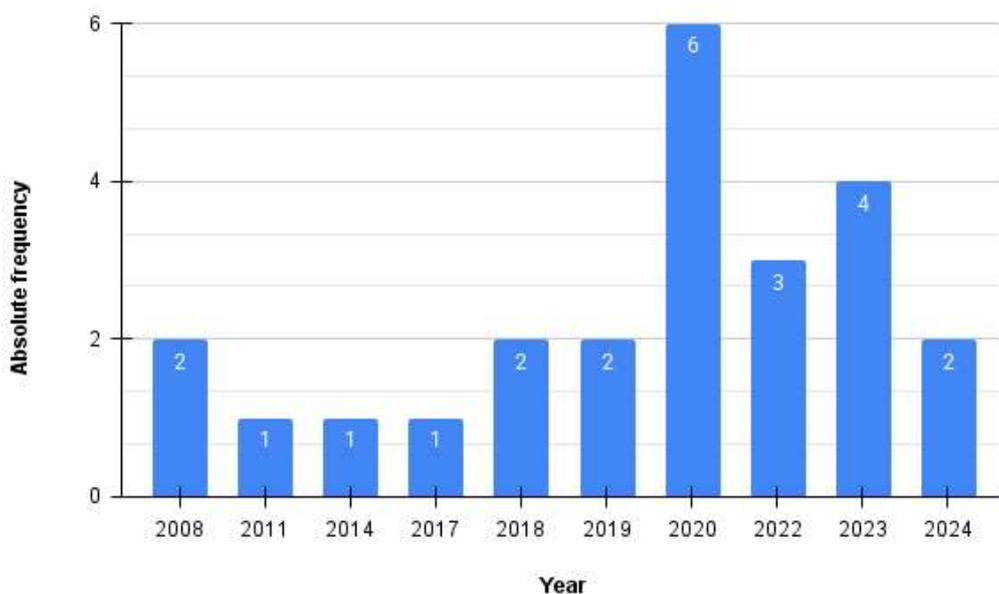
Geology, and Biological Sciences—offered in both licentiate (teaching) and bachelor's degrees modalities (Alves et al., 2023).

These programs train prospective teachers and researchers who are responsible for mediating and fostering the construction of geoscientific knowledge, and the absence of research focused on education in paleontology for this audience compromises the development of appropriate pedagogical strategies, thereby hindering the optimal training of these professionals and the social reach of paleontology (Alves et al., 2023). Thus, the low academic production in this area not only limits the advancement of paleontology teaching in Brazil but also undermines the quality of the training of those who will teach it.

Regarding the temporal distribution of theses and dissertations, a modest growth in the field is observed, especially from the early 2020s onward (Figure 3).

**Figure 3**

*Distribution of stricto sensu scientific production on education in paleontology by year of publication (n=24), 2000–2024.*



Our temporal scope (2000–2024) shows that the first Brazilian master's dissertation was deposited in the national databases in 2008. From that point onward, an interval of three years occurred between each subsequent dissertation. However, starting in 2018, this interval began to decrease, leading to an increase in stricto sensu research focused on paleontology teaching.

The gaps in academic production on paleontology teaching in the early years can be attributed to insufficient funding and the limited number of specialized researchers in the field (Hohemberger et al., 2023). The absence of significant

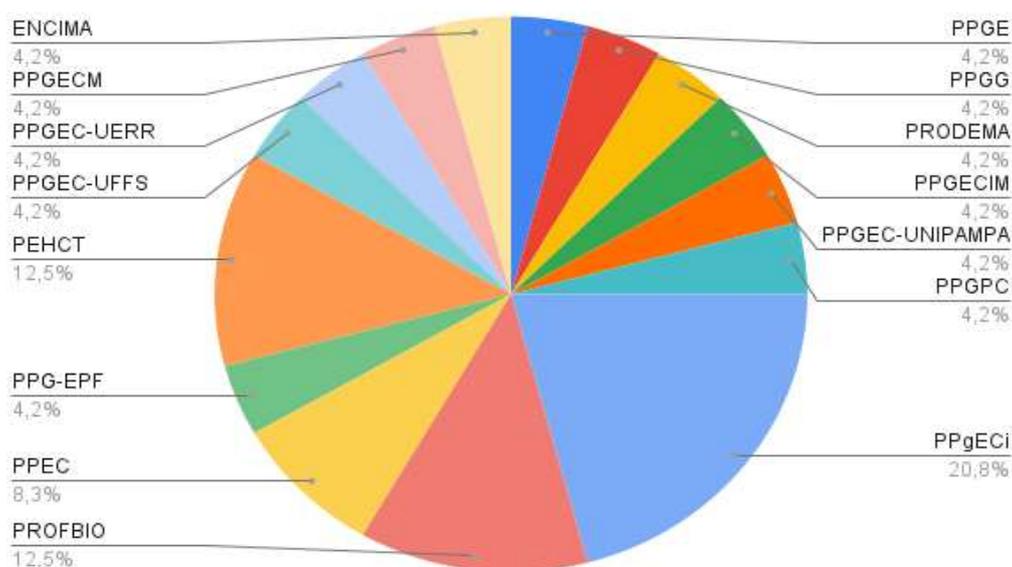
investment limits dedication to research and leads to sporadic activities that do not consolidate into robust academic productions, such as dissertations and theses.

Moreover, the lack of an established research culture in the field may lead researchers to prioritize other topics, neglecting the pedagogical issues involved in paleontological science. Additionally, the gaps in academic production on paleontology teaching may be related to the “possibility of non-inclusion of theses and dissertations in databases due to system inconsistencies” (Hohemberger et al., 2023, p. 159). The production consistency from 2018 onward may be linked to growing interest among researchers, frequent fossil discoveries, and increased media coverage of the area (Hohemberger et al., 2023).

Regarding graduate programs, a nationally observed phenomenon is the absence of specific research lines focused on teaching within paleontology graduate programs (PPGs) (Hohemberger et al., 2023). Consequently, the responsibility of training professionals specifically qualified to act in paleontology teaching falls on programs with a more general concentration, such as those in science education or those more focused on science teaching (Figure 4).

**Figure 4**

*Distribution of stricto sensu scientific production on education in paleontology by graduate program (n=24), 2000–2024.*



Abbreviations: PPG, Graduate Program; PPGE, Graduate Program in Education (UFSM); PPGG, Graduate Program in Territorial Management: Society and Nature (UEPG); PRODEMA, Graduate Program in Development and Environment (UFPB); PPGECIM, Graduate Program in Science and Mathematics Teaching (ULBRA); PPGEC-UNIPAMPA, Professional Master’s Program in Science Teaching (UNIPAMPA); PPGPC, Graduate Program in Cultural Heritage (UFSM); PPgECi, Graduate Program in Science Education: Chemistry of Life and Health (UFSM/UFRGS/UNIPAMPA); PROFBIO, National Network

Professional Master's Program in Biology Teaching; PPEC, Professional Master's Program in Science Teaching (UEG); PPG-EPF, Graduate Program in Teaching and Educational Processes (UNESP); PEHCT, Graduate Program in Teaching and History of Earth Sciences (UNICAMP); PPGEU-UFFS, Graduate Program in Science Teaching (UFFS); PPGEU-UERR, Professional Master's Program in Science and Mathematics Teaching (UERR); PPGEUM, Graduate Program in Natural Sciences and Mathematics Teaching (UFMT); ENCIMA, Professional Master's Program in Science and Mathematics Teaching (UFC).

Figure 4 reveals that, within the analyzed temporal scope, the majority of *stricto sensu* degrees related to paleontology teaching, according to records, originate from the Graduate Program in Science Education: Chemistry of Life and Health (PPgECi) (20.8%). This is followed by the Graduate Program in Teaching and History of Earth Sciences (PEHCT) at UNICAMP (12.5%) and the Professional Master's Degree in Biology Teaching in a National Network (PROFBIO) (12.5%)—a nationwide interinstitutional program.

The PPgECi, established in 2004, currently offers master's and doctoral degrees. It is a regional interinstitutional initiative operating through a broad association among three federal universities in Rio Grande do Sul: Federal University of Santa Maria (UFSM), Federal University of Rio Grande do Sul (UFRGS), and Federal University of Pampa (UNIPAMPA) (UFRGS, 2025). Affiliated with CAPES' Area 46—Science and Mathematics Teaching, the program seeks to integrate various theoretical and practical perspectives on science teaching and teacher education. Its research lines encompass: 1) Teaching and learning processes in formal and non-formal environments; 2) Analysis and evaluation of scientific production and public policies in Science, Technology, and Innovation (ST&I) and science dissemination; 3) Implications of scientific practices on the constitution of subjects and curricula; and 4) Scientific, technological, and social perspectives in the science education process.

Regarding PEHCT, founded in 2004, the program offers master's and doctoral courses and is associated with the Institute of Geosciences (IG) at UNICAMP (Carneiro et al., 2020; Chaves et al., 2014). As a pioneer in the field of geoscience education in Brazil, linked to the area of science and mathematics teaching of CAPES (Area 46 - Teaching), it is the only graduate program in the country specialized in connecting the areas of geosciences and teaching. It encompasses three research lines covering studies at different educational levels: 1) History and Philosophy of Natural Sciences; 2) Education, Teacher Training, Educational Technology, and Communication in Natural Sciences; and 3) Geoethics, Geoconservation/Geoheritage, Citizenship, and Environmental Legislation.

The Professional Master's Degree in Biology Teaching in a National Network (PROFBIO), established in 2016, is a national interinstitutional graduate program that

brings together 18 public higher education institutions (federal and state) (PROFBIO, 2019). PROFBIO offers semi-presential *stricto sensu* training for biology teachers working in basic education. Linked to the area of science and mathematics teaching of CAPES (Area 46 - Teaching), PROFBIO aims to promote educators' professional qualification by articulating academic knowledge with teaching practices. With centers distributed across various Brazilian institutions, the program comprises three research lines: 1) Communication, Teaching, and Learning in Biology; 2) Organization and Functioning of Organisms; and 3) Origin of Life, Evolution, Ecology, and Biodiversity, contributing to the improvement of biology teaching and learning in basic education throughout the country.

Furthermore, according to the analysis of advisors associated with the *stricto sensu* productions, the PEHCT includes two paleontologists—Carolina Zabini and Fresia Soledad Ricardi Torres Branco—who are affiliated with the program and have been conducting research in the field of education in paleontology. Following PEHCT, other programs that also have one paleontologist on their faculty include the Graduate Program in Cultural Heritage (PPGPC) at UFSM, the Graduate Program in Science Teaching (PPGEC) at UERR, the PROFBIO program at UERN, and the Professional Master's Program in Science Teaching (PPEC) at UEG, with Átila Augusto Stock Da-Rosa, Juliane Marques de Souza, Kleberson de Oliveira Porpino, and Pedro Oliveira Paulo, respectively. Until a few years ago, the PPgECi at UFSM also included paleontologist Cibele Schwanke (*in memoriam*) on its faculty. She was, in fact, one of the pioneers actively engaged in research and academic advising in the field of education in paleontology in Brazil.

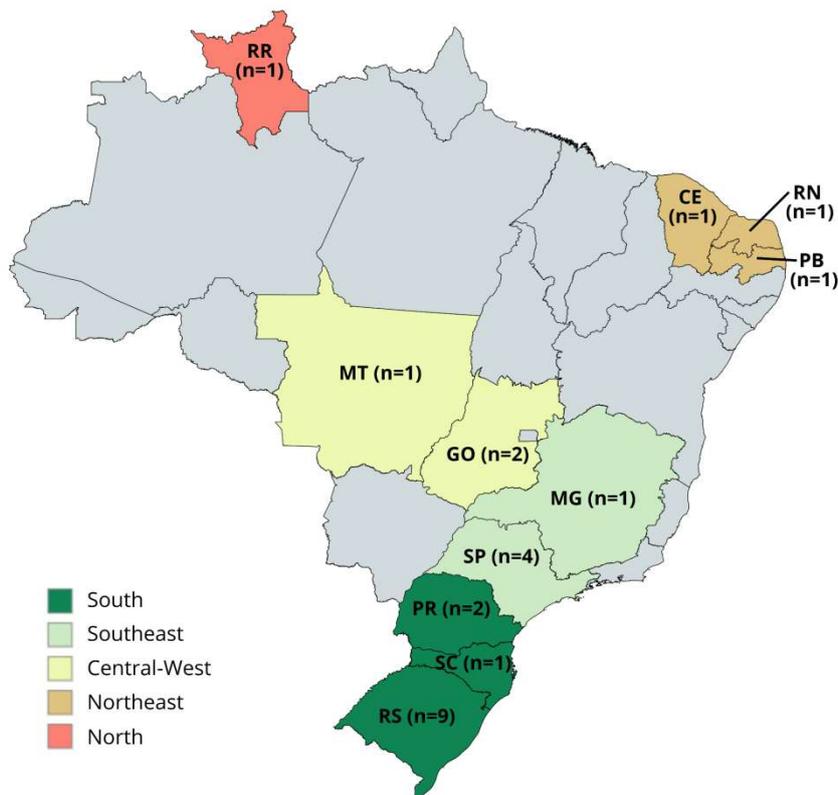
The presence of a paleontologist affiliated with a graduate program with a research line in paleontology teaching, although rare, is essential, mainly due to their geoscientific expertise. This professional brings specialized knowledge about fossils, evolution, and geological processes, thereby enriching the content and theoretical foundation of the courses (Alves et al., 2023).

Moreover, the paleontologist can make significant contributions to the development of innovative pedagogical strategies. With a background that combines science and teaching, they can adapt content and develop didactic methodologies that facilitate the understanding of complex paleontological concepts, such as geological time and fossil preservation (Alves et al., 2023), thereby making teaching more accessible and engaging and promoting deeper, more meaningful learning for students.

Regarding the geographical distribution of the productions, these are primarily concentrated in the South and Southeast regions (Figure 5).

**Figure 5**

*Map of the distribution of national stricto sensu scientific production on education in paleontology by Brazilian region (n=24), 2000–2024.*



Abbreviations: CE, Ceará; GO, Goiás; MG, Minas Gerais; MT, Mato Grosso; PB, Paraíba; PR, Paraná; RR, Roraima; RN, Rio Grande do Norte; RS, Rio Grande do Sul; SC, Santa Catarina; SP, São Paulo.

Of the 24 stricto sensu scientific productions found, 50% are associated with various universities in the South region (UFSM, ULBRA, UFRGS, UNIPAMPA, UFFS, UFPR, and UEPG), 20.8% with the Southeast region (UNICAMP, UNESP and UFMG), 12.5% with the Center-West (UEG and UFMT) and Northeast (UFPB, UERN, and UFC) regions, and 4.2% with the North region (UERR).

This concentration in the South and Southeast regions is likely a result of the presence of universities with graduate programs offering research lines in paleontology, as well as paleontological research centers (Alves et al., 2023). Studies indicate a significant concentration of research groups registered with CNPq in these states, due to the greater number of universities and the considerable demand for researchers (Coutinho et al., 2012).

These offers mentioned above lead to the formation of more paleontology research groups, thereby concentrating the workforce in the field. Consequently, it

promotes the valorization of basic paleontological research and its application in education, especially in museums, schools, and non-formal teaching environments (Hohemberger et al., 2023).

Furthermore, the works found originate from graduate programs belonging to various CAPES evaluation areas (Table 1) and bear different denominations, encompassing Education, Science Education, Teaching of Science and Mathematics, Teaching and History of Earth Sciences, Teaching of Natural Sciences, Biology Teaching, Teaching and Formative Processes, Cultural Heritage, Development and Environment, and Territorial Management. This thematic diversity reflects not only the interdisciplinarity of paleontology, which spans a wide range of knowledge beyond biological sciences, but also highlights the contribution of different fields to the construction of paleontology teaching (Costa & Scheid, 2024). Such plurality is essential both for discussions on the specificities of this educational field and for the training of professionals working in it, underscoring the need to integrate diverse perspectives and methodologies to expand the scope and effectiveness of education in paleontology.

### **Conceptual Characterization of the Research**

Studies indicate that prior searching for relevant works addressing themes similar to the one under investigation is an effective strategy, allowing the researcher to identify the most appropriate terms to accurately represent their own study (Garcia et al., 2019). Based on this, we examined the keywords present in the analyzed academic productions, organizing and analyzing the data through the Word Cloud (WC) technique, as detailed in the Methodology section. Figure 6 presents the WC generated from the descriptors of the studied scientific productions, highlighting the most frequent and relevant terms for the topic.



**Table 2**

*Distribution of stricto sensu scientific production on paleontology teaching by objective and nature of the study (n = 24), 2000–2024.*

Objective	Nature of the study	Author
To interrelate knowledge from geography and paleontology, associated with the potential paleontological use within the municipality.	Theoretical	Cruz (2008)
To implement the proposed educational activity at Colégio Antônio Ramos through the Art/Education Project, involving a group of 6th-grade elementary school students, culminating in the creation of the <i>Educational Guide to the Fossil Remains of Santa Maria</i> , illustrated with images of the sites and fossils found in the municipality.	Practical	Martins (2008)
To develop and implement a methodology that uses paleontology as a tool for environmental education in a public high school in the municipality of João Pessoa.	Practical	Albuquerque (2011)
To develop diversified pedagogical strategies using paleontology teaching and palynology, from an integrated and holistic perspective, through the implementation of a continuing education course.	Practical	Nobre (2014)
To explore and experiment with activities that stimulate the tension between information and knowledge—especially regarding paleontological and paleoanthropological themes—as well as to propose participatory and investigative activities aimed at fostering student agency, writing, reflection, critical thinking, inquiry, and the construction of learning in both virtual and physical environments.	Practical	Suterio (2017)
To identify the conceptions of students and teachers from the municipality of Mata, RS, regarding paleontology.	Practical	Hohemberger (2018)
To develop a booklet about the paleontological heritage of the central region of Rio Grande do Sul, focusing on the municipalities of Mata, São Pedro do Sul, Dilermando de Aguiar, Santa Maria, Candelária, Cachoeira do Sul, the Quarta Colônia Italian immigration region, as well as Novo Cabrais and Paraíso do Sul, as a tool for disseminating paleontology to high school students.	Theoretical	Stochero (2018)
To identify the knowledge, activities, and practices available to students and teachers in the textbooks currently approved by the National Textbook and Didactic Material Program (PNLD) and used by students and teachers in schools.	Theoretical	Nizer (2019)
To present, promote, and disseminate diversified methodologies to be applied in workshops on geological time, the rock cycle, and fossils, aiming for meaningful learning among elementary school students.	Prático	Silva (2019)
To develop a guide and booklet focused on field activities that enable high school biology teachers to explore the geological and paleontological potential of the Apodi-RN region.	Theoretical	Alvarez (2020)
To analyze how Paleontology is incorporated in biology textbooks and which methodologies are employed by teachers in the state education system of Anápolis to facilitate the understanding of this content.	Theoretical	Gatinho (2020)
To produce and make available free video lessons and teaching materials for the continuing education of early childhood education teachers.	Theoretical	Nascimento (2020)

To evaluate whether the use of an educational game can contribute to the dissemination of the paleobotanical collection from the Araripe Geopark.	Practical	Nunes (2020)
To investigate, based on the analysis of visits by elementary school groups (Grades 1–5), <i>whether</i> and <i>how</i> the exhibition “Dinosaurs (?) at the IG,” held at the State University of Campinas, contributed to promoting learning among its visitors regarding knowledge related to the natural sciences, particularly paleontology.	Practical	Ribeiro (2020)
To analyze how a short continuing education course about paleontology history, based on the educational needs of teachers from the state of São Paulo, can contribute to the teaching of this field.	Practical	Sampaio (2020)
To analyze how a continuing education process for teachers, offered through a remote workshop on the theme of paleontology, can contribute to the educational and reflective practices of science teachers.	Practical	Brasil (2022)
To investigate the approach to paleontology in science teaching based on the curriculum outlined in the BNCC, the RCG, and the LDs.	Theoretical	Costa (2022)
To analyze whether the investigative teaching kit “A Day in the Life of a Paleontologist” promotes learning and the development of scientific literacy among 6th and 7th-grade elementary school students, and to understand how this process occurs based on Vygotsky’s historical-cultural theory.	Practical	Mariano (2022)
To analyze how the use of an educational application, PaleonApp, contributes to the learning of high school students.	Practical	Aguiar (2023)
To analyze the potential of using paleontology knowledge in the development of an activity for mathematics teaching.	Practical	Godoi (2023)
To propose an investigative instructional sequence (IIS) aimed at understanding the importance of studying Brazilian paleozoology—focusing on dinosaur species and their evolutionary correlates—as a facilitating agent for comprehending the evolutionary process, and to suggest measures to mitigate the deficiency of this topic in basic education.	Practical	Santos (2023)
To develop a contextualized educational practice in paleontology teaching through a continuing education course based on the Magueréz Arc methodology for basic education teachers in the city of Mata, RS, aiming to promote understanding of the topic and local reality, considering the abundance of plant fossils present in the community.	Practical	Hohemberger (2023)
To investigate how the approach to the theme of paleontology in the early years can contribute to scientific literacy.	Practical	Boelter (2024)
To investigate the perceptions of teachers and students regarding the theme of paleontology in science teaching in elementary school and high school, as well as the methodologies adopted to address the topic.	Theoretical	Peres (2024)

Of the 24 works analyzed, 16 were classified as “practical,” representing 66.7% of the total, while eight were categorized as “theoretical,” corresponding to 33.3%. This demonstrates a predominance of studies involving practical pedagogical interventions.

Regarding the theoretical works, these generally focus on the production of materials such as booklets, guides, and video lessons, as exemplified by Nascimento

(2020) and Stochero (2018), or on the analysis of textbooks and curricular documents, as seen in Alvarez (2020), Costa (2022), Gatinho (2020), and Nizer (2019). Additionally, some studies investigate teachers' and students' perceptions of specific paleontological topics (e.g., Peres, 2024) or propose teaching strategies directed at educators (e.g., Cruz, 2008).

Practical works, on the other hand, involve a variety of educational actions. These studies aim to implement activities through lectures, as demonstrated by Martins (2008), or to promote more dynamic and interactive learning, as in Mariano (2022), who analyzed the impact of an investigative teaching kit. Moreover, many projects include conducting workshops and other educational activities, as observed by Boelter (2024) and Silva (2019).

Field trips and visits to squares and museums are also mentioned, as described by Hohemberger (2018) and Ribeiro (2020), along with the use of educational games and digital applications, as in Aguiar (2023), Nunes (2020), and Santos (2023), and the implementation of mathematical modeling proposals on the length of dinosaur tibiae, as presented by Godoi (2023). Various didactic strategies are discussed by Albuquerque (2011), and continuing education courses for teachers are addressed in Brasil (2022), Hohemberger (2023), Nobre (2014), and Sampaio (2020). Collective hypertexts and physical and digital devices are also mentioned, as in Suterio (2017).

Except for Hohemberger (2018, 2023), who employed the problematization methodology of the Maguerez Arc, and Aguiar (2023), Albuquerque (2011), and Nunes (2020), who used gamification, as well as Santos (2023), who combined gamification and inquiry-based teaching, there is no explicit emphasis on the implementation of active learning methodologies in most of the recovered works. Most studies classified as “practical” mention traditional pedagogical interventions, such as lectures, field trips, and pedagogical workshops (Hohemberger et al., 2023).

It is noteworthy that, in this study, strategies such as field trips—although configured as classical active practices—were not classified as active methodologies, but rather as active teaching strategies, following the conceptual distinction adopted in the analysis. In this sense, an active methodology is understood as a broad pedagogical approach that guides the entire teaching-learning process (Berbel, 2011; Valente, 2018), whereas an active strategy corresponds to specific actions or activities applied within this approach to promote student engagement and active participation in knowledge construction (Anastasiou & Alves, 2015).

Furthermore, even the few works that employed active teaching methodologies or strategies do not indicate the theoretical frameworks on active learning nor specify the use of active methodologies as a central approach in their research. We believe that the absence of theoretical grounding and the poor understanding of the theoretical assumptions of active learning may lead to inconsistencies in practice, difficulties in evaluating the effectiveness of the strategies applied, barriers to continuing teacher education, and limitations in pedagogical innovation and improvement, as well as reduced academic and practical interest (Alves et al., 2024; Corsini et al., 2022; Hohemberger et al., 2019).

## **Conclusions**

The scientometric analysis highlights a scarcity of *stricto sensu* postgraduate research dedicated to the application of paleontology in education, revealing a research area that remains incipient and poorly consolidated in Brazil. This gap is especially evident in the absence of theses and dissertations that systematically explore in depth the practices and methodologies aimed at paleontology teaching, which limits theoretical and methodological advancements in this field at the intersection of paleontology and teaching.

This survey makes clear the urgent need to intensify research in this area, as paleontology is a crucial subject for advancing the natural sciences and geosciences. Although there has been modest growth in the number of publications over the last decade, the topic remains marginalized, possibly due to lower institutional valuation and weak recognition of education in paleontology as an autonomous field of scientific-pedagogical investigation.

Another relevant aspect is the limited availability of data in the analyzed databases, suggesting that part of the academic production on paleontology teaching may not be properly indexed. This raises concerns regarding the visibility and tracking of Brazilian scientific production in the field, creating gaps that hinder a comprehensive analysis of the current situation in the country.

A geographic concentration of research is also observed in the South and Southeast regions of Brazil, with a predominant focus on basic education. The absence of studies focused on paleontology teaching in Brazilian higher education compromises the development of effective pedagogical practices, essential for training teachers and researchers in the field. Without a solid body of knowledge

regarding effective methodologies for paleontology teaching at the higher education level, the quality of professional training in this field remains weakened.

Furthermore, there is a notable shortage of research employing active teaching methodologies, globally recognized for their positive impact on student engagement and meaningful learning. The lack of theoretical grounding associated with learning theories across many of the analyzed theses and dissertations also underscores the need for greater investment in research that explores and validates these approaches, reflecting the broader lack of continuing education for teachers.

Finally, based on the data gathered, this analysis demonstrates that paleontology teaching still faces significant structural and theoretical challenges that must be overcome to strengthen this field within the Brazilian educational context.

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