

The state of evolution education research in Brazil: A review of the national and international literature 2013-2025

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Abstract

We provided an overview of the current state of evolution education research in Brazil, based on a systematic literature review of papers published in national and international journals from 2013 to 2025. We identified 301 papers, including 266 published in Portuguese (PT) and only 35 in English (EN), suggesting that Brazil can be considered a peripheral country regarding science education research. Although the yearly number of papers published in PT increased substantially during 2013-2025, the yearly number published in EN remained low. Most papers were published in high-quality A-journals, with a particular focus on upper secondary education. Papers published in PT focused mainly on didactic methods and evolution understanding, and to a lesser extent, acceptance, teaching resource analyses, discussions about history, philosophy, and sociology of science and literature reviews, while curricula and teacher education, acknowledged as critical problems concerning evolution education, were largely neglected. Papers addressing didactic methods and teaching resources analyses focused mainly on respectively, games and teaching sequences, and textbook analyses. By contrast, most papers published in EN focused on the understanding and acceptance of evolution, with only a few papers focusing on the other categories, indicating that evolution education research in Brazil available for international readers does not provide an adequate overview of the current state of research.

Keywords: biology education, evolution, literature review

INTRODUCTION

It is important to conduct science education research, not only to help science teachers to improve their classroom practice, but also to understand what has been investigated in the past, and to have a better idea of what could be investigated further in the future (Chang et al., 2010; Vojřr & Rusek, 2019). Moreover, for science education research to be relevant, it is important to interpret research results in the context of other studies on the same topic (Vojřr & Rusek, 2019). However, given that the number of science education research papers has been increasing rapidly in recent years, in particular due to the contribution of researchers from non-English speaking countries (Lee et al., 2009), it is getting complicated to follow all research, even in one specific

field. Hence, literature reviews gain in importance as they help researchers to more easily orient themselves in a specific research area (see e.g., Chang et al., 2010; Lee et al., 2009; Tsai & Wen, 2005).

However, although the internationalization of academic production has changed the publishing culture in the world with increasing participation of multilingual scholars in international journals (Belcher, 2007), scholars from the so-called semi-peripheral countries may, depending on the specific discipline, still publish the majority of relevant research in their own language rather than in English (EN) (Monteiro & Hirano, 2020). The division between countries with substantial international participation and those that are isolated is represented by three regions. Whereas the center is composed of Anglophone countries and other

Contribution to the literature

- This study provides the first comprehensive review of scientific journal publications on evolution education in Brazil, covering the period from 2013 to 2025 and synthesizing evidence from 301 papers.
- The findings reveal major research trends, educational levels addressed, gaps, and underexplored areas, particularly regarding curriculum-focused and teacher education research.
- By comparing publications in Portuguese (PT) and EN, the study highlights important challenges related to the internationalization and global visibility of evolution education research produced in Brazil.

countries primarily located in Western Europe (Bennett, 2014), the semi-periphery has more material resources and incentives to publish than peripheral nations, but not as many resources as countries from the center. Fast developing nations such as Brazil belong to the semi-periphery (Bennett, 2014).

However, disciplinary differences have been noted as an important factor determining peripherality in academia (Ferguson et al., 2011). For example, in Brazil, scholars from humanities and social sciences publish much more frequently in PT than in EN when compared to those from the exact and biological sciences (Monteiro & Hirano, 2020). This appears to be particularly true for a discipline such as education, implying that relevant science education research on specific research topics published in PT may not be available for the international research community.

However, in science education, comparative research including semi-peripheral regions, characterized by specific (cultural and religious) contexts, may contribute substantially to the field. For example, in evolution education research with regard to the role of religion in the level of acceptance and understanding of the evolution theory (da Silva Oliveira et al., 2022). Hence, to inform the international research community and to promote international collaboration between research groups from (semi-)peripheral and center regions, there is a need for reviews focusing on science education research within specific research topics, such as evolution education, in semi-peripheral countries, including not only papers published in EN but also in these countries' own languages. Brazil can be considered a semi-peripheral country in general but a peripheral country regarding science education research in particular (Monteiro & Hirano, 2020), suggesting that evolution education research is published more frequently in national than international journals. Therefore, the main aim of this study is to perform a literature review on the state of evolution education research in Brazil for the 2013-2025 period, including both papers published in EN and PT.

Evolution Education Research

Evolution education is an important research topic in science education research. The theory of evolution, acknowledged as the unifying theme of life sciences, has been advocated as the element capable of integrating the

various contents belonging to biological knowledge (Nehm, 2018; Pinxten et al., 2020). In addition, a good understanding of evolution is important for promoting scientific literacy (Fowler & Zeidler, 2016), addressing a variety of societal issues, such as biodiversity loss and climate change (Carroll et al., 2014), developing evidence-based thinking (Heddy & Nadelson, 2012) and a greater understanding of the nature of science (Nelson et al., 2019). However, due to a variety of factors, evolution is one of the most challenging topics to be effectively taught and learnt (Nehm & Kampourakis, 2022). Consequently, "despite its centrality in the life sciences, evolutionary change by natural selection is still poorly understood by students throughout the educational hierarchy" (Nehm et al., 2012, p. 92).

Despite that research on evolution education has been increasing in the past few decades (Smith, 2010a), general systematic literature reviews on the topic, not focusing on a specific subtopic, such as Glaze and Goldston (2015), are scarce. This is, presumably, because evolution education is a wide field of research which encompasses a large number of possible research topics. For instance, in their literature reviews, Smith (2010a, 2010b) focused on the philosophical/epistemological issues and pedagogical issues, Sickel and Friedrichsen (2013) focused on teacher education, Ziadie and Andrews (2018) focused on pedagogical content knowledge and Kuschmierz et al. (2020), focused on the knowledge and acceptance of evolution.

Based on these reviews and other recent studies, some of the main research topics within evolution education can be identified. The aspects related to the understanding and acceptance of evolution, including knowledge, beliefs, perceptions and attitudes toward the theory, are certainly one of the most investigated topics (Glaze & Goldston, 2015; Kuschmierz et al., 2020). However, the subject is frequently explored from different perspectives, depending on the geographical and cultural context. As an example, the acceptance or rejection of evolution seems to be a major concern for scholars in the United States, particularly due to the religious tension that prevails in the country (Glaze & Goldston, 2015). On the other hand, European researchers seem to distribute their focus more equally between the understanding and acceptance of evolution and to consider religion as one among other also important socio-cultural factors that might influence the

acceptance or rejection of the theory (Kuschmierz et al., 2020).

The aspects concerning the approach to the subject in the classroom, including teaching strategies and resources, have also been the focus of numerous studies in the past (Glaze & Goldston, 2015; Ziadie & Andrews, 2018) and are still being investigated (Nehm, 2018; Nehm & Kampourakis, 2022). When investigating the available research on the pedagogical content knowledge related to the teaching of evolution, Ziadie and Andrews (2018) demonstrated that the majority (75%) of studies focused on instructional strategies for teaching evolution. In addition to being implemented as the cornerstone of biological knowledge, scholars have been arguing, for instance, that evolution should be taught as early as possible (Pinxten et al., 2020; Sá-Pinto et al., 2021), that misconceptions should be explicitly addressed during classes, that students' world views – including religion – should be considered and respected, and that the nature of science should be simultaneously addressed while teaching about evolution (Nehm & Kampourakis, 2022).

Other topics regularly explored within the area of evolution education are teacher education and curricula (Glaze & Goldston, 2015; Mavrikaki et al. 2024), which are considered to be major factors that influence the teaching and learning of the theory (Nehm & Kampourakis, 2022). Despite their importance, they seem to receive less emphasis when compared, for example, to the understanding and acceptance of evolution or to proposing strategies and resources to be implemented in the classroom. Moreover, literature reviews and/or analyses and theoretical discussions, especially related to the philosophical/epistemological aspects of teaching evolution are also cited as topics or types of research, although often associated with the previously mentioned subjects (Glaze & Goldston, 2015; Sickel & Friedrichsen, 2013; Smith, 2010a; Ziadie & Andrews, 2018).

Evolution Education Research in Brazil

Although Brazilian researchers have also been advocating for the importance of evolution being treated as the central and unifying theme of biology in the country (Carvalho et al., 2020; Colli et al., 2021), research has shown that this is not how the subject is generally taught in the classroom (Araujo et al., 2023; Colli et al., 2022). Different factors have been associated with the lack of effectiveness in the teaching and learning of evolutionary theory in Brazil. For instance, recent studies have suggested that Brazilian textbooks have historically failed to properly present and explain the evolutionary phenomena (Santos & Nagashima, 2021), as well as to establish the theory of evolution as the unifying element of biological knowledge (Azevedo & Alle, 2022). Moreover, it has also been demonstrated that many biology undergraduate students and teachers do not fully understand the theory of evolution and its

fundamental role in biology (Silva et al., 2021; Souza & Freitas, 2021) and that even when they do, differing circumstances prevent them from accurately addressing the subject in the classroom (Araujo et al., 2023; Colli et al., 2022).

Evolution education has become an important aspect of Brazilian biology education. However, even though the amount of research regarding the subject has increased in the last few years in the country, it is still underrepresented compared to other topics within biology and in particular when considering its relevance for the biological sciences (Felix & Oliveira, 2021; Santos & Fernandes, 2024). Moreover, only few studies have recently established an overview of the current scenario with regard to evolution education in Brazil and none has reviewed scientific papers with this purpose in the last decade. Thus, besides the necessity for more studies, it is also important to identify what has recently been investigated in this area, to stimulate local research and international collaboration regarding specific research topics within evolution education. In other words, there is a need for a background that can support and guide the development of further research in the field.

The educational system in Brazil consists essentially of two major levels of education: basic and higher education. Basic education is divided into four stages (Lei de Diretrizes e Bases da Educação Nacional [LDB], 1996). Although they do not fully correspond to the international standard classification of education (ISCED) (European Commission, 2019), we chose to adjust them to the ISCED nomenclatures in order to facilitate the international readers' understanding. Therefore, the four stages of basic education are: early childhood education (from 0 to 5 years old), primary education (from 6 to 10 years old), lower secondary education (from 11 to 14 years old) and upper secondary education (from 15 to 17 years old). Higher education in Brazil encompasses the courses that require at least a secondary education degree, such as graduation and post-graduation,

During the five years of primary education and four years of lower secondary education in Brazil, biological knowledge competes for space with chemistry and physics, forming the school subject 'sciences'. It is exclusively during upper secondary education that biology has the status of a school subject, although the discipline is only mandatory for the two first years (Base Nacional Comum Curricular [BNCC], 2018). It means that it is expected that all biological knowledge, including evolution, considered necessary for Brazilian citizens' education will be learnt during two years, even though the workload of the subject is usually less than two hours a week. As a result, research has demonstrated that biology has been presented to students as a collection of unrelated contents in Brazilian schools, depending more on their memorization than actual comprehension (Carvalho et al., 2020).

In addition to the above-mentioned knowledge gaps related to research on evolution education in Brazil, information regarding the main focuses of recent studies on the topic is scarce. According to Felix and Oliveira (2022), PhD and master theses in the 2008-2018 period focused primarily on analyses of teaching resources, use of non-school spaces, perceptions of teachers and students, and implementation of proposed teaching strategies and resources, but comparable information regarding scientific publications in international and national journals is lacking. The major problems regarding evolution education in Brazil seem to be related to the curriculum, as it directly influences what is presented in the textbooks and what and how teachers teach (Araujo et al., 2023; Azevedo & Alle, 2022; da Silva Oliveira & Bizzo, 2018), and to teacher education, due to the crucial role of teachers in the classroom and, consequently, to how critical it is that teachers have sufficient content knowledge about the topic (Silva et al., 2021; Souza & Freitas, 2021). Therefore, these two topics are expected to be among the most prioritized by researchers when investigating evolution education in the country.

Although poor acceptance and understanding of evolution has been frequently related to religious orientation (Bizzo & Araújo, 2021), recent investigations suggest that this is not among the most significant obstacles in Brazil (da Silva Oliveira & Bizzo, 2018; da Silva Oliveira et al., 2022; Tavares & Bobrowski, 2018). Rather, the same studies indicate that other factors, such as the curriculum, have a greater influence and suggest that an accurate understanding of evolution can potentially overcome misconceptions and lack of acceptance generated by religious biases, which is in accordance with what is argued by Kuszmierz et al. (2020).

McManus et al. (2020) and Alencar and Barbosa (2021) have demonstrated that the number of papers published by Brazilian authors in international journals and in collaboration with international researchers has increased over the last years. This might be due to the Brazilian government policies for internationalization of the country's science, implemented in the last two decades. However, not all scientific areas follow the same pattern. Although they acknowledge the importance of publishing in EN in order to communicate and promote their work to the international scientific community (Monteiro & Hirano, 2020), researchers from humanities and social sciences, including education, defend the importance of publications in PT respecting the enrichment of the country's culture, especially considering that young Brazilian students, researchers and basic education teachers are mostly not fluent in EN (Forattini, 1997). To our knowledge, no study has compared the proportion of national and international scientific publications focusing on evolution education in Brazil, nor whether these differ regarding the specific

evolution education topics, or the levels of education studied. However, authors from semi-peripheral countries may prefer to select specific evolution education topics for publication in national rather than in international journals, as appears to be the case in Turkey (Muğaloğlu, 2018).

The aim of the present study is to provide an overview of the current state of research regarding evolution in the context of science education in Brazil. We analyzed papers published in EN or PT between 2013 and 2025. Our specific goals, inspired by the above-mentioned knowledge gaps and by previously published science education review papers (Chang et al., 2010; Lee & Hong, 2013; Lin et al., 2019; Vojříř & Rusek, 2019) were:

- to identify the general characteristics of these studies, such as the number of articles per year, the number and quality of the journals, and the levels of education,
- to characterize the main research topics, and
- to compare the general characteristics and main research topics between papers published in PT, largely aimed at a Brazilian and other PT speaking readership, and papers published in EN, focusing on the international scientific community.

METHODS

The electronic search was initially conducted between August 2023 and February 2024 and supplemented between February and April 2026, covering papers published during 2013-2025. We performed a keyword search in Google Scholar, which includes articles from national and international journals. The keywords used were '*ensino de ciências*' and '*evolução biológica*', and their respective translation into EN, 'science education' and 'biological evolution' in combination with the terms 'Brazil' and 'Brazilian'. Furthermore, the option 'anywhere in the article' instead of 'in the title of the article' was chosen.

We obtained, in total, more than 2,700 publications in PT and EN and one in Spanish. The latter was not included in further analyses. The other publications were all pre-analyzed, consisting of reading the titles, the keywords and, when relevant, the abstracts of all papers in order to identify those that were eligible for this review. The criteria we used to consider further inclusion were the following: it had to be a paper published in a scientific journal (books, proceedings of congresses, PhD or master theses, or other types of publications were excluded), addressing specifically and explicitly evolution education in Brazil. After pre-selecting the eligible papers, they were all checked for duplicates or for any other inconsistencies related to the criteria previously defined, resulting in a final number of 301 papers, which were all subsequently fully read and analyzed. During this last analysis we primarily focused

on identifying the main characteristics of the studies and categorizing the main research topic addressed.

From the 301 papers reviewed, 266 were in PT, 34 in EN and one in both languages (see [Supplementary File](#)). For the analyses we considered the paper available in both EN and PT, as a paper in EN, since one of our goals was to compare papers exclusively targeted at the PT speaking scholar community with those also accessible for international researchers. Therefore, 266 (88.4%) of the selected papers were available only in PT (referred to as PT-papers) and 35 (11.6%) were available in EN (referred to as EN-papers).

We analyzed the number of papers published per year between 2013 and 2025 and identified the journals in which the papers were published and the number of publications per journal. The quality of the journals was analyzed based on Qualis, the current Brazilian official assessment of scientific journals, which is a retro-active evaluation that occurs every four years. The assessment used in this study was made available in 2025 and refers to the period of 2021-2024. Regarding the assessment, Qualis classifies the journals according to nine quality levels: A1-A4, B1-B4, and C, with A1 representing the highest quality and C the lowest (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior [CAPES], 2023). In order to classify the journals, Qualis defines the universe of journals belonging to the same main area and uses Google Scholar h5-index as the indicator to determine the percentiles for each one of them. Therefore, depending on the percentile each journal is allocated in a certain level, namely: A1 (100%-87.6%), A2 (87.5%-75.1%), A3 (75%-62.6%), A4 (62.5%-50.1%), B1 (50%-37.6%), B2 (37.5%-25.1%), B3 (25%-12.6%), B4 (12.5%-0%). Journals classified as C do not have the indicators used by the model and/or do not comply with good editorial practices according to the criteria utilized by CAPES (2023).

In addition, the articles were classified according to the level(s) of education they primarily focused on basic education (early childhood education, primary education, lower secondary education, upper secondary education) or higher education.

Ultimately, 'main research topics' were defined in order to categorize the articles according to their main focuses and objectives. As a result, the studies were categorized according to the following seven research topics: didactic methods, which includes proposals of new didactic methods or resources for teaching evolution, understanding and/or acceptance, teaching resources analysis, which encompasses research aiming at analyzing any existing potential resource for teaching evolution such as textbooks, films, magazines; discussions about, the history, philosophy, and sociology of science (HPSS) in the context of evolution education, literature reviews, teacher education, and curriculum analysis.

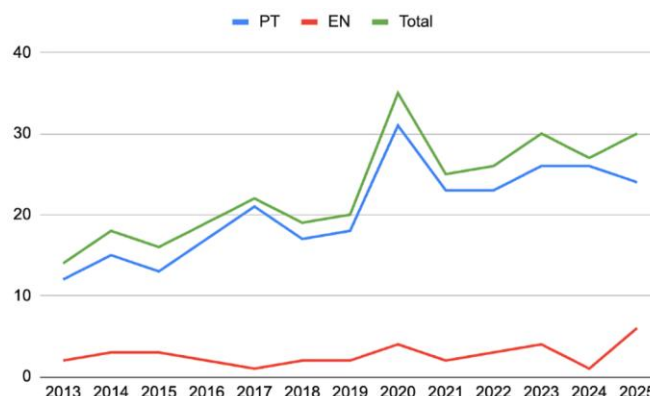


Figure 1. Number of evolution education papers published per year (2013-2025) (PT: Papers published in Portuguese & EN: Papers published in English) (the authors' own elaboration)

For some research topics we were able to create subcategories. In the case of understanding and/or acceptance we identified the distinct population studied, for didactic methods we identified the specific methods and resources proposed, for literature review, the types of publication addressed and for teaching resources analysis, the types of resources analyzed in the studies.

The identification of the general characteristics and the research topic addressed was done for the total of all papers as well as separately for PT-papers and EN-papers. We compared the proportion of the general characteristics and research topics between PT and EN-papers, applying Fisher's exact tests, which were computed using the QuickCalcs software from the GraphPad website (<http://www.GraphPad.com>). A significance level of $\alpha = .05$ was employed for all tests.

RESULTS

General Characteristics

The average total number of articles published per year was 23.2 ± 6.2 standard deviation (range: 14-35). The average number of PT-papers per year was 20.5 ± 5.7 (range: 12-31), which was much higher than the average number of EN-papers, which was only 2.7 ± 1.4 (range: 1-6). The total number of publications peaked in 2020 with the yearly number from this year onwards being always higher than in the 2013-2019 period ([Figure 1](#)). A comparable pattern was found when considering only PT-papers. By contrast, the yearly number of published EN-papers remained relatively constant throughout 2013-2025 ([Figure 1](#)).

The 301 papers included in this review were published in 148 different journals. Of these 148 journals, 86 (58.1%) belonged to Qualis A (A1 to A4), including 22 (14.9%) A1 journals, of which 17 are national and 5 are foreign journals. In addition, 38 (25.7%) journals belonged to Qualis B (B1 to B4), 13 (8.8%) to Qualis C and 11 (7.4%) were not-scored journals.

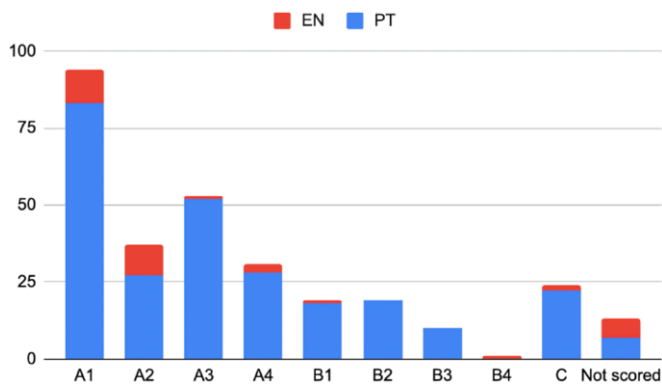


Figure 2. Number of papers published in each of the nine different Qualis levels for journals (PT: Papers published in Portuguese & EN: Papers published in English) (the authors' own elaboration)

According to the analyzed papers, 215 (71.4%) were published in A journals, 49 (16.3%) in B journals, 24 (8%) in C journals while 13 (4.3%) were published in not-scored journals (Figure 2). The proportion of papers published in A journals did not differ significantly between PT-papers (190/266 = 71.4%) and EN-papers (25/35 = 71.4%). Focusing exclusively on A1 journals, 31.2% (94/301) of all papers, including 31.2% (83/266) of PT-papers and 31.4% (11/35) of EN-papers were published in journals belonging to this stratum, with no significant difference in the proportion of PT-papers and EN-papers.

Regarding the number of papers published per journal, 96 (64.9%) of these 148 journals published only one paper addressing evolution education in Brazil during 2013-2025, followed by 39 (26.4%) journals with two to five publications, 10 (6.8%) journals with six to nine publications and only 3 (2%) journals with more than ten publications. These three latter, all national journals, were: 'Revista de Ensino de Biologia da SBEnBio' ('Journal of Biology Education of SBEnBio') (A1), with 10 publications; 'Experiências em Ensino de Ciências' ('Experiences in Science Education') (A3), with 11 publication; and 'Investigações em Ensino de Ciências' ('Investigations in Science Education') (A1), with 17 publications.

Considering only the 35 EN-papers, these were published in 20 different journals, including 13 foreign journals and 7 national journals. Evolution: Education and Outreach (A2) was the journal with the highest number of publications (n = 6), followed by Science & Education (A1), Journal of Biological Education (A2), International Journal of Science Education (A1), *Conexão Ciência* (A4) (each n = 3), Journal of Teaching and Education (not-scored), Procedia-Social and Behavioural Sciences (not-scored) (each n = 2), and 13 journals with only one publication: *Enseñanza de las ciencias: revista de investigación y experiencias didácticas* (A1), *Góndola, ensenza y aprendizaje de las ciencias* (A2), *Transnational Curriculum Inquiry* (B4), *Pro-Posições* (A1), *Jornal*

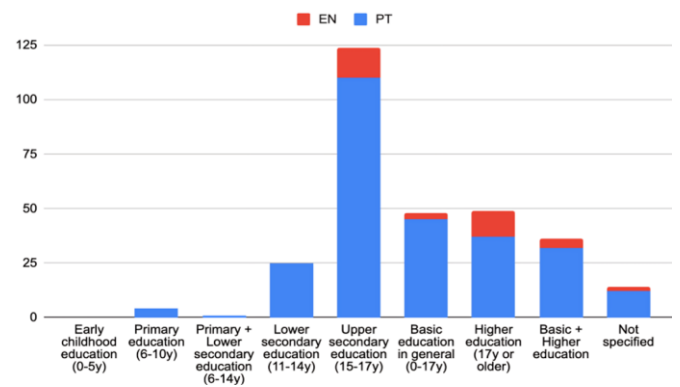


Figure 3. Distribution of the specific level of education that the reviewed papers mainly focused on (Total: All papers, PT: Papers published in Portuguese, & EN: Papers published in English) (the authors' own elaboration)

Bioeducatika (not-scored), Theology and Science (not-scored), PLOS One (A1), Journal of Science Education (B1), *Ciência & Educação (Bauru)* (A1), *RGSA – Revista de Gestão Social e Ambiental* (C), *Revista Caderno Pedagógico* (C), *Revista Estudos de Religião* (A1), *Educação em Foco* (A3).

Concerning the levels of education, in total 238 (79.1%) papers addressed basic education and 85 (28.2%) higher education, including 36 papers focusing on both levels. Excluding the latter category, 67.1% (n = 202) addressed exclusively basic education, which is a significantly higher proportion (p < 0.0001) compared to the 16.3% (n = 49) articles addressing only higher education. Within basic education, the most addressed stage was upper secondary education, in 61.4% of the 202 papers, which was addressed significantly more often (p < 0.0001) than basic education in general (23.8%), lower secondary education (12.4%), primary education (1.9%), primary + lower secondary education (0.5%) and early childhood education (0%). The latter level was not investigated by any study found in the last 13 years (see Figure 3).

Considering the 266 PT-papers, 81.6% addressed basic education, while 25.9% addressed higher education, including the papers that addressed both basic and higher education. In contrast, 60% of the 35 EN-papers addressed basic education, while 45.7% addressed higher education. EN-papers focused significantly less (p < 0.007) on basic education and significantly more (p = 0.026) on higher education than the PT-papers. Moreover, none of the EN-papers addressed the levels lower than upper secondary education within basic education.

Research Topics

Of the 301 papers, 33.2% focused on didactic methods and 32.9% on the understanding and/or acceptance of evolution, which is a significantly higher proportion of papers (p < 0.0001) than those focusing on teaching resources analysis (13.6%), discussions about HPSS

Table 1. Main research topics addressed in the 301 reviewed papers

Main research topics	PT	EN	Total
Didactic methods	97	3	100
Understanding and/or acceptance	74	25	99
Teaching resources analysis	41	0	41
Discussions about HPSS	21	2	23
Literature reviews	21	0	21
Teacher education	6	3	9
Curriculum analysis	6	2	8
Total articles	266	35	301

Note. Total: All papers; PT: Papers published in Portuguese; EN: Papers published in English

(7.6%), literature reviews (7%), teacher education (3%), and curriculum analysis (2.7%), with the proportion focusing on teaching resources analysis also being significantly higher than the four latter categories ($p = 0.024$). The above pattern was comparable in PT-paper. By contrast, the majority of EN-papers focused on understanding and/or acceptance, with the research topics didactic methods, teaching resources analysis, discussions about HPSS, and literature reviews being (almost) exclusively addressed in PT-papers only (see **Table 1**).

Hence, compared to EN-papers, PT-papers were significantly less focused on the understanding and/or acceptance of evolution (27.8% versus 71.4%, $p < 0.0001$), and significantly more on didactic methods (36.5% versus 8.6%, $p = 0.0002$) and teaching resources analysis (15.4% versus 0%, $p = 0.0072$), while there were no significant differences between PT-papers and EN-papers regarding the proportion of papers focusing on discussions about HPSS (7.9% versus 5.7%), literature reviews (7.9% versus 0%), teacher education (2.3% versus 8.6%, $p = 0.074$), and curriculum analysis (2.3% versus 5.7%).

Considering the 99 papers addressing understanding and/or acceptance of evolution, 46 (46.5%) focused on understanding only, 40 (40.4%) on both understanding and acceptance, and 13 (13.1%) on acceptance only, the latter representing a significantly lower proportion ($p < 0.0001$, **Table 2**). Including papers focusing on both understanding and acceptance, the total proportion of papers focusing on understanding (86.9%) was significantly higher than the proportion of papers focusing on acceptance (53.5%, $p < 0.0001$). Considering the 74 PT-papers and 25 EN-papers separately, the proportion of PT-papers focusing on understanding only was significantly higher than the proportion of EN-papers (54.1% versus 24%, $p = 0.011$), while the proportion of PT-papers focusing on acceptance only was significantly lower (8.1% versus 28%, $p = 0.018$). The proportion of PT-papers and EN-papers focusing on both understanding and acceptance (37.8% versus 48%) did not differ significantly. Including the latter papers, the proportion of PT-papers focusing on understanding was also significantly higher than the proportion of EN-

Table 2. Population addressed in the understanding and/or acceptance of evolution studies

Population addressed	A	U	U&A	T*
School students	5	12	18	35
Teachers	1	20	13	34
Undergraduate students	2	18	8	28
Brazilian population	5	0	1	6
Postgraduate students	0	1	1	2
Participants of a lecture	0	1	1	2
Number of papers*	13	46	40	99

Note. A: Acceptance; U: Understanding; U&A: Understanding and acceptance; T: Total each group; *Some papers addressed more than one group

papers (91.9% versus 72%, $p < 0.018$), while the proportion of PT-papers focusing on acceptance was significantly lower (45.9% versus 76%, $p = 0.011$).

Table 2 shows the prevalence of specific study populations investigated in the 99 papers addressing understanding and/or acceptance of evolution. Considering that some studies investigated more than one group, the most studied groups were school students (35.4% of the 99 articles), teachers (34.3%), and undergraduate students (28.3%), which were all investigated in a significantly higher proportion of the papers ($p < 0.0001$) than the Brazilian population (6.1%), postgraduate students (2%) and participants of a lecture (2%). Considering the three categories of paper separately, papers addressing exclusive understanding also focused significantly more often on teachers ($p < 0.0001$), undergraduate students ($p < 0.0001$) and school students ($p = 0.0017$). Similarly, papers addressing understanding and acceptance focused significantly more often on school students ($p < 0.0001$), teachers ($p < 0.001$), and undergraduate students ($p < 0.03$). By contrast, papers addressing exclusively acceptance, focused significantly more often on school students and the Brazilian population ($p = 0.04$).

Considering the 100 publications focusing on didactic methods, which were almost all, except three, PT-papers, a total of 24 different types of teaching strategies and/or resources were addressed. Within this wide range of subcategories, the only two that were addressed significantly more often than all other subcategories were games, in 28 (28%, $p < 0.0001$) of the 100 papers, and teaching sequences, in 24 (24%, $p < 0.0006$) papers. Of the remaining 48 papers, 4 papers were considered as not-specified. The other 44 papers were distributed across the following 22 different subcategories: workshops and comics (each in 6 papers), classes (in 5 papers), films (in 4 papers), non-formal spaces (in 3 papers), websites, active learning and software (each in 2 papers) and narratives, reading and writing, blogs, mini-course, music, painting, analogies, drama, practical classes, seminar, round table discussion, handcraft, event, and didactic manual (each in one single paper).

In total 28 (68.3%, $p = 0.0005$) of the 41 studies categorized as teaching resources analysis (which were

all PT-papers), were related to textbooks analyses. In addition, magazines were analyzed by 4 (9.8%) papers, comics by 3 (7.3%) papers and analyses of books, digital handouts, films, educational software, documentaries, and animation/simulation were each addressed by only 1 (2.4%) paper.

Of the 21 PT-papers categorized as literature reviews, 8 (38.1%) reviewed publications in scientific journals, other 8 (38.1%) reviewed PhD and/or master theses and the remaining 5 (23.8%) reviewed proceedings of congresses. None of the eight reviews performed on scientific publications were systematic literature reviews on evolution education in Brazil. The few systematic literature reviews found on this topic were all performed on PhD and/or master theses.

DISCUSSION

Our literature review showed that the number of publications concerning evolution education in Brazil increased during the 2013-2025 period, particularly after 2020. These results reinforce earlier reported trends regarding PhD and master theses between 2008-2018 (Felix & Oliveira, 2021), and between 1991-2021 (Santos & Fernandes, 2024) and demonstrate that it even intensified in the last six years. This more intense increase in papers regarding evolution education in Brazil after 2020 is possibly related to the growth of the amount of PhD and master theses on the subject, which peaked in 2019 (Santos & Fernandes, 2024). Moreover, Abdullah (2022) has recently demonstrated that the increase in scientific publications on biology education, peaking in 2019 and 2020, is a worldwide trend. Considering the Brazilian context, it might also be related to the recent curriculum reform, officialized in 2018 (BNCC, 2018), which may have been influencing authors to investigate science education in this new arrangement, especially in basic education.

The fact that only 11.6% of the papers regarding evolution education in Brazil between 2013 and 2025 were published in EN and that the very low yearly number of EN-publications (1-6 per year) has not been proportionally increasing in the same period, indicates that evolution education research in Brazil is not yet sufficiently internationalized. Hence, our results confirm the conclusions from an earlier study by Monteiro and Hirano (2020) showing that in Brazil, scholars from humanities and social sciences publish much more frequently in PT than in EN. This indicates that potentially relevant evolution education research in Brazil published in PT is not available for the international research community, in this way also preventing potentially fruitful partnerships with international scholars on communal research topics.

Considering the journals where the reviewed papers were published in, almost 80% of them had only one or two publications with regard to evolution education in

Brazil, which indicates that the scientific production on this theme is rather dispersed across several journals than concentrated on fewer journals more focused on the area. Although around 58% of the journals belonged to Qualis A, more than 71% of the papers were published in these A journals, with the proportion of EN and PT-papers published in A journals being identical. When focusing exclusively on the highest quality (A1) journals, although these represented only 14.9% of all journals, 31.2% of all papers were published in these journals, with a similar proportion between EN and PT-papers. These results suggest that regarding evolution education Brazilian authors publishing A1-quality papers do not aim more at an international readership by publishing in EN but seek to publish in high-quality journals both in PT and in EN.

Our results related to the education levels addressed in the papers were similar to those found by Felix and Oliveira (2022), investigating PhD and master theses on evolution education in Brazil. Although the majority of papers reviewed focused exclusively on basic education, which is important since most Brazilian citizens do not attend higher levels of education (*Instituto Brasileiro de Geografia e Estatística [IBGE], 2023*), the largest part focused exclusively on upper secondary education, which consists of the last three years of basic education (LDB, 1996). A likely explanation is that it is only at this stage that biology has the status of a school subject in Brazil, separated from the other natural sciences (BNCC, 2018). Therefore, it is probably easier and more convenient to investigate evolution exclusively in the context of biology classes than to do the same in a broader context, which also includes physics and chemistry. However, since only 10% of articles focused specifically on the stages earlier than upper secondary education, with almost none on primary education and none on early childhood, these results indicate that research during 2013-2025 in Brazil was not in accordance with what various authors have been lately advocating, namely that teaching and learning evolution should begin as early as possible, preferably already during primary education, in order to improve its acceptance and understanding (Pinxten et al., 2020; Sá-Pinto et al., 2021). It should also be noted that PT-papers focused significantly less on higher education and significantly more on basic education than EN-papers, indicating that Brazilian researchers aim more at a Brazilian readership, not fluent in EN, when investigating basic education, in which evolution is largely instructed.

Research about evolution education in Brazil in the last 13 years appeared to be mainly concentrated on the topics didactic methods and understanding and/or acceptance of evolution, while teaching resources analyses, HPSS, literature reviews and in particular teacher education and curriculum analyses received considerably less attention. These results are in

accordance with international evolution education research trends (Glaze & Goldston, 2015; Ziadie & Andrews, 2018). It is interesting to notice that teacher education and curriculum analysis together represented only 5.6% of the investigations. Although various authors argue that these two are among the most critical problems concerning evolution education in the country (Araujo et al., 2023; Azevedo & Alle, 2022; Silva et al., 2021), but also in many European countries (Mavrikaki et al., 2024), our results suggest that both have been considerably neglected by Brazilian researchers in recent years.

However, considering EN-papers and PT-papers separately provided different results. Whereas the topics addressed by PT-papers followed the above-mentioned trend, the majority (71.4%) of the EN-papers focused on the understanding and/or acceptance of evolution. Didactic methods ($n = 3$), discussion about HPSS ($n = 2$), teaching resources analyses and literature reviews (each $n = 0$) were virtually only addressed in papers published in PT. The latter focused significantly less on understanding and/or acceptance and significantly more on didactic methods and teaching resources analyses. Considering that we found only 35 (11.6%) papers available in EN and that 71.4% of these were related to one particular topic, namely the understanding and/or acceptance of evolution, these results indicate that research on evolution education in Brazil available for international readership is even less diverse than it seems, preventing these readers and researchers from having an adequate overview of the Brazilian current state of research in this area, a problem that we addressed with this review paper.

More specifically related to the studies focused on the understanding and/or acceptance of evolution, our results showed that they addressed substantially more the understanding than the acceptance, especially the papers written in PT. Compared to a recent European review on the same topic (Kuschmierz et al., 2020), which showed an equivalence between the number of investigations on the understanding and acceptance, Brazilian researchers seem to be more concerned about the understanding of evolution than its acceptance. A possible explanation may be that recent research has shown considerably higher levels of acceptance of evolution than understanding in students (Santos-Gouw et al., 2013), undergraduate students (Tavares & Bobrowski, 2018) and teachers (Almeida et al., 2014) in the country. In addition, various studies have indicated that a proper instruction on the topic is probably more important for its acceptance than other factors, such as religion (da Silva Oliveira & Bizzo, 2018; da Silva Oliveira et al., 2022). Our results also showed that the most investigated groups regarding the understanding and/or acceptance of evolution in Brazil were school students and teachers, followed by undergraduate students. In contrast, research in Europe on this topic

seems to focus much more on undergraduate students, especially pre-service teachers (Kuschmierz et al., 2020).

Considering didactic methods, the second most investigated research topic in Brazil, it should be emphasized that 97 of the 100 papers addressing the topic were published in PT, and hence not available for international readers. These included a wide range of strategy and resource proposals for teaching evolution, although our results indicate that most researchers choose to employ games and teaching sequences. A likely explanation for this phenomenon is that most of these didactic methods developed by the researchers, especially games (Teixeira & Valle, 2025) and teaching sequences (Dall'Acqua & Mano, 2024), are an effort to provide teachers with accurate tools for teaching evolution. Therefore, as most Brazilian basic education teachers are not fluent in EN (Forattini, 1997), it is expected that these tools are largely published in PT.

Regarding the teaching resources analyses, the majority (68.3%) of the studies within this category analyzed textbooks. Some other printed and less formal resources, such as books, comics and magazines, were also investigated, but by only 19.5% of the papers. Although digital technology has influenced many different fields in recent years, including education (Haleem et al., 2022), we identified that only 12.2% of the studies within this category – summing the percentage of the studies addressing digital handouts, films, educational software, documentaries and animation/simulation – analyzed digital resources. Textbooks are known to play an important role in education (Weiss et al., 2003). In Brazil, according to Santos and Nagashima (2021), textbooks are the most important and, frequently, the only teaching resources Brazilian teachers have access to, which might justify why these were by far the most investigated teaching resources regarding evolution education in the country and why other types of resources, including digital, have been receiving considerably less attention. Likewise, Panayides et al. (2024) recently investigated which evolution concepts are addressed in science textbooks from the 1st to the 9th grade in eight European countries and reported that textbooks lack or rarely address concepts considered important for evolution understanding.

The analysis of the papers categorized as literature reviews revealed that there have been few systematic literature reviews and none of them investigated scientific papers. Besides, none of these reviews was written in EN. Hence, to the best of our knowledge, the present study is the first literature review aiming at international readership, focusing on the state of research regarding evolution education in Brazil by reviewing papers published in scientific journals. However, it should be noted that the results of this study are limited in several aspects. First, we chose only Google Scholar to search for papers. Using other

databases such as Web of Science or ERIC might have resulted in identifying other or additional papers published in scientific journals. On the other hand, Google Scholar has been used as the only database in other evolution education review papers (f.e. Kuschmierz et al., 2020). Second, papers were classified according to the prevailing topic, but some papers also addressed other topics apart from the chosen one, which could cause some distortion of the overall image.

CONCLUSIONS

Although we agree with Forattini (1997) about the importance of Brazilian authors publishing in PT so the studies can reach Brazilian professionals and have a direct impact on this country's culture, we also argue that Brazilian researchers, particularly from the science education field, need to increase their research communication with the international community by publishing more often in EN. As our results show, in the specific case of evolution education, Brazilian authors already perform high-quality research that is relevant enough to be published in EN and thus shared with the community of science education researchers around the world. This can bring more attention and international collaboration for investigating and dealing with Brazilian educational issues, contributing to further insights into how to improve evolution education in general.

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