

Academic production in biology teaching: analysis of dissertations and theses, and reflections for the science education area

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ABSTRACT

We analyzed the academic production related to Biology Teaching from 1972–2016 and identified 1,613 dissertations and theses defended in graduate programs held in the five regions of Brazil, studied in this article according to the following categories: releasing year and quantitative evolution; institutions of origin and geographical distribution; academic degree; supervisor. The research findings were examined based on the literature produced by authors dedicated to reflecting on the evolution of research and graduate studies in the educational field. In the results, we explain some characteristics of the institutional base that supports this production and the investigative field, commenting on the most recent trends and reflecting on the evolution of the Science Education area in Brazil.

KEYWORDS

dissertations; thesis; state of the art; biology teaching.

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PRODUÇÃO ACADÊMICA EM ENSINO DE BIOLOGIA: ANÁLISE SOBRE DISSERTAÇÕES E TESES E DERIVAÇÕES REFLEXIVAS PARA A ÁREA DE EDUCAÇÃO EM CIÊNCIAS

RESUMO

Analisamos a produção acadêmica relacionada ao ensino de biologia no período 1972–2016, com a identificação de 1.613 dissertações e teses defendidas em programas de pós-graduação pertencentes às cinco regiões do país, estudadas neste artigo conforme as seguintes categorias: ano de defesa e evolução quantitativa; instituições de origem e distribuição geográfica; titulação; e orientadores. Os achados da pesquisa foram examinados de acordo com a fundamentação da literatura produzida por autores dedicados a desenvolver reflexões sobre os rumos da pesquisa e da pós-graduação na área educacional. Nos resultados, explicitamos algumas características da base institucional sustentadora dessa produção e do campo investigativo, comentando tendências caracterizadoras do período mais recente e estabelecendo reflexões a respeito dos rumos da área de educação em ciências no país.

PALAVRAS-CHAVE

dissertações; teses; estado da arte; ensino de biologia.

PRODUCCIÓN ACADÉMICA EN LA ENSEÑANZA DE LA BIOLOGÍA: ANÁLISIS DE LAS DISERTACIONES Y TESIS Y REFLEXIONES PARA EL ÁREA DE LA EDUCACIÓN EN CIENCIAS

RESUMEN

Se analizó la producción académica relacionada con la Enseñanza de la Biología en el período 1972–2016, con la identificación de 1.613 disertaciones y tesis defendidas en programas de posgrado pertenecientes a las cinco regiones del país, estudiadas en este artículo según las siguientes categorías: año defensa y evolución cuantitativa; instituciones de origen y distribución geográfica; titulación; asesores. Los hallazgos de la investigación fueron examinados a partir de la literatura producida por autores dedicados a desarrollar reflexiones sobre la dirección de la investigación y los estudios de posgrado en el campo educativo. En los resultados, explicamos algunas características de la base institucional que sustenta esta producción y del campo investigativo, comentando las tendencias que caracterizan el período más reciente y estableciendo reflexiones sobre el desarrollo del campo de Educación Científica en Brasil.

PALABRAS CLAVE

disertaciones; tesis; estado del arte; enseñanza de biología.

INTRODUCTION

Since 2004, when we began our doctoral research, we have made a continuous effort to conduct research studies dedicated to the analysis of data about Brazilian academic studies in *biology education*. We dived into a field of studies known as *state of the art* and the so-called *meta-research* with the understanding that they offer strategic elements for the foundations of a systematized knowledge about the trajectory of this field within a certain historic period. The idea is to understand the developments in academic production in Brazil during a historic series beginning in 1972. Thus, with the gradual presentation of the results of our studies, we periodically provide the academic community with information that is fundamental to mapping out the production of dissertations and theses in one of the most active and representative subareas¹ within the broader group of research in science education (Teixeira, 2008; Teixeira and Megid Neto, 2006, 2011, 2012, 2017).

We understand that the descriptive and analytical study of theses and dissertations offers significant advantages over analyses of other modalities of publication. Primarily because theses and dissertations represent a fundamental and predominant share of the studies conducted at institutions of higher education. As Salem (2012, p. 22) indicated, dissertations and theses “more directly and specifically reflect academic production”, and are characterized by studies conducted in graduate programs, which are considered the main source of education for researchers who enter the field. One should bear in mind that, in the educational field, most of the research studies are conducted at the graduate level and by individuals educated in these spaces (Macedo and Sousa, 2010). In addition, we understand that theses and dissertations are more suitable documents for state-of-the-art analyses², given that they are primary documents containing complete and more in-depth reports of the studies conducted by researchers in training and their supervisors. Subsequently, as a rule, these studies are published more succinctly in the form of articles in journals, papers presented in events, books, and book chapters (Salem, 2012; Teixeira and Megid Neto, 2017).

When considering graduate studies, research in the field of education — including soon after the creation of research lines in science education — has been conducted for at least 50 years³. Despite fluctuations in research production within graduate studies, there have been clear advances in education and science education. This study focuses on science education, which is currently present in several graduate programs in various regions, contributing, as a group, to human resources

1 Based on the work of Bourdieu (2004), we consider biology education as one of the subareas of the science education area.

2 In *state-of-the-art* studies, the idea is to “compile an inventory, describe, and analyze academic production” in a given field of knowledge and according to a previously defined time period (Ferreira, 2001, p. 49).

3 The first graduate programs in the area of education in Brazil arose in the 1965 (Gatti, 2007; Macedo and Sousa, 2010).

for basic and higher education⁴, a community of researchers, teaching and research associations, research groups, and of course, the production of knowledge targeting the challenges of learning and teaching sciences.

This is a unique study because it is part of a project dedicated to mapping out Brazilian research studies in *biology education*, aggregating information about previously conducted studies. Therefore, in this phase of the project, we added five more years to the historic series analyzed. Only documents specifically aimed at the subarea of *biology education*⁵ were considered, building on studies undertaken to describe and systematize data about academic production in this category. In our judgment, as the area became better organized, production increased and diversified, creating the need for a periodical follow up of its evolution, in a process of self-reflection, to identify trends and traditions, oscillations and changes, and to indicate perspectives and challenges for future studies (Teixeira, 2008; Salem, 2012; Silva and Jacomini, 2017).

This article presents some of the results of a study undertaken to identify, describe, and analyze the production of master's dissertations and doctoral theses, over 45 years of academic studies in graduate programs in the area of biology education in Brazil. Upon completing the main phase of the project, we present data that are useful to the revision of the information presented in our last study, published in 2017 (Teixeira and Megid Neto, 2017). Thus, some of the important questions considered include: How has academic production in *biology education* developed quantitatively and qualitatively over time? What is the institutional base that supports academic production? Do we have programs, supervisors, and research groups that are well established in the production of knowledge and training of researchers in this subfield? Based on the data from this study, what challenges are faced by the field of science education in the near future?

METHODOLOGY

The research focused on an interval between the year in which the first studies in biology education were defended in Brazil (1972) and 2016, a year determined as the cutoff date for data collection from databases of dissertations and theses. In addition to searching for data at Brazilian Federal Agency for Support and Evaluation of Higher Education (*Coordenação de Aperfeiçoamento de Pessoal*

4 In Brazil, "basic" education includes the levels of early childhood, elementary, middle, and high school education.

5 The research focused on studies that in some way include references to teaching and learning biological sciences contents. One or more of the following elements was found in each study examined and was directly or at least partially related to *biology education*: the school environment studied; the subjects involved in the research (teachers, instructors, students, students in teacher accreditation courses); courses for initial and or continuing teacher education; didactic materials and resources; teaching methods and techniques tested; educational programs proposed; evaluation of curriculums in their various levels and possibilities; legislation; and educational and training experiences reported in the studied conducted (Teixeira, 2008; Teixeira and Megid Neto, 2017).

de Nível Superior – CAPES), which is an important source of studies focused on dissertations and theses, we also consulted the internet pages of graduate programs registered in the field of education and teaching, and the institutional repositories of the institutions of higher education offering these graduate programs. Supplementary information referring to the programs and the supervisors was collected from the Lattes and Sucupira platforms⁶.

During this study, we did not examine studies from professional master's degrees offered by a network of institutions, given that they follow a logic of organization and functioning that is different from that properly examined by the evaluation committees designated by CAPES' Directorate of Evaluation.

The procedures adopted to support the search for data, including the use of keywords⁷, titles, references, and abstracts, have been improved over time. With the experience gathered in our studies, we identified that the CAPES Catalog of Theses and Dissertations (*Catálogo de Teses e Dissertações* – CAPES⁸) is not regularly updated, and various studies are registered with a delay or simply do not appear in the database. Thus, it was essential to establish a process of source triangulation for collecting information that would be useful to identify the scope of each work, thus ensuring that a significant portion of the studies produced in Brazil, in the period in question, were “captured”. However, it is not possible to guarantee that all of the studies defended over 45 years have been included in the set of documents designed to act as the base for the *corpus* of the study. Therefore, we reiterate what was mentioned in our previous articles, when we observed how significantly the field had expanded; retrieving, analyzing, and cataloging academic production have become increasingly difficult and complex due to the high number of studies defended each year and the need to consult various information sources to collect the data (Megid Neto, 2014; Teixeira and Megid Neto, 2017).

Considering the limitations mentioned above, at the end of the search process, which was concluded in February 2020, the results obtained totalized 1,613 references. We have continued the search process, knowing that we will locate new dissertations and theses within the period stipulated for this study, which will be examined in a future phase of the study.

By identifying the abstracts, and the institutional and bibliographic references of each study, the information was organized in individual forms and analytical tables. During the research process, considering its broader objectives, to examine the material obtained with a mixed-nature approach⁹ (Creswell, 2014), we con-

6 On Lattes platform, we can find the curriculum of supervisors, and Sucupira platform is a source of data about graduate programs.

7 Keywords used in combination in the search process: biology; biological sciences; teaching; learning; education; teaching biology; science; teaching science; science education; scientific education; scientific literacy.

8 Available at: <https://catalogodeteses.capes.gov.br/catalogo-teses/#/>. Accessed on: Feb 15, 2020.

9 According to Creswell (2014), mixed studies are those that combine procedures based on quantitative and qualitative analyses.

ducted a preliminary analysis of the documents, classifying them according to the following descriptors:

- a) year of defense and quantitative evaluation of the academic production;
- b) institutions where the studies were conducted and their geographic range;
- c) title;
- d) supervisors;
- e) school level examined in the studies;
- f) thematic lines and foci;
- g) genres of academic work.

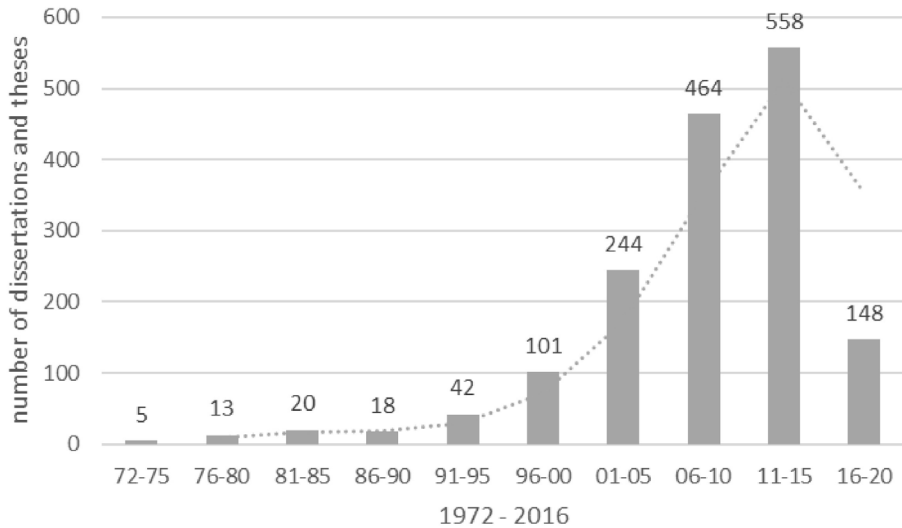
The analysis initially involved the organization of data in text files (Word) and then in spreadsheets, tables, and charts to facilitate the identification of the characteristics and trends emerging from the set of documents identified during the study. The general references for each work helped build what we call the *institutional base*, that is, a set of information that allows us to examine the dynamic of production by various Brazilian institutions, their diachronic development, and their institutional and academic characteristics, considering the Brazilian reality and the area of science education. This was done with the help of some of the descriptors mentioned (descriptors a, b, c, and d). In turn, by reading the abstracts, we were able to briefly understand the content of each study and identify themes, challenges, and levels of schooling examined, focusing on the academic studies and modalities of research (descriptors e, f, g). Going deeper, the original copies of the papers available were consulted when the abstracts and institutional/bibliographic references did not provide the information sought in this step. A large portion of the dissertations and theses (98%) was obtained online (in PDF files) or in print, for a deeper analysis, involving the full content of each study.

In the general framework of the research, the results were analyzed in two parts, one based on what we call the *institutional base*, and the other, focused on the research problems and on the *thematic and methodological trends* that characterize academic production in biology education. In this article, because of space constraints, we will only present data and reflections about the *institutional base* that supports this academic production, stimulating reflections and analyzing potential implications for the area of science education.

ANALYSES AND REFLECTIONS

Following the tendency of previous studies, we can affirm that in the period under analysis, especially over the last five years, academic production in biology education has continued to grow. This expansion is the result of graduate programs being broadened and diversified, which was significantly intensified in the past decade, at least until 2018, when a crisis removed the legally established president from office and implemented liberal concepts in the Brazilian government, creating uncertainty and attacks to public policy systems, including education, universities, and graduate programs, as well as the fields of science, technology, and many others.

The evolution of academic production is represented in Graph 1 that shows the 1,613 dissertations and theses produced since 1972.



Graph 1 – Diachronic distribution of the 1,613 dissertations and theses defended from 1972 to 2016.

Nevertheless, it is also clearly important to highlight the increased production in quantitative terms (observe the trend line) since the first papers were first made available in the early 1970s. Modest and irregular growth was seen until the mid-1990s because Brazil was still in the process of creating graduate programs, in a system that was still emerging. During its early development, it was composed of programs that were established in large urban centers, particularly in state capitals. Considering the entire period, this expansion took place simultaneously with the development of the area of science education and educational research in a broader sense, as indicated by the studies of Macedo and Sousa (2010), Salem (2012), Teixeira (2012), Megid Neto (2014), and Teixeira and Megid Neto (2011, 2012, 2017).

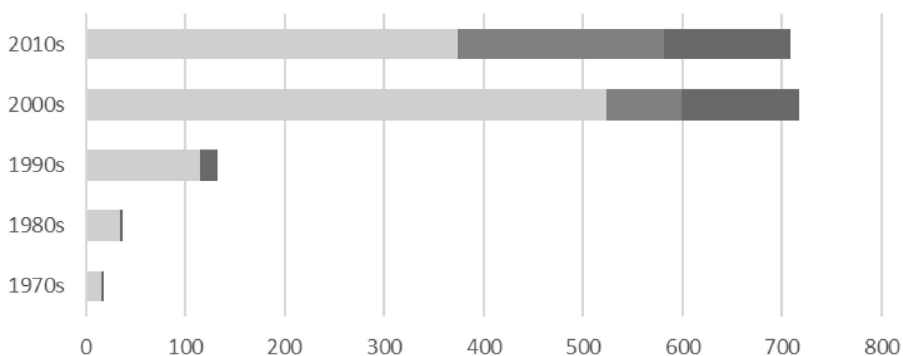
The more vigorous growth observed since the late 1990s until the current period is the result of the larger number of programs throughout Brazil, a process induced by various factors including: the creation of the area of science education (Area 46) at CAPES, which was later converted into the current field of education; the creation of new universities and professional programs; and the most recent graduate programs¹⁰, with goals set to grow and increase the

10 *PNPG: National Graduate Studies Plan*. For example, we can use PNPG 2005–2010 as reference, which sought an equitable distribution of the national graduate studies system “to successfully meet the various demands of society” (Brasil, 2010, p. 29).

presence of graduate studies throughout the country, and eliminate discrepancies between the various Brazilian regions. According to Lopes and Costa (2012, p. 717), “although graduate education programs [...] were initiated in the 1970s, significant expansion of their organization in research groups and lines was only observed in the first decade of 2000”. Because of all of these aspects, the past 15 years account for some 86% of the defenses in the entire period of 1972–2016.

The distribution of production indicates an average of 35.8 studies per year. In the 1990s, this average was 8 studies per year. In the late 1990s, the average rose to 25 studies per year. In the first decade of the twenty-first century, there was impressive growth, reaching an average of more than 70 dissertations and theses per year in the area. Finally, in the last five years of the historic series examined, there was an equivalent of 118 dissertations and theses per year, representing an increase of 16% over the previous five-year period (2007–2011).

Graph 2 shows the distribution of dissertations and theses according to the descriptor — degree. The production of academic master’s dissertations increased throughout the period. These studies represent 65.9% of all the studies analyzed. Doctoral theses were rare until the late 1980s, with only five studies defended until 1990. In the 1990s, the total production increased three-fold compared to the previous decade; and in the 2000s, it reached 118 dissertations and theses, maintaining this rhythm of production until 2016, when there were 125 dissertations and theses. In summary, doctoral theses correspond to 16.5% of the production analyzed.



	1970s	1980s	1990s	2000s	2010s
■ MA	15	35	115	524	374
■ MP	0	0	0	75	208
■ D	3	2	18	118	126

MA: Academic Master’s; D: Doctorate; MP: Professional Master’s.

Graph 2 – Distribution of dissertations and theses in biology education (1972–2016) by decade, considering the descriptor/degree.

There were 284 professional master's dissertations¹¹ until 2016. Considering the entire period, they accounted for 17.6% of the studies identified. However, in the last 11 years studied, since the first professional masters appeared in 2006, this percentage increased to 24.2%, being the category with the most significant increase among the three categories examined.

Although academic programs continue to generate most of the studies, the professional master's certainly stimulated the field in the past ten years, given its significant expansion (Moreira and Nardi, 2009). In fact, the professional masters [programs] were "widely supported for nearly two decades in our country" (Antunes Júnior, Ostermann and Cavalcanti, 2019, p. 268).

One fact that helps understand the expansion of professional programs can be found when we compare the situation of the Area of Education/Teaching (CAPES) in 2016 to the current moment. In May of that year, there were 162 graduate programs: 58 Master of Arts programs, 31 doctoral programs, and 73 professional master's. Today, according to a page in CAPES area of education, most of the programs in this area are professional master's (96 out of 230). In addition, there are eight professional doctoral programs. In the area of education, until the early 2010s, professional programs were not permitted, but there are now 54 professional programs in the area, 19% of the total of programs¹².

It would be interesting to analytically follow the unfolding of this movement in the coming years, particularly considering the current emergence of professional doctoral programs. Some analyses about the professional programs are beginning to emerge in the literature (Schäfer and Ostermann, 2013; Villani *et al.*, 2017) in an effort to translate the impact of these programs as a modality aimed at continuing education or as "educational spaces with great potential so that teachers can develop professionally in different dimensions of their teaching careers" (Villani *et al.*, 2017, p. 128).

Evidently, the growth in these professional programs is expected to have positive implications for teacher education and the pursuit of transformations in teaching and learning processes (Grassi *et al.*, 2016). However, we understand that deeper analyses about the role of the professional master's programs on the development of our field of research and production of knowledge are still scarce. One exception is the editorial text of Villani and Mattos (2011), who addressed the increase in the number of these programs, associating this process with a situation

11 Professional master's programs were established in 1995 through Capes Ordinance No. 47, regulated by Ordinance No. 80/1998, in which the Ministry of Education "assumes responsibility for regulating and offering these programs". The proposal for making *Stricto Sensu* graduate studies more flexible at the master's level (academic and professional) was based on the need for university-level education that met social demands, considering that technological changes, and economic and social transformations require professionals with profiles of specialization" that differ from those traditionally existing until that time (Chisté, 2016, p. 790).

12 Data from CAPES website. Available at: <https://www.gov.br/capes/pt-br/aceso-a-informacao/acoes-e-programas/avaliacao/sistema-nacional-de-pos-graduacao-snpng/dados-do-snpng/cursos-recomendados-reconhecidos>. Accessed on: May 2020.

that could potentially trigger a “depletion of rigor and quality based on which research studies and their results are currently evaluated, particularly in academic master’s programs” (Villani and Mattos, 2011, p. 8).

This indicates the need for more in-depth studies about the influence of professional degrees to provide data to support reflections on this phenomenon within the educational field, and in particular, within the field of science education. In our recent analyses, we have problematized the directions of graduate studies. More than an effort to define distinctive elements that separate academic or professional master’s (Freire and Germano, 2009), it is important to analyze the identity issue of academic programs, given that the profile of professional programs, which are more associated with training teachers to work with basic education, appears to be consensual. Our hypothesis is that the scope of research in graduate degree programs [known as *stricto sensu* in Brazil] has deteriorated because, in recent years, we have gradually focused our efforts on becoming the main foundation for human resources training in the educational field¹³. In our case of science education, special attention is now clearly given to the scope of teacher education with the expectation that the area will provide responses to the Brazilian educational crisis. The professional programs have clearly taken on this perspective¹⁴. In the wake of the process, we suspect that the academic programs have also gradually turned their attention to these projects, which are obviously legitimate, but inevitably create dilemmas for our field, as an area of research and production of knowledge. For example, as Silva and Jacomini (2017, p. 643) highlighted:

We speak of the interpellations of the articulation between what is studied in undergraduate [and graduate] programs and the reality of basic education as if applications are sought in the programs of higher education that would automatically empower us for efficient practice. These decontextualized notions have established a strong apparatus (including ideologically) for education to be increasingly focused on knowing how to do, moving away from the conceptual domain.

13 In this regard, it is important to mention that, according to the National Education Plan (*Plano Nacional de Educação – PNE*), Brazil will have 60,000 masters in 2024, 50% of whom will be teachers of basic education. According to the Field of Expertise Factsheet - Education (Brasil, 2019), the area of Education “is [...] associated with goals 15 and 16 of the PNE and with one of the missions of Capes: teacher education” (Brasil, 2019, p. 7).

14 See, for example, Field of Expertise Factsheet - Education (Brasil, 2019), which advocates “that the vocation for researching educational products and processes to meet social demands is more pronounced in professional courses (Master’s and Doctoral degrees), aimed primarily at basic education”. The document also indicates that it is “expected that actions and projects undertaken in graduate programs in the field seek to transform the practice of teachers and, to do so, rely on the constitution of a *teacher as a researcher*, including of their own practice. Thus, with proper and sound education, it is expected that graduates of the programs also act as agents who contribute to having important social impact as to the quality of teaching in educational institutions, in their diversity” (Brasil, 2019, p. 9, our emphasis).

The education of professors for higher education and the training of technicians who work with education in government administration have certainly been the goals planned for graduate studies (Kuenzer and Moraes, 2005; Macedo and Sousa, 2010; Silva and Jacomini, 2017). Subsequently, graduate programs were modified, “shifting the focus from teaching [in higher education] to researching” (Kuenzer and Moraes, 2005, p. 1,347). For this reason, we place greater value on the education of researchers and the production of knowledge. Another modification occurs through the proposal of the 5th *National Graduate Education Plan* (2005–2010), a document outlining guidelines for graduate programs focusing on “educating professors for institutions of higher education, *qualifying basic education teachers*, professional specialization [...], and training technicians and researchers for public and private companies” (Brasil, 2004, p. 49, our emphasis). According to these authors, this has two significant novelties, one of which is associated with the responsibility programs have to qualify teachers for elementary and middle school, high school, and technical education.

Considering this trend, the Field of Expertise Factsheet (*Documento de Área*), one of the guidelines for designing programs registered in the Area de Education (the former Area of Science and Mathematics Education) specified the idea that “research in Teaching is strategic as it is one of the components needed to promote changes in Basic Education and Higher Education” (Brasil, 2019, p. 3). In addition, it indicates that the growth and performance expectations for this Area are founded on “the situation of Basic Education in Brazil, as well as in the challenges for the continuing education of university professors and teachers who work in Basic, Technical, and Higher Education, and of educators in general” (Brasil, 2019, p. 3).

As can be seen, given the information presented, various challenges have emerged in recent years. For this reason, the following questions have to be asked: does the current model combine these priorities, with the production of knowledge being integrated into the education of teachers and other educational professionals, but without reducing the dimension of research, training of researchers, and production of knowledge? Or are programs becoming certification and continuing education courses aimed more specifically at teacher education? Thinking of science education, what will the configuration of graduate programs and our area as a field of production of knowledge be in the near future?

Addressing other aspects that characterize the *institutional base* that supports the academic production under study, we will now focus on its geographic distribution. We found that the studies produced continue to be concentrated in Brazil’s South and Southeast regions, and regional asymmetries are still present.

However, this process has been mitigated in the period studied. The South and Southeast regions, which have some of the oldest and earliest graduate programs¹⁵ with research lines in the area, jointly account for 73% of the documents

15 The pioneer graduate programs in the field were created in the 1970s: the physics education program at UFRGS was created “as a line of the PPG [graduate program] in Physics” and that of USP was implemented through a partnership between the university’s Institute of Physics and the School of Education (Delizoicov, 2007). For more information about the history of implantation of these initial programs in science education, see Delizoicov (2007), Megid Neto (2007), and Nardi (2007).

examined. The Southeast accounts for most of the studies, with 49%, nearly half of all the documents. Studies were identified in 24 states, including the Federal District. However, there were no studies in the states of Tocantins and Maranhão. Other states, such as Rondônia, Roraima, Acre, Piauí, Paraíba, and Espírito Santo, have very limited production. This shows that although there has been valuable progress in recent decades, more institutions and spaces, both for undergraduate and graduate education, are still needed in various locations, particularly outside city capitals through Brazil.

The states with the highest number of studies produced are São Paulo, 457 studies; Rio de Janeiro, 218; Rio Grande do Sul, 155; Paraná, 136; Minas Gerais, 107; Santa Catarina, 101; Bahia, 90; and Pernambuco, 51. The Table 1 illustrates the 1,613 dissertations and theses distributed according to the percentage contribution of each Brazilian region.

Table 1 – Distribution of dissertations and theses in biology education by Brazilian region (1972–2016).

Region	Number of Dissertations/Theses	%
North	57	3,6
Center-West	136	8,4
Northeast	237	14,7
South	392	24,3
Southeast	791	49,0
TOTAL	1,613	100,0

As mentioned earlier, we continue to observe a gradual increase in representativeness for the Center-West, Northeast, and North regions. Together, these regions accounted for 15% of the dissertations and theses until 2004; rose to 17.1% by 2006; reached 21.5% in 2011; and now account for 26.7% (Figure 1).

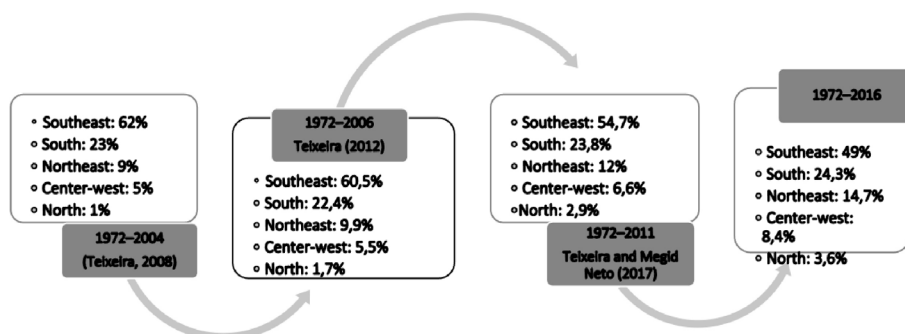


Figure 1 – Dynamic of the distribution by region of dissertations and theses in four different moments characterized by studies related to the mapping of academic production.

Thus, the hypothesis formulated in our previous work, that there is a moderate decentralization of research studies in the field, has been confirmed. This is reflected in the public policies implemented in the past 20 years for the creation of higher education institutions in the regions mentioned above and elimination of asymmetries among the various Brazilian regions, particularly regarding research funding and generation of master's and doctoral programs in institutions located in the North, Northeast, and Center-West regions (Teixeira and Megid Neto, 2017). The question is, was this process interrupted by the recent changes in the Brazilian political and economic scenario?

The data found corroborate the evaluation of the area of education at CAPES, recognizing that there is still room for growth in “graduate programs in all regions, in particular those that are historically short in availability” (Brasil, 2019, p. 13).

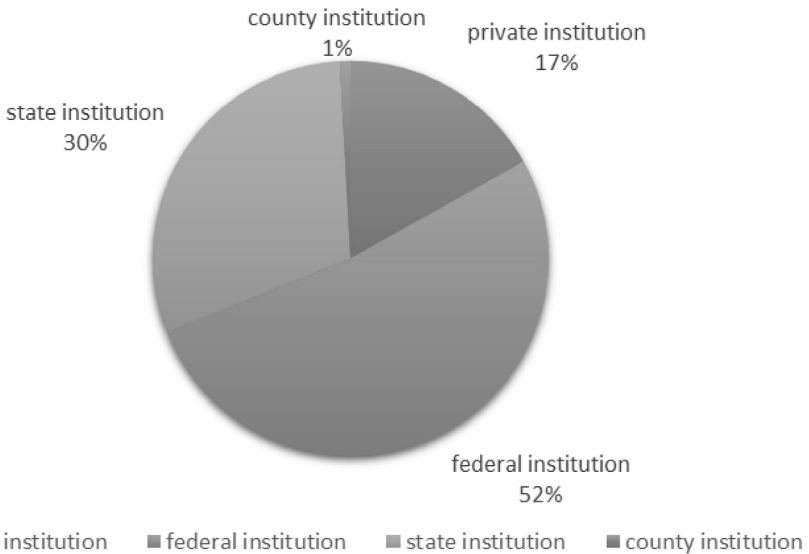
We identified studies from 120 different institutions and found that production evolved more significantly in public institutions, which accounted for 1,341 defenses, among which 488 are in state institutions, 839 in federal institutions, and 14 in one municipal institution of higher education¹⁶. Among state institutions, most of them are located in São Paulo, which concentrates 320 studies out of a total of 1,613 documents [Universidade de São Paulo (USP): 148; Universidade Estadual Paulista “Júlio de Mesquita Filho” (UNESP): 112; Universidade Estadual de Campinas (UNICAMP): 60]. The state institutions of Paraná [Universidade Estadual de Londrina (UEL); Universidade Estadual de Maringá (UEM)] also have significant production (74 DT). Among the federal institutions, Universidade Federal de Santa Catarina (UFSC) (82), Universidade Federal do Rio de Janeiro (UFRJ) (67), Universidade Federal da Bahia (UFBA) (58), Fundação Oswaldo Cruz (Fiocruz) (50), Universidade de Brasília (UnB) (46), and Universidade Federal Rural de Pernambuco (UFRPE) (36) stand out. The distribution of dissertations and theses by institution is illustrated in Graph 3.

Thus, studies defended at public institutions account for 83% of the total production and the remaining 17% come from private universities (272 dissertations and theses), highlighted by Pontifícias Universidades Católicas (PUCs), such as Pontifícia Universidade Católica de Minas Gerais (PUC-MG), Pontifícia Universidade Católica do Rio Grande do Sul (PUC-RS), and Pontifícia Universidade Católica de São Paulo (PUC-SP).

Over all, the data available in the historic series place an emphasis — once again — on the irreplaceable role of public institutions as the predominant environment for the education of teachers and researchers, and research in the area.

It is also interesting to observe the increased number of studies defended in federal institutions over the last years analyzed because of the creation of new programs at various universities and in Federal Institutes of Education, Science, and Technology. At a time when the role of public universities has been questioned, particularly by conservative and reactionary movements, and material (budget cuts) and symbolic attacks have been made because of the dissemination of “unfounded

¹⁶ Fundação Universidade Regional de Blumenau (FURB), in the state of Santa Catarina.



Graph 3 – Distribution of dissertations and theses according to the nature of the institution (1972–2016).

information [and] bad faith use of incorrect data”¹⁷ in an attempt to disqualify public education and research institutions (Costa, 2019), the information presented here can effectively show the importance of public institutions in the education of human resources and production of knowledge in the field of science education.

In terms of the graduate programs responsible for the production of the dissertations and theses analyzed, we have the following information. The specific programs of sciences and mathematics education confirm their positions as important research centers in the subarea studied and are responsible for 939 documents (58.2%). The institutes, colleges, and centers of education total 501 documents (31%), naturally associated to master’s and doctorates in the area of education. Meanwhile, biological sciences programs (biology, genetics, ecology) total 54 dissertations and theses (3.3%). The other 7.5% refer to studies in diversified programs with no tradition in the production of studies in our field (psychology, language and literature, linguistics, health, biochemistry etc.).

As seen with the indicators shown, the main locus of education of master’s and doctoral students in the biology education subarea nowadays are the typical programs of science and mathematics education, which mostly belong to the current Area of Education at CAPES.

17 Observation of Sandra Almeida, the dean of Universidade Federal de Minas Gerais (UFMG), during her participation in the seminar “O papel da universidade pública no desenvolvimento da ciência, tecnologia e do conhecimento” [The role of public universities in the development of science, technology, and knowledge], held at the House of Representatives, in Brasília, in October 2019.

A response can now be outlined to one of the questions formulated at the beginning of this article: do we have consolidated graduate programs, supervisors, and groups dedicated to the production of knowledge and the education of researchers in this subarea?

To reflect on this, we crossed the data described with the information about the supervisors of the programs that produced the most studies. In numeric terms, the main centers that produced studies are: Universidade de São Paulo (USP) (148 dissertations and theses); Universidade Estadual Paulista “Júlio de Mesquita Filho” (UNESP) (112); Universidade Federal de Santa Catarina (UFSC) (82); Universidade Federal do Rio de Janeiro (UFRJ) (67); Universidade Estadual de Campinas (UNICAMP) (60); Universidade Federal da Bahia (UFBA) (58); Fundação Oswaldo Cruz (Fiocruz-RJ) (50); Universidade de Brasília (UnB) (46); Pontifícia Universidade Católica de Minas Gerais (PUC-MG) (44); Universidade Estadual de Maringá – Paraná (UEM-PR) (40); Pontifícia Universidade Católica do Rio Grande do Sul (PUC-RS) (36); Universidade Federal Rural de Pernambuco (UFRPE) (36); and Universidade Estadual de Londrina (UEL) (34).

Thus, when we mention USP, one of the important nuclei is the School of Education (*Faculdade de Educação*), but we also found studies from the Institute of Biosciences (*Instituto de Biociências*) and other centers. The current highlight is Inter-unity Program – Science Teaching. As for UNESP, we indicate the Graduate Program in Science Education on Bauru, SP campus. At UFSC, the Center for Education Science has been a long time favorite, while in recent years the Scientific and Technological Education Program has grown in importance. UFRJ has its School of Education (*Faculdade de Educação*) and the Healthcare Education Technology Center (*Núcleo de Tecnologia Educacional para a Saúde – NUTES*), which currently have recognized and consolidated programs in the area.

Meanwhile, at UNICAMP, we have studies produced in the former program of the Institute of Mathematics, Statistics, and Scientific Computing (*Instituto de Matemática, Estatística e Computação Científica – IMECC*), a Master Degree in Science and Mathematics Teaching — 1975–1984, at the School of Education (*Faculdade de Educação*), the Institute of Biology (*Instituto de Biologia*) and, more recently, the works in the field are concentrated in the Multi-unity Graduate Program in Science and Mathematics Teaching (PECIM). UFBA has the Education, Philosophy, and Science History Program¹⁸. Fiocruz-RJ has an important program in the field of biosciences and health education. Finally, we have UnB, UEM, PUC-MG, PUC-RS, UEL, and UFRPE, which have programs in science education and/or teaching of sciences and mathematics.

Table 2 presents all of these programs. In terms of the number of dissertations and theses produced, these nuclei are the most representative within the subarea of biology education. We also include in some cases, programs in the area

18 This program at UFBA is organized in conjunction with Universidade Estadual de Feira de Santana (UEFS).

Table 2 – Main graduate programs in the production of dissertations and theses in biology education (1972–2016) in quantitative terms.

Higher Education Institution	Center/College/Program	Type of Program	CAPES Evaluation
USP	School of Education, Graduate Program in Education	Academic	5
	Inter-unities, Graduate Program in Science Teaching	Academic	5
UFSC	Center for Education Sciences, Graduate Program in Education	Academic	4
	Multi-center, Graduate Program in Scientific and Technological Education	Academic	6
UNESP/BRU	School of Sciences, Graduate Program in Education for Science	Academic	5
UFRJ	School of Education, Graduate Program in Education	Academic	6
	NUTES Institute for Science and Healthcare Education	Academic	6
UNICAMP	School of Education, Graduate Program in Education	Academic	5
	Multi-unities (PECIM), Graduate Program in Science and Mathematics Teaching	Academic	4
UFBA	Institute of Physics, Graduate Program in Education, Philosophy, and Science History	Academic	5
FIOCRUZ-RJ	Oswaldo Cruz Institute, Graduate Program in Biosciences and Healthcare Teaching	Academic	6
UnB	Multi-center, Graduate Program, Doctorate in Science Education	Academic	4
	Multi-center, Graduate Program, Professional Master's in Science Teaching	Professional	4
UEM	Center for Exact Sciences, Graduate Program in Science and Mathematics Education	Academic	4
PUC-MG	Graduate Program in Sciences and Mathematics Education	Professional	5
PUC-RS	Graduate Program in Sciences and Mathematics Education	Academic	5
UEL	Center for Exact Sciences, Graduate Program in Science and Mathematics Education	Academic	7
UFRPE	Multi-center, Graduate Program in Science Teaching	Academic	4

CAPES: Brazilian Federal Agency for Support and Evaluation of Higher Education (*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*); USP: Universidade de São Paulo; UFSC: Universidade Federal de Santa Catarina; UNESP: Universidade Estadual Paulista "Júlio de Mesquita Filho"; UFRJ: Universidade Federal do Rio de Janeiro; UNICAMP: Universidade Estadual de Campinas; UFBA: Universidade Federal da Bahia; Fiocruz: Fundação Oswaldo Cruz; UnB: Universidade de Brasília; UEM: Universidade Estadual de Maringá; PUC-MG: Pontifícia Universidade Católica de Minas Gerais; PUC-RS: Pontifícia Universidade Católica do Rio Grande do Sul; UEL: Universidade Estadual de Londrina; UFRPE: Universidade Federal Rural de Pernambuco; NUTES: Healthcare Education Technology Center; PECIM: Multi-unities in Science and Mathematics Education; MP: Professional Master's.

of education, given that the examples listed have important connections with the academic production of interest to our study.

As seen in Table 2, within this group of programs, there are more programs of an academic nature; two also have professional programs (PUC-MG and UnB). From the supplementary information found on CAPES Sucupira platform, we find indicators about these programs in the last process of Evaluation in the Areas of Education and Teaching. Most of them are programs belonging to the area of education, which was previously the area of science and mathematics education. Considering all of these examples, we see evaluation scores ranging from 4 to 7 in the current system of evaluation, indicating the existence of programs of excellence considering the National System of Evaluation of Graduate programs.

Therefore, these institutions and their respective programs clearly constitute the main nuclei of groups that produce dissertations and theses, in quantitative terms, and play an important role in the history of implantation of the area, and in the education of researchers who now play an important role in this subarea. Another peculiarity is that most of these programs include supervisors who are important leaders in the area as a whole. Other programs are more recent, but also have important professors and research groups and play a strong role in the area.

Concerning supervisors, there is still an indication of some level of dispersion or isolation, considering the large number of supervisors linked to just one, two, or three dissertations or theses ($\cong 85\%$ of the supervisors).

Table 3 indicates only the supervisors linked to at least a dozen dissertations or theses defended in the period of this study. There is a presence of researchers linked to research, studies, and publications in biology education since the 1970s. Others defended their doctoral studies in the 1980s–1990s, and began to act as supervisors, and since then, have played a crucial role in consolidating graduate programs and research lines and/or groups, and training new researchers in these subareas. Not included in the table are the professors who have concluded fewer than a dozen supervisions, who are in the process of consolidating their work at graduate level research groups.

Therefore, when we consider the 45 years of academic production in biology education, it appears there is a large number of supervisors with strong ties to the subarea. The supervisors mentioned account for 12.7% of the supervisions in the entire period. Most of them are professors who are still working and five of them are CAPES research productivity fellows. In general, their initial education was in the fields of biological sciences and natural history, except for two of them, who according to Lattes Curriculum (*Currículo Lattes*) work in the fields of psychology and medicine.

Another point to be highlighted, which confirms the data presented in previous studies, is that most supervisors are linked to only a few studies in biology education. It is important to remember that science education is an interdisciplinary, plural, and multifaceted field, and that many researchers work with broader categories than those specifically focused on biology education, such as history and philosophy of science, teacher education, curriculum, and teaching-learning. The research lines mentioned in Figure 2 corroborate this argument.

Table 3 – The leading supervisors of dissertations and theses in biology education in the period of 1972 to 2016 in numeric terms.

Supervisors	Institution	Quantity
Ana Maria A. Caldeira	UNESP-BRU	21
Charbel Niño El-Hani	IB-UFBA	20
Sandra L. Escovedo Selles	FE-UFF	18
Silvia L. F. Trivelato	FEUSP	18
Nelio M. V. Bizzo	FEUSP	18
Myriam Krasilchik	FEUSP	16
Maria Helena S. Carneiro	UnB	14
Regina Maria R. Borges	PUC-RS	13
Luzia Marta Bellini	UEM	13
Fernando Bastos	UNESP-BRU	12
Álvaro Lorencini Júnior*	UEL/UEM	11
Eliane Brígida de Moraes Falcão	UFRJ/NUTES	11
Denise de Freitas	UFSCAR	11
Ana Maria dos Anjos Carneiro Leão	UFRPE	10
Total	–	206

* Professor and researcher at Universidade Estadual de Londrina who also supervises some graduate students at Universidade Estadual de Maringá; Universidade Estadual Paulista “Júlio de Mesquita Filho”; IB-UFBA: Institute of Biology - Universidade Federal da Bahia; FE-UFF: School of Education - Universidade Federal Fluminense; FEUSP: School of Education - Universidade de São Paulo; UnB: Universidade de Brasília; PUC-RS: Pontifícia Universidade Católica do Rio Grande do Sul; UEM: Universidade Estadual de Maringá; UEL: Universidade Estadual de Londrina; UFRJ: Universidade Federal do Rio de Janeiro; NUTES: Healthcare Education Technology Center; UFSCar: Universidade Federal de São Carlos; UFRPE: Universidade Federal Rural de Pernambuco.



Figure 2 – Word cloud illustrating the research lines in the graduate programs that produce the largest number of dissertations and theses in biology education (1972–2016).

Nevertheless, the large number of supervisors with only a few studies in the field is somehow concerning. In fact, when we review the literature more broadly, focusing on the relationship of researchers with their respective lines of research, some information indicates a lack of coherence and dispersion in the research lines, programs, and theoretical-methodological references (Barros, 2002; Moreira, 2004; Salem, 2012). This is certainly an aspect that the researchers, the graduate programs, and the area as a whole should evaluate more carefully, in pursuit of strategies to mitigate this problem.

Considering all the information above, to have an idea of the number of challenges faced by the main research nuclei, upon accessing the webpages of the programs that produce studies in this field and Lattes Curriculum of the supervisors mentioned in Table 3, we identified some of the research lines most frequently mentioned, which provided the elements of the word cloud shown below. The most expressive research lines, numerically speaking, are highlighted in the illustration (Figure 2).

Most of them are related to research lines associated with teacher education; the teaching-learning process; history and philosophy of science; education in science, technology, society, and the environment; didactic resources; and language and discourse.

Finally, to complement information gathering for the study, we surveyed data about indicators of studies produced under co-supervision. We found that in 11.5% of the 1,613 studies, the authors report, in the first pages, that the study was conducted in cooperation with a second supervisor. This is an indicator about which there is practically no consolidated data and scarce literature, particularly concerning science education. However, we understand there is a very low number of studies conducted under co-supervision, and that it is important to advance in this regard. The presence of co-supervisors indicates a trend to work in partnership and through the creation of collaborative networks. That is, co-supervision is “a form of expression of the results of scientific collaboration that deserves to be more highly valued by us, especially because it can contribute to a better education for our master’s and doctoral students” (Lopes and Costa, 2012, p. 720)¹⁹.

In this light, the situation found by the analysis of institutions and supervisors reiterates the argument formulated by Megid Neto (2014) and, subsequently, by Teixeira and Megid Neto (2017), who highlight the presence of traditional institutions and programs that are strongly engaged in fostering the field, indicating the existence of renowned centers with an extensive production of studies, in conviviality with other more recent institutions, but with robust production; and others with low and sporadic production. This does not show the existence of consolidated supervisors and research groups or those with more regular and systematic interest, at least considering the subarea linked to biology education.

19 The authors cited examined co-authorship regimes in bibliographic production in the area of education, which is different from our case, given that we analyzed the presence of co-supervision regimes within the dissertations and theses examined.

FINAL CONSIDERATIONS

In this article, we focused our attention on the *institutional base* that supports academic production in biology education from 1972 to 2016. Other details of this production, such as those related to levels of education, thematic lines and problematics of investigation, and theoretical and methodological aspects that characterize this group of work will be presented in a forthcoming article.

The reflections presented herein articulate the descriptive data obtained from the reflections found in the literature that shed light on the analysis, which was produced by authors dedicated to the study of research in the educational field. Thus, even considering that this article did not present data from the analysis of dissertation and thesis contents, some interesting aspects should be noted that promote reflections and help identify implications that are useful to the entire area of science education, considering that the subarea of biology education is a significant subset of the studies produced within this field.

The study found that academic production continues to grow, reflecting the advances of graduate studies in Brazil. As shown, graduate studies in biology education have expanded significantly, as observed by the number of programs, their dissemination, and presence throughout Brazil, especially by the annual growth in the number of people with advanced degrees, teachers, and researchers who can thus interact more effectively within this field of studies. Therefore, the data presented herein reveal important factors about the reality of Brazilian education. The number of academic programs in biology education has increased, as well as the number of professionals, driven by the important role universities and programs play in the area of education. In this sense, during this difficult and adverse moment in Brazilian history, it is necessary to more intensively advocate for public institutions and endeavor efforts to prevent Brazil and our institutions from being negatively affected by anti-democratic movements that deny and distrust scientific and academic studies, while attacking the public educational system, science, and Brazilian democracy itself. We must also resist movements that attack universities, graduate studies, and public education in general under the pretext of a fiscal crisis.

As mentioned earlier, there was a diversification of graduate programs in biology education in the period studied, with an oscillation of their functions and priorities. The objectives that consistently have been historically present in the field include the preparation of human resources for institutions of higher education, research and production of knowledge, and technological development. More recently, the objectives have come to include continuing education of teachers, and articulations and commitments assumed with basic education.

In fact, the area of science education, particularly after it was converted into the area of education, has been strongly impacted by an increase in the number of academic programs and, more recently, by the growing wave of programs and courses of a professional nature. In this process, the professional master's programs in the area have strengthened the training of teachers and concomitantly driven a notable increase in academic production. The area of education is now constituted by 187 programs, of which 97 are professional ones and 90 academic.

We argue that these courses and/or programs are strongly aligned with teacher education, but also risk meeting instrumentalist, technical, and pragmatic demands linked directly to teaching and learning, as they are highly valued products and processes that represent short-term “solutions” for the problems faced by science education in basic education. As stated by Moreira and Nardi (2009, p. 5), professional master’s programs in science education are expected to train students to become “professionals who are well qualified to work in the classroom and the educational system, not researchers”. This argument precisely marks the identity of the professional programs. At the same time, the academic programs, at least theoretically, will continue to concentrate efforts on educating researchers and producing research studies. However, although graduate guidelines indicate differences between these modalities, we believe there has been an approximation and loss of identity involving academic programs, particularly master’s degree programs. The exploratory and preliminary analysis of the Field of Expertise Factsheet, the main reference for the organization of graduate programs in our field, reinforces our thesis, especially in the cases of programs created more recently that do not have a consolidated academic tradition.

On one hand, this situation is positive, given that the area has always sought to improve science education in basic education. On the other hand, we are concerned with the idea of research and production of knowledge “dehydration” in academic graduate programs, considering that while they are not the only spaces responsible for maintaining and defining the research field, they are certainly one of its most significant elements. After all, the most engaged supervisors work in the graduate programs and they are responsible for training new researchers. Therefore, the direction of the field faces a challenge in the coming years, particularly if a “practical” trend is even more intensively encouraged. We use “practical” in the sense of building a concept of educational research that values its direct application to the reality of classrooms only and programs for continuing education of teachers, thus “reinforcing linear understandings between education and its practical use” (Silva and Jacomini, 2017, p. 644). We fear that this rationale will weaken and depreciate more systematized processes of teacher–researcher education, given that in such a “practical” perspective, research and “theoretical effort [are associated] with a loss of time or metaphysical speculation” (Kuenzer and Moraes, 2009, p. 194).

Therefore, more detailed studies are needed about the curricular organization of our academic and professional programs, with comparative analyses of their curricular structure, research lines, educational processes, graduates, and the dissertations and theses produced. In recent years, very few studies have focused on the organization of our programs and studies or sought to examine education offered by graduate programs aimed at research and teaching, considering their academic and/or professional identities.

In this context, it would be important to follow the development of the area and its respective programs given the goals established by the most recent Field of Expertise Factsheet (Brasil, 2019), which defines the area of education as a field in motion. It would be interesting to examine the repercussions of this perspective about our nature and pretensions as a research field. To do so, we understand that

a deeper and more analytical study of this Field of Expertise Factsheet is urgently and extremely necessary.

In conclusion, it is important to mention that although not every master's student wants to pursue a doctorate and invest personal effort in their education as a researcher, we cannot help but think that the small number of doctoral programs is a limiting factor. This is confirmed by the fact that the percentage of doctoral theses has never gone beyond 17% of the total production of dissertations and theses over the past 25 years. How is it possible to further consolidate the existing programs when it comes to doctorate degrees? Will the professional doctoral programs help to mitigate this bottleneck? What is the impact of the professional doctoral programs on the area? These questions require additional analyses and reflections in future studies.

Finally, a gradual increase in the representativeness of the Northeast, North, and Center-West regions should be noted. This indicates progress has been made in trying to reduce the uneven distribution of programs in the area throughout the various Brazilian regions. The challenge is to find the means and resources needed to expand opportunities for graduate education and consolidate new spaces for *stricto sensu* graduate education in the area. In this sense, public policies, particularly those encouraged by CAPES, must be maintained and even intensified when possible, although the current political and economic situation of Brazil seems to pose major obstacles to the development of this project.

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