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Productions on biology teaching in Brazil: a balance sheet of scientific documents

Producciones sobre la enseñanza de la biología en Brasil: un balance de documentos científicos

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Abstract
A broad survey was carried out in Brazilian productions that discussed the teaching of biology, but with a greater focus on the use of modeling for teaching and with theoretical support from the Theory of Meaningful Learning. The survey was made in a cut between the years 1997 and 2011. It is a state of knowledge, of a qualitative nature and of bibliographic nature. Descriptors were used in platforms of major scientific importance in Brazil. With an emphasis on dissertations and theses, 25 documents were found that fit the search items. The Brazilian region with the major production in the area is in the South, the most representative state is São Paulo. The dissertations were more representative, making up 68% of the documents. It is believed that the data produced are significant and that they can contribute to the teaching of biology, in the Brazilian and international context.
Keywords: State of knowledge; teaching biology; bibliographic survey; meaningful learning

Resumen
Se realizó una amplia encuesta en producciones brasileñas que discutió la enseñanza de la biología, pero con un mayor enfoque en el uso de modelos para la enseñanza y con el apoyo teórico de la Teoría del aprendizaje significativo. La encuesta se realizó en un corte entre los años 1997 y 2011. Es un estado de conocimiento, de naturaleza cualitativa y de naturaleza bibliográfica. Los descriptores se utilizaron en plataformas de gran importancia científica en Brasil. Con énfasis en disertaciones y tesis, se encontraron 25 documentos que se ajustan a los elementos de búsqueda. La región brasileña con la mayor producción en el área es el Sur, el estado más representativo es São Paulo. Las disertaciones fueron más representativas, constituyendo el 68% de los documentos. Se cree que los datos producidos son significativos y que pueden contribuir a la enseñanza de la biología, en el contexto brasileño e internacional.
Palabras clave: estado del conocimiento; enseñanza de biología; encuesta bibliográfica; aprendizaje significativo

Introduction

The advancement of the field of research in Education and Science Teaching, in the last 40 years, is an indisputable fact. However, while recognizing that growth, in quantitative terms, represents a high-value achievement, it is essential to establish a reflective process on educational research carried out in the country, since, as the number of studies and the volume of information increase, the research field gains density and it is necessary to stop and look around to see what has already been done, where it has been and where it is intended to go, as pointed out by Teixeira & Megid Neto (2011).

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Thus, in times of mobilization of efforts to evaluate and even rethink the paths involving graduate studies in Education and Science Teaching in Brazil, it is opportune to develop descriptive and analytical studies that focus on the set of academic production developed in this software.

The field of educational research focused on Science Education in Brazil, in terms of postgraduate studies, had its origins demarcated in the transition period between the 1960s and 1970s. Since then it has experienced a significant expansion, both in the volume of dissertations and theses defended, as well as the number of programs with specific lines of research for the area. Teixeira (2008) states that with the growth of research, the volume of available information has also grown, so that the field of investigation has gradually gained density and broadened its investigative horizons. That is why the need arises to stop and look around to see what has already been done, the paths followed and what possibilities are reserved for the future. In this context, the question is: what do we know about these surveys? And more specifically, what do we know about the production of dissertations and theses and articles on teaching biology in the country?

The teaching model based on this type of rationality, also considered as a traditional teaching model, does not provide interaction between teachers and students, nor between students themselves, making it difficult to promote the construction of knowledge. The use of textbooks is the source of valid knowledge. A simplistic view of teaching and being a teacher prevails among teachers, which consists of transmitting scientific truths considered immutable, which must be assimilated by students, without any concern for the contexts, be they historical, philosophical and / or socio-cultural.

For Alffonso (2019), the diversity of methodological strategies is of great importance for the school routine, this study was prepared based on the relevance that practical classes have in the teaching of Science and Biology. Thus, that in this type of class the student is able to associate the theoretical content with the phenomenon experienced, stimulating him to create hypotheses for such an event, leading him to search for new information. Thus, however essential the application of these classes is, teachers often choose not to do it, presenting as a justification the lack of time, structure and materials.

The proposition of methodologies and / or methods that enable a more efficient and meaningful learning has been one of the biggest reasons for concern among teachers and researchers, thus, several authors have published works presenting different didactic strategies and resources that aim to facilitate and improve the process teaching and learning. In this regard, they propose the use of didactic models as an interesting pedagogical resource. Vinholi Junior & Gobara (2016) emphasize that, given the absence of costly equipment in the locus of teaching, characteristic of Brazilian public schools, the use of didactic models enabled greater interaction between students, in addition to facilitating the teaching and learning process.

The content of cell biology, especially with regard to the cytoplasmic context, studies the relationship between structure and function of organelles / biomolecules and the understanding of several dynamic biological events that occur at the cell level. Although most biology textbooks present color images of biomolecules, organelles and the biological events that surround them, they generally do not allow a three-dimensional view of the structures, nor of the abstract processes represented.

Thus, the use of didactic models for teaching concepts of cell biology, based on David Ausubel's Theory of Meaningful Learning can enhance learning. Particularly for the subject of cell cytoplasm, where several metabolic mechanisms indispensable for cell survival and maintenance occur, which require characteristics such as abstraction, imagination and patience from the student, the development of several three-dimensional didactic models in these study conditions can facilitate the assimilation of concepts and, mainly, make the classes more interesting, motivating, productive and provide the students with greater ability to relate the content to their daily lives.

In order to search for elements that help answer the question asked, this work essentially assumes the characteristic of a study of the State of knowledge type, aiming at mapping, describing and organizing production linked to the teaching of biology. In addition, the work will also present results related to research published through articles in journals, dissertations or theses or complete works in annals of a recognized event in the area of science education. I seek to produce the State of knowledge on themes related to my research developed Graduate Program in Education - Doctorate course, from the Federal University of Mato Grosso do Sul (Brazil), in the line of research Teaching of Sciences and Mathematics. The research is entitled: "Didactic Modeling as a teaching strategy for meaningful learning in cell biology". Thus, in this state of knowledge, the objective is to elucidate which aspects and dimensions have been highlighted on the themes of the research, with the purpose of delimiting the object, investigating the epistemological and psychological bases and the conclusions reached and the possibilities of overcoming this reality.

Indeed, the involvement in research that seeks to list and analyze studies carried out on the teaching of biology will have direct repercussions on my work practice, as an educator and researcher interested in the aspects that articulate research and teacher training, and its implications for improvement, especially from the Brazilian public school.

Materials and methods

Knowing the academic productions related to the teaching of biology is part of the methodology of this work, of qualitative nature, bibliographic nature and of the State of Knowledge type, whose objective was to know the researches carried out on the subject under study. To carry out this work, four themes were used:

1) Differentiated strategies for teaching and learning biology;

2) Use of didactic models as a resource for teaching and learning;

3) David Ausubel's Theory of Meaningful Learning;

4) Use of Concept Maps.

I tried to map a large part of the scientific production that fits the themes mentioned above, covering in all its complexity, both Basic Education and Higher Education, identifying predominant thematic axes, institutional origins and existing trends in terms of the research methodologies adopted.

The sources consulted to carry out this work were:

- CAPES Thesis Bank (Coordination for the Improvement of Higher Education Personnel) - for themes 1, 3 and 4;
- Brazilian Digital Library of Theses and Dissertations - for theme 2;
- SciELO - ScientificElectronic Library Online - for all topics;
- Proceedings of ENPEC (National Research Meeting in Science Education) - for all topics.

Thus, I organized this State of knowledge in the themes already mentioned above (differentiated strategies for teaching biology learning; use of didactic models as a resource for teaching and learning; Theory of Meaningful Learning by David Ausubel and Use of Concept Maps), where the initial data collection process brought me to some questions:

- What are the main centers of academic production on these themes?
- How is the periodicity of publications in these areas?
- What are the main journals that publish articles in the areas of interest for this research?

Thematic 1 (differentiated strategies for teaching biology learning) was chosen for the mapping of academic productions in the dissertations and theses category, where the abstracts of master's and doctoral dissertations available in the CAPES database were used.

It is worth pointing out that only the work in teaching biology related to the research developed by me in the PhD course was selected to be discussed and presented in this State of knowledge, since the search for the keyword of a term generic can identify a large number of works that do not match the interest in the proposal to carry out a particular research.

The methodological details of the process as the State of knowledge was organized will be explained below, where the three categories presented and discussed will be subdivided:

1 - Theses and Dissertations (CAPES Thesis Bank and Brazilian Digital Library of Theses and Dissertations);

2 - Articles in Journals (SciELO – Scientific Electronic Library Onlin) and;

3 - Complete articles in annals of events (National Research Meeting in Science Education).

Results and discussion

1) Theses and Dissertations

The author's option to search and analyze documents such as dissertations and theses is linked to some aspects. It is worth considering, initially, that universities are potential places for investigations of this type of documents, since, in the Brazilian context, they offer the vast majority of postgraduate courses in the country.

These post-graduate researches are configured in important documents and quite aligned with a state-of-the-knowledge type research, as they are larger documents, with more possibilities for authors to write more widely and freely, different from scientific articles, which usually have rules and very careful standards for writing.

For Teixeira and Megid Neto (2011), the academic production linked to the Science Teaching area, in the form of theses and dissertations, has existed since the early 1970s, and has been consolidating itself as an important research field in the educational scenario of the parents. A significant portion of this production refers to works focusing on the teaching of biology.

Following the item Abstracts, you have the option of the Author's Name, Subject or Institution Name. Since the interest in this state of knowledge is mainly in research on the teaching of biology, regardless of the name of the author or institution, only the Subject field was used. In the lower left corner of the screen there is the option to choose the level and the options "master's", "doctorate" or "professional" are available. Bearing in mind that the intention was to research master's dissertations and doctoral theses, the three options were used. Still in the lower left corner there is the option “choose a base year for the survey”. The search was initiated, through abstracts, productions defended in the year 1997 to 2011.

The Capes Thesis Bank was used for research in teaching biology, concept maps and David Ausubel's Theory of Meaningful Learning. For research on the use of didactic models, the Brazilian Digital Library of Theses and Dissertations was used.

The option for choosing abstracts was at the expense of the website not providing the full texts of these productions. However, an appendix (in table form) is presented with a balance of the productions of interest to the research, which include: author, year of defense, modality (dissertation or thesis), institution and title. Each abstract was presented in this work, with its respective title, keywords, advisor and examining board. The parts of interest in the search for a particular abstract were highlighted as highlighted in the body of the abstract text and are presented in the appendices at the end of this work, separated by search search themes.

From the abstracts, I searched the graduate programs page for the full text of all the productions, which were stored in folders.

2) Articles In Journals

To search for articles published in journals, the search was carried out by the SciELO portal. The SciELO portal provides access to its collection of journals through an alphabetical list of titles, or through a list of subjects, or through a module for searching journals' titles, by subject, by the names of the publishing institutions and by the place of publication. The interface also provides access to the full texts of the articles through an author index and a subject index, or through an article search form, which searches for the elements that compose it, such as author, title words, subject, words of the text and year of publication.

Thus, SciELO was used as a portal for this work because it presents very selective eligibility criteria, in addition to allowing several magazines in the area of education and science teaching to be consulted.

Integrated search for articles (author, subject and research) was used, but I opted for the search field with the same keywords that were used to search for theses and dissertations in the CAPES thesis database. The parts of interest in the search for a particular abstract were highlighted as highlighted in the body of the text of the abstract and are presented in the appendices at the end of this work, separated by search search themes.

3) Complete articles in annals of the National Research Meeting in Science Education

The National Research Meeting in Science Education (ENPEC) is a biennial event promoted by the Brazilian Association for Research in Science Education (ABRAPEC) which aims to bring together and promote the interaction of researchers in Physics, Biology and Chemistry Teaching, Geosciences, Environment, Health and related areas, with the purpose of discussing recent research work and dealing with topics of interest to the Brazilian Association for Research in Science Education. This is the event with the greatest dissemination of research information in the area of Science Education in the country, with the participation of researchers from all regions of Brazil and with a significant number of works presented, being respected by teachers of basic and higher education, and its articles, almost in general, used widely in academic works, journals and dissertations / theses.

Thus, I chose to choose as a reference for this work the articles published in the annals of the years 2005 and 2011 of ENPEC (years in which productions were made available in electronic media).

The parts of interest in the search for a particular abstract were highlighted as highlighted in the body of the text of the abstract and are presented in the appendices at the end of this work, separated by search themes.

4) Search preference items

As a matter of empirical view of the reality to be studied, I chose to work mainly with research that focuses on the teaching of biology, in the form of master's dissertations and doctoral theses presented at the CAPES Thesis Bank.

In this sense, research that is interested in publications that focus in some way on the teaching of biology or that have references to the teaching of contents related to the Biological Sciences (especially to the topics of cell biology, which will be the main focus of study in doctoral research). Indeed, the school environment investigated, the subjects involved in the research (teachers, trainers, students, interns, etc.), the initial and / or continuing training courses, the didactic materials and resources analyzed, the teaching methods and techniques tested, the proposed teaching programs, the evaluation of curricula at their various levels and possibilities, the legislation, the educational experiences reported in the researches, in short, one or more of these elements present in each work must be directly or partially related to the teaching of biology or of biological sciences.

It is worth noting that there is a great diversity of works that can be considered of interest for research. We cannot forget that biology is not the object of teaching only in the basic school (formal education: infant education, elementary and high school) and higher education (in specific courses for the training of biologists and science and biology teachers).

Vinholi Junior, Cabreira & Dias (2020) recommend that the biological sciences teaching material should be potentially significant, that is, elaborated according to the previous knowledge existing in the student's cognitive structure and the predisposition to learn, which are fundamental elements for the occurrence of significant learning, according to this learning theory. For this reason, emphasis was given to theses and dissertations that sought, in some way, to analyze the present and "transmitted/taught" biology in a context linked to an efficient applied methodology and with consistent theoretical foundation.

5) Characteristics and trends of dissertations and thesis

The presentation of the results will be presented with the discussion of some details that concern the institutional base that supports the research in teaching biology in Brazil carried out in the form of dissertations and theses found in the CAPES database. This part of the state of knowledge will be based on the analysis carried out considering the following descriptors: year of defense; institution of origin of the work and degree of title of the 25 works found in the CAPES thesis database (Table 1).

Table 1. General table of the classification of the 25 dissertations / theses in Teaching Biology, between the years 1997 to 2011.

Nº	Author	Institution	Type of program	Defense Year	Title
01	Ademir José Rosso	UFSC	Education	1998	Thesis

02	Ana Amélia de Carvalho Melo Cavalcante	UFPI	Education	1997	Dissertation
03	Alessandra Cláudia Ribeiro	UEM	Science Education	2008	Dissertation
04	Acacio Alexandre Pagan	USP	Education	2009	Thesis
05	Alcionete Pschisky	UFSC	Education	2003	Dissertation
06	Alessandra Maziero Lalin Soato	UEL	Science teaching and mathematics education	2010	Dissertation
07	Ana Maria Gonçalves Pravadelli	USP	Education	2003	Dissertation
08	Ana Maria Rocha de Almeida	UFBA	Teaching, Philosophy and History of Sciences	2004	Dissertation
09	Antonio Carlos Hidalgo Geraldo	UNESP/ Bauru	Science and mathematics teaching	2006	Thesis
10	Cláudia Avellar Freitas	UFMG	Education	2002	Dissertation
11	Daniela Lopes Scarpa	USP	Education	2009	Thesis
12	Eliane Cerdas Labarce	UNESP/ Bauru	Science and mathematics teaching	2009	Dissertation
13	Fernanda Franzolin	USP	Education	2007	Dissertation
14	Ione Ines Pinsson Slongo	UFSC	Education	2004	Thesis
15	Karla Maria Castello Branco da Cunha	FIOCRUZ	Teaching in Biosciences and Health	2011	Dissertation
16	Kellen Giani	UnB	Science teaching	2010	Dissertation
17	Leonaldo de Oliveira Costa	FIOCRUZ	Teaching in Biosciences and Health	2006	Dissertation
18	Mara Matilde Vieira de Barros.	UnB	Science teaching	2005	Dissertation
19	Marco Antonio Ferreira Randi	UNICAMP	Cellular and Structural Biology	2011	Thesis
20	Maria da Glória Raposo da Rocha	UFRPE	Science teaching	2010	Dissertation

21	Mariana Aparecida Bologna Soares De Andrade	UNESP/ Bauru	Science and mathematics teaching	2007	Dissertation
22	Paulo Marcelo Marini Teixeira	UNICAMP	Education	2008	Thesis
23	Sandra Mara Mourão Cardinali	PUC / MG	Science and mathematics teaching	2008	Dissertation
24	Tania da Silveira Cardona	FIOCRUZ	Teaching in Biosciences and Health	2007	Thesis
25	Vanessa Daiana Pedrancini	UEM	Science Education	2008	Dissertation

Source: the author

As a starting point, it is worth noting a slight increase in the number of studies in the period studied, in quantitative terms, showing that, since 2003, research focused on teaching biology has expanded, albeit with modest and irregular growth, until the middle of the year. 2007. As can be seen, there was little growth in 2003, with little fluctuation in 2005. Until 2003, there is a small and discontinuous production, which is intensified a little more through the work with the appearance of programs in the area of Science Education in the country. From 2006 to 2011, there was a period of moderate growth, although almost continuous (Table 2). Considering the entire period, this growth process is possibly linked to a wide expansion of graduate courses in Brazil in recent years, especially, as advocated by Dias, Therrien & Farias (2017). In addition, the expansion of postgraduate courses in Science and Mathematics Teaching in the professional modality in recent years was notable.

For Ramos & Silva (2014), the growth of a large multidisciplinary area and its diversification resulted in the creation of the Teaching area by CAPES, with the aim of "attending to educational programs that had differences in the area of Sciences and Mathematics, the which was not done without the record of discontent of researchers in this area (Science and Mathematics Teaching).

Table 2. Distribution of 25 dissertations and theses in Biology Teaching, showing the number of works defended each year.

Year	Number of theses and dissertations
1997	1
1998	1
1999	0

2000	0
2001	0
2002	1
2003	2
2004	2
2005	1
2006	2
2007	3
2008	4
2009	3
2010	3
2011	2

Source: the author

It is possible to verify that approximately 68% of the defenses occurred in the period between 2006 and 2011. The distribution of this production indicates an annual average of almost three jobs. This period coincides with the creation of new Postgraduate courses, some of which are specific to the area of Science Education, enhancing research in this sub-area, which demonstrates that the field of research dedicated to teaching biology is in significant growth.

As for geographical distribution (Table 3), there is a strong concentration in the South and Southeast regions. Together, they make up 74% of studies on teaching biology.

Table 3. Distribution of 25 dissertations and theses in Biology Teaching by Brazilian region

Brazilian Region	**Number of Documents**	**Percentage**
Midwest	1	4 %
Northeast	3	12 %
North	0	-
Southeast	6	24 %
South	15	60 %

Total	25	100 %

Source: the author

The Southeast region concentrates most of the works, totaling 60% of production. Jobs were found in nine states of the federation, including the Federal District. The states with the highest production frequency are: São Paulo: 09 jobs and Santa Catarina, Rio de Janeiro and Paraná: 03 jobs. Table 4 shows the distribution of dissertations and theses on teaching biology by Federative Unit, between 1997 and 2011.

Table 4. Distribution of 25 dissertations and theses on Teaching Biology by Federative Unit

Federative unit	**Number of Documents**	**Percentage**
Bahia	1	4 %
Distrito Federal	2	8 %
Minas Gerais	2	8 %
Paraná	3	12 %
Pernambuco	1	4 %
Piauí	1	4 %
Rio de Janeiro	3	12 %
Santa Catarina	3	12 %
São Paulo	9	36 %
Total	25	100 %

Source: the author

In reference to the concentration of academic production in the South-Southeast axis, a very common and recurrent characteristic in the Brazilian scientific academy, especially for the area of education, it is argued that the production on a smaller scale in the North, Northeast and Midwest regions restricts the research development process in the aforementioned regions. However, a justification in this regard is that many professors from these regions travel to the South and Southeast to attend master's and doctoral degrees.

Still on the irregular distribution of the analyzed production, the almost monopoly of institutions in the South and Southeast, especially São Paulo, in the production of research in the area of Science

Education, reflecting distortions in the Brazilian educational system and inducing "an academic production that is not compatible with regional interests and needs ".

Regarding the institutions where the production of dissertations and theses in the teaching of biology is developed, studies were found in 13 different institutions. Public institutions are responsible for 12 works, of which seven (59%) refer to federal institutions and five (41%) to state institutions. Among state institutions, there is a clear predominance of those located in the States of São Paulo and Paraná, concentrating 100% of all identified studies (state private).

In a study carried out by Teixeira & Neto (2011), where data from theses and dissertations in biology teaching were compiled from 1972 to 2004, it was proved that about 1/3 of the academic production analyzed is located in the state public universities of São Paulo , that is, at the University of São Paulo (USP), State University of Campinas (UNICAMP) and State University Paulista (UNESP). Among the federal universities, the authors found a predominance of the Federal University of Santa Catarina (UFSC), with 9.9%; Federal University of Rio de Janeiro (UFRJ), with 4%; and Federal University of São Carlos (UFSCar), with 4% of the works defended in this area.

The sum of the number of works defended in public institutions is equivalent to 92% of the total production. The remaining 8% refer to theses and dissertations produced at a private university, highlighting only the Pontifical Catholic University of Minas Gerais. Table 5 presents the list of Universities, nature and quantity of production on Teaching Biology in the studied period.

Table 5. List of Academic Institutions: classification by nature number of documents per institution

Nº	**Name**	**Initials**	**Nature**	**Amount**
01	Oswaldo Cruz Foundation	FIOCRUZ	Federal Public	3
02	Pontifical Catholic University of Minas Gerais	PUC-MG	Particular	1
03	University of Brasilia	UnB	Federal Public	2
04	University of Sao Paulo	USP	State Public	4
05	Campinas State University	UNICAMP	State Public	2
06	Londrina State University	UEL	State Public	1
07	Maringá State University	UEM	State Public	2
08	Paulista State University "Júlio de Mesquita Filho"	UNESP	State Public	3
09	Federal University of Bahia	UFBA	Federal Public	1

10	Federal University of Minas Gerais	UFMG	Federal Public	1
11	Federal University of Santa Catarina	UFSC	Federal Public	3
12	Federal University of Piauí	UFPI	Federal Public	1
13	Rural Federal University of Pernambuco	UFRPE	Federal Public	1

Source: the author

As can be seen, among the main centers of production of theses and dissertations in the studied area, considering academic productivity measured in quantitative terms, four public domain institutions stand out, which concentrate approximately 52% of student production in teaching biology. They are: USP, with four works (16%); FIOCRUZ, UNESP and UFSC, with three papers each (12%).

Regarding the degree, there is a clear predominance of master's dissertations, constituting 68% (17 works) of production, while doctoral theses correspond to only 32% (eight works) of the investigated volume.

There is a considerable discrepancy in the titration indices. It is worth remembering that most elementary and high school teachers in Brazil have only undergraduate and specialization courses. With the expansion of graduate studies in the country, due to the massive investment in education in the scope established for this research, many teachers started to enroll in master's courses, in academic and professional modalities.

Conclusions

Concluding this work, I highlight that researches as a State of knowledge demand time to carry out the readings, however, they do allow a series of reflections and countless considerations, depending on the focus of interest of the reader.

Knowledge of methodologies implemented in the context of biology teaching in Brazilian public schools is of fundamental importance, especially for the acquisition of new public policies that are effectively viable and that significantly improve the teaching and learning of this discipline in schools.

Works of the State of Knowledge type are of fundamental importance, considering that they add a compilation of documents that gather specific characteristics of a particular search aggregate stipulated by the author. An interesting example in this article was information about the institutions that produce the most in this area. This will later serve for future master's or doctoral students who want to investigate which are the main production centers on the teaching of biology in Brazil, as well as to seek information on the use of modeling in the context of teaching and learning and on theory of David Ausubel's significant learning.

Anyway, the presentation of this information contributed significantly to broaden my understanding of the differentiated strategies for teaching and learning biology, as the main objective of this research work.

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