MAPPING OF THESESES AND DISSERTATIONS ON THE FORMATION OF THE
MATHEMATICS TEACHER: A LOOK AT THE PRODUCTION IN STATISTICAL
EDUCATION

MAPEAMENTO DAS TESES E DISSERTAÇÕES SOBRE A FORMAÇÃO DO
PROFESSOR DE MATEMÁTICA: UM OLHAR PARA A ProduÇÃO NA EDUCAÇÃO
ESTATÍSTICA

MAPEO DE TESIS Y DISERTACIONES SOBRE LA FORMACIÓN DEL PROFESOR
DE MATEMÁTICAS: UNA MIRADA A LA PRODUCCIÓN EN LA EDUCACIÓN
ESTADÍSTICA

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**ABSTRACT:** This paper aims to present a mapping of the scientific production of researchers linked to the Statistical Education group (GT-12) of SBEM, based on theses and dissertations that focused on training of Mathematics teachers concerning the teaching and learning of statistics and probability in the period between 2000 and 2020. The mapping was made from the researchers' curricula lattes, Theses and Dissertations Bank of CAPES, and Digital Library of Theses and Dissertations (BDTD). Sixty works were identified and categorized into six thematic focuses and nine sub-focuses concerning Fiorentini's (2022) theoretical-methodological guidelines. The results showed a homogeneous distribution of studies in Basic Education and little adoption of methodologies such as life stories and narratives. It's expected that research gaps highlighted in this mapping can direct further work in Statistical Education.


**RESUMO:** Este artigo tem por objetivo apresentar um mapeamento da produção científica dos pesquisadores vinculados ao grupo de Educação Estatística (GT-12) da SBEM, a partir das teses e das dissertações que tomam como objeto de estudo a formação do professor de Matemática no que se refere ao ensino e à aprendizagem da estatística e probabilidade no período compreendido entre 2000 a 2020. O mapeamento tomou inicialmente como fonte de dados: o currículo lattes dos pesquisadores do grupo GT-12 da SBEM, o Banco de Teses e Dissertações da CAPES e a Biblioteca Digital de Teses e Dissertações (BDTD). Foram revelados 60 trabalhos distribuídos e organizados em seis focos e nove subfocos temáticos a partir das orientações teórico-metodológicas de Fiorentini (2002). Os resultados apontam uma distribuição homogênea dos estudos na Educação Básica, pouca adoção de metodologias como histórias de vida e narrativas. Espera-se que as lacunas de investigação apontadas nesse estudo possam ser um ponto de partida para novos trabalhos na Educação Estatística.


**RESUMEN:** Este artículo tiene como objetivo presentar un mapeo de la producción científica de los investigadores vinculados al grupo de Educación Estadística (GT-12) de la SBEM, a partir de tesis y disertaciones que toman como objeto de estudio la formación de profesores de Matemática en lo que respecta a la enseñanza y el aprendizaje de estadística y probabilidad en el periodo comprendido entre 2000 y 2020. El mapeo tomó inicialmente el currículum lattes de los investigadores, el Banco de Tesis y Disertaciones de la CAPES y la Biblioteca Digital de Tesis y Disertaciones (BDTD). Sesenta obras fueron reveladas, distribuidas en seis focos y nueve sub-focos temáticos basados en las orientaciones teórico-metodológicas de Fiorentini (2002). Los resultados apuntan a una distribución homogénea de los estudios en Educación Básica, poca adopción de metodologías como relatos de vida y narrativas. Se espera que las lagunas de investigación destacadas en este estudio puedan ser un punto de partida para futuros trabajos en educación estadística.

Introduction

This paper aims to present a mapping of scientific production carried out in Brazil by the Statistical Education Working Group (GT-12) of the Brazilian Society of Mathematics Education (SBEM) over the last 20 years, based on theses and dissertations that consider the thematic training of Mathematics teachers within the scope of Statistical Education. This perspective on the training of Mathematics teachers who teach probability and statistics is the result of doctoral research by the first author of this manuscript under the guidance of the second author (BARBOSA, 2022).

Investigations into the training of mathematics teachers who teach probability and statistics have reported several gaps arising from initial training courses. Among other reasons, such gaps have resulted in a teaching method based on technical rationality and distant from the students' context. Given this, the teaching of statistics has served more closely the epistemology of Mathematics than the epistemology of statistics itself (BATANERO, 2001; CARDONA; GOMEZ, 2017; LOPES, 2013; MAGALHÃES, 2015; MARCELO GARCÍA, 1999; PAMPLONA, 2009; PFANNKUCH; BEN-ZVI, 2011, SCARLASSARI; LOPES, 2019).

There has been, in recent years, an increase in the number of research in Statistical Education, which has resulted in the publication of several works, including scientific papers, dissertations, and doctoral theses from the main Brazilian postgraduate programs, mainly after the creation of the SBEM's working group on Statistical Education (GT-12), which brings together several Brazilian researchers who study this topic and directly contribute to increasing publication in national and international journals, as well as guiding theses and dissertations.

However, the guidance and publication of works generate a large amount of information, which can lead, over time, to the pattern of behavior in studies in this area of knowledge not being understood by the scientific community. Thus, reviewing what has been produced in Statistical Education with a focus on teacher training is a crucial way to discover weaknesses and point out directions for researchers to follow, thus contributing to organizing the field of knowledge (SANTOS, 2015, SCHREIBER; PORCIÚNCULA, 2019). Therefore, it is necessary to map scientific work in a certain area to obtain the most credible view possible of the reality in question.

Therefore, in the following section, we present an overview of the importance of Statistical Education in the training of Mathematics teachers. In continuation, the methodological aspects adopted in this paper, the main results contained in mapping theses and dissertations related to teacher training, and, finally, some final considerations.
Statistical Education and GT-12

In recent years, knowing statistics has proven to be essential for decision-making due to the numerous occasions in which the main information vehicles have demanded that individuals take a position in the face of scenarios where uncertainty and variability are decisive elements that affect people’s personal and professional lives. “In newspapers, magazines, radio, and television, as well as in books and reports, we are confronted with tables, graphs, surveys, maps... that contain statistical information about the most diverse phenomena and activities” (FERNANDES et al., 2004, p. 166, our translation). Therefore, to understand the relevance of the information, a new look is necessary on the part of teachers who teach probability and statistics in Basic Education, with a view to educating students who can exercise their citizenship.

Due to its importance in society, the teaching of Statistics was incorporated into the curriculum as a part of Mathematics through the publication of the National Curricular Parameters (PCN) for the initial years of Elementary School in 1997, in the final years of Elementary School in 1998 and High School in 1999 and reaffirmed in the reform promoted by the National Common Curricular Base (BNCC) in 2018. However, this last document indicates that “uncertainty and data processing are studied in the thematic unit Probability and Statistics” (BRASIL, 2018, p. 230, our translation), which then denotes that the teaching of Statistics must be different from Mathematics due to the uncertainty and variability present in real data.

Although it has been indicated that Statistics content is part of the mathematics curricula, this does not guarantee that teachers are working on such content, and when they are, the technical rationality that, not infrequently, guides the conduct of mathematics content also goes back towards statistical content. Believing that students learn statistics through tireless memorization of formulas that are far from their cultures is a serious error that has caused a lack of interest among students and teachers in initial or continuing training.

Lopes (2008, p. 70, our translation) states that “teacher training currently does not incorporates systematic work on stochastics, making it difficult for these professionals to develop significant work on this topic in basic education classrooms”. As the initial training has been flawed, this ends up causing the mathematics teacher who teaches probability and statistics to repeat the same mechanical processes that were taught to him. He does not have the knowledge that allows him to do different.

Costa and Nacarato (2011, p. 384, our translation) state that “Statistics contents, developed in undergraduate courses [...] do not include the movement of critical thinking and
the development of research or investigation, making learning stagnant and not transformer”. Lopes (2013, p. 905, our translation) adds that “to teach statistics, it is not enough to understand the mathematical theory and statistical procedures; it is necessary to provide real illustrations to students and know how to use them to involve students in developing their critical judgment”. In this way, the importance of context for the theorists becomes evident as a way of giving students the possibility of making judgments about information from their daily lives.

In this scenario of gaps and difficulties, of insistence on decontextualized teaching practices and immersed in mathematical formulas that do not promote autonomy and criticality in the teaching of Statistics, Statistical Education emerged in the 1970s. According to Cazorla et al. (2010), the needs presented by teachers who teach concepts and procedures related to Statistics in higher-level courses and the inclusion of statistics content in Basic Education drove the development of research in this area. After all, as Lopes (2010) points out, Statistical Education is fundamental to contributing to citizenship based on the criticality of the data conveyed and decision-making based on statistical and probabilistic knowledge.

In Brazil, several researchers have dedicated themselves to studying Statistical Education, which has contributed greatly to leveraging this area of knowledge in the country (CAZORLA et al., 2010; COSTA; NACARATO, 2011, COUTINHO, 2007; JACOBINI; WODEWOTZKI, 2001; LOPES, 2008, 2010; SAMÁ, 2019, among others). Thus, in view of the growing Brazilian production on the subject and as a way of integrating researchers interested in studying the area, in 2000, it was created during the first International Research Seminar in Mathematics Education (SIPEM), promoted by the Brazilian Society of Education Mathematics (SBEM), the Working Group on Teaching Statistics and Probability – GT12 of SBEM. This Group has focused its attention on studies of processes related to the teaching and learning of Statistics, with involvement of cognitive and affective aspects, the epistemology of statistical concepts, and didactic-pedagogical development to promote statistical literacy (CAZORLA, 2009).

The creation of this group provided better communication between researchers and increased the number of published works. Furthermore, several postgraduate programs in mathematics education were created that became part of a line of research linked to statistical education, which led to an increasing number of publications by students from these programs and partnerships with other researchers. Therefore, investigating the contribution of these researchers on the national scene in terms of teacher training is very relevant so that new research scenarios can be designed.
Methodology

The methodology taken as a reference and the results presented in this mapping come from State of Knowledge type research, which, according to Romanowski and Ens (2006), is not only based on the identification of production but rather on analysis and categorization, with a diverse look at the focuses, the trends of the work, the thematic and methodological gaps in the work. Furthermore, “[...] mapping has become a resource for building a framework of references or a theoretical scheme, in an attempt to have a broad and general perspective on a given subject or theme” (BIEMBENGUT, 2008, p. 23, our translation).

Therefore, this mapping analyzes the theses and dissertations supervised or co-supervised by researchers belonging to the Statistical Education Working Group (GT-12) of SBEM in the period from 2000 to 2020, with a thematic focus on the training of Mathematics teachers within the scope of Statistical Education. The investigation started on March 14, 2021, identified 46 researchers registered in the Statistical Education Working Group (GT12) on the page http://www.sbembrasil.org.br/sbembrasil/index.php/grupo-de-trabalho/gt /gt-12 from the Brazilian Society of Mathematics Education (SBEM), of which 13 presented productions in line with the objectives of the proposed study.

The selection of works initially took as a reference the information contained in the lattes CV of the researchers in this working group. This screening focused on dissertations and theses already completed by the start date of the study and which were associated with the following descriptors interrelated to Statistical Education: Statistical Education, “teaching-learning”, “teacher training (initial and continuing)”, “development professional”, “professional identity”, “distance learning” and “distance education”.

After becoming aware of the titles of the works, based on the analysis of the Lattes Curriculum of the SBEM GT12 researchers, we conducted a search in the Bank of Theses and Dissertations of the Coordination for the Improvement of Higher Education Personnel – CAPES and the Brazilian Digital Library of Theses and Dissertation – BDTD. Furthermore, we used the Library of Postgraduate Programs when we could not identify the complete work in the two repositories mentioned. Even so, as the complete work was not found in any of these repositories mentioned, an electronic message (e-mail) was sent to the supervisors and, if necessary, to the authors of the manuscripts.

However, when collecting the name and title of the works, from the Lattes CV of these researchers, we identified that the name entered in the CV was different from the name contained in these main repositories, which created an initial difficulty in producing the
Thus, after reading the titles, abstracts, and keywords, 60 master's and doctoral works were selected from the repositories described previously to compose the corpus of analysis. However, in some works, even with this floating reading, it was not possible to identify whether the Mathematics Teacher training focus was being studied because the research subjects were not presented in the summary. However, this problem was resolved by reading the methodology. The difficulty encountered when reading the abstracts of the works is in line with what Fiorentini (2002) recorded when discussing the difficulties encountered in reading the abstracts and some complete works.

After selecting the theses and dissertations, according to the criteria already listed, a chronology was created, highlighting criteria contained in the works such as the year of defense, the educational institution where the defense was conducted, name of the author, name of the advisor/co-advisor, title, summary, year of defense, keywords, educational institution, postgraduate program, whether or not a member of the SBEM GT-12 group, type of work (thesis or dissertation) for organization of the database. Furthermore, despite the difficulties encountered while reading the abstracts, with this organization, it was possible to broaden the view of the characteristics of each selected work.
The present work does not dare to consider that the selected works represent the totality of what is produced in Postgraduate programs, guided or co-supervised by researchers who are members of the SBEM GT-12 group. It is known that none of the sources used have a faithful and complete catalog, as failures in sending metadata by educational institutions may occur. In addition to this factor, the researchers' outdated Lattes CVs can cause gaps in the research database.

Therefore, even with all the effort put into selecting these manuscripts, some works may not be included. So, this mapping aimed to determine the number of works that most represented Brazilian productions linked to the SBEM GT-12 Statistical Education working group with a focus on teacher training, both in initial and continuing education. In short, we hope that the results of these works reveal trends and new perspectives for research in Statistical Education with a focus on Mathematics teacher training.

Analysis and Results

The survey conducted through master's theses and dissertations listed based on the productions of the members of the GT-12 working group in the period from 2000 to 2020 in Brazil revealed 60 works, 20 theses and 40 dissertations, 30 of which came from academic master's degrees and 10 professional master's degrees.

The results presented in Graph 1 indicate that these correspond to 33% of the total mapped production and dissertations, at 67%. Similarly, professional dissertations account for 25%, and academic master's degrees account for 75% of the total produced by dissertations. Furthermore, the professional master's program has contributed to an increase in production in Statistical Education with a focus on teacher training. An explanation for why almost 2/3 of the works are at master's level is due to the time involved in producing a thesis, which generally takes four years to produce compared to the two years of the dissertation.
Graph 1 – The distribution of data about theses and dissertations

Source: Prepared by the first author

Graph 2 shows the evolution over the last 20 years of the production of the working group on Statistical Education (GT-12) from the perspective of teacher training. Initially, it is possible to observe that in the years 2005 and 2008, there was no production associated with the scenario proposed by this study. Furthermore, a peak in production was seen in 2007, a direct result of the Postgraduate Program in Mathematics Education at the Pontifical Catholic University – PUC/SP, which, during this period, produced one doctoral thesis and six dissertations in the professional modality.

From 2009 onwards, there was a significant increase in work focusing on teacher training within the scope of Statistical Education, driven by the creation of the Working Group on Statistical Education (GT-12) in 2000 and by the insertion of several researchers who passed to turn their attention to the field of knowledge Statistics Education. Consequently, this increase in production is also a direct result of the creation of postgraduate programs in mathematics education in Brazilian colleges and universities and the partnerships established by these researchers after their insertion into the working group.

4 Green: Theses; Blue: Dissertations.
Graph 2 – Temporal evolution in the production of Brazilian theses and dissertations from the SBEM GT-12 group produced in Brazilian postgraduate programs from 2000 to 2020

Table 1 illustrates the works that address the contents of statistics, probability, statistics, and probability, stochastic, combinatorial, and statistical inference used in the 60 works analyzed. This organization provides a more specific look at content that needs to be further explored in Statistical Education research in Brazil. Thus, of the 60 works analyzed, more than half, that is, 60%, made use of content associated with descriptive statistics such as measures of central tendency, dispersion, analysis and interpretation of graphs and tables, and even the simultaneous use of these contents.

Soon after, we found studies that take combinatorics as content to be explored in their research, with 11.7%. Although an important evolution can be seen in the studies promoted by researchers from SBEM's GT-12 in the line of teacher training that involves content that arises from statistical inference (sampling, probability distributions, etc.) (5%), this result denotes that there is a broad appeal for more studies to look at this content from Basic Education (MAKAR, 2016).
Table 1 - Content explored in works published in GT-12.

<table>
<thead>
<tr>
<th>Searched content</th>
<th>Number of works</th>
<th>% of works</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistic</td>
<td>36</td>
<td>60%</td>
</tr>
<tr>
<td>Probability</td>
<td>05</td>
<td>8.3%</td>
</tr>
<tr>
<td>Statistics and Probability</td>
<td>06</td>
<td>10%</td>
</tr>
<tr>
<td>Stochastic (Statistics, Probability and Combinatorics)</td>
<td>03</td>
<td>5%</td>
</tr>
<tr>
<td>Combinatorial</td>
<td>07</td>
<td>11.7%</td>
</tr>
<tr>
<td>Statistical Inference</td>
<td>03</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: Prepared by the first author

Henning and Bessa (2012) already described this predominance of statistical content focused on statistical measures, graphs, tables, and probability in Brazil, with some approaches focused on statistical inference. The authors also report on the importance of developing activities involving topics such as population, samples, estimation of population parameters, and probability distribution in the classroom.

Encouraging students to acquire contextualized statistical knowledge and fundamental elements of statistical inference is difficult for mathematics teachers who teach probability and statistics. These obstacles are often related to a curriculum that prioritizes theoretical aspects more than practice and the lack of vertical integration with pedagogical subjects throughout the course. Furthermore, many continuing education courses do not help expand the mathematics teacher's view of teaching statistical inference. According to Viali (2008), mathematics degree courses have only one probability and statistics discipline in their curricula, and the most covered topics focus on descriptive statistics and probability, and this will directly influence what will be covered in the future teacher's classroom.

Table 2 depicts the Brazilian production of theses and dissertations focused on statistical education by state, region, and educational institution.
Mapping of theses and dissertations on the formation of the mathematics teacher: A look at the production in statistical education

Table 2 - Distribution of theses and dissertations by region, state, and universities

<table>
<thead>
<tr>
<th>Region</th>
<th>Stade</th>
<th>University</th>
<th>Quantity</th>
<th>Total</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southeast</td>
<td>São Paulo</td>
<td>Pontifícia Universidade Católica (PUC/SP)</td>
<td>26 (43.3%)</td>
<td>37 (61.7%)</td>
<td>58.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Universidade Cruzeiro do Sul (UNICSUL/SP)</td>
<td>5 (8.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Universidade Estadual de Campinas (UNICAMP/SP)</td>
<td>4 (6.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minas Gerais</td>
<td>Universidade Federal do Triângulo Mineiro (UFTM)</td>
<td>2 (3.3%)</td>
<td></td>
<td>3.3%</td>
</tr>
<tr>
<td>South</td>
<td>Paraná</td>
<td>Universidade Estadual de Londrina (UEL)</td>
<td>1 (1.7%)</td>
<td>2 (3.3%)</td>
<td>1.7%</td>
</tr>
<tr>
<td></td>
<td>Rio Grande do Sul</td>
<td>Universidade Federal do Rio Grande (FURG)</td>
<td>1 (1.7%)</td>
<td></td>
<td>1.7%</td>
</tr>
<tr>
<td>North East</td>
<td>Pernambuco</td>
<td>Universidade Federal de Pernambuco (UFPE)</td>
<td>19 (31.7%)</td>
<td>21 (35%)</td>
<td>31.7%</td>
</tr>
<tr>
<td></td>
<td>Bahia</td>
<td>Universidade Estadual de Santa Cruz (UESC)</td>
<td>2 (3.3%)</td>
<td></td>
<td>3.3%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>60 (100%)</td>
<td>60 (100%)</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: Prepared by the first author

The contribution of the southeast and northeast regions to the expansion of studies over these 20 years of production within the proposed scenario is significant. This high production is reflected in the number of master's and doctoral programs in these regions and the fact that studies have begun in mathematics and statistics education. A notable absence was work from the north and central-west regions of the country within the scenario presented.

Still, according to Table 2, the Pontifical Catholic University of São Paulo – PUC/SP has 26 works, including theses and dissertations focusing on training mathematics teachers in Statistical Education. Furthermore, the result can be explained by the wide scope of the postgraduate program, which currently has a master's degree and a doctorate in Mathematics Education. Soon after, the Federal University of Pernambuco – UFPE showed high publication growth because of the production of the Postgraduate Programs in Mathematics and Technological Education in the academic modality (master's and doctorate) and the Postgraduate Program in Education.

Similarly, Table 3 presents a diversity of postgraduate programs that study themes associated with Statistical Education in Brazil with a focus on teacher training, ranging from specific Mathematics Education programs to programs that have a line of research in teacher training.
Table 3 – Postgraduate programs where Brazilian research in Statistical Education was produced with a thematic focus on teacher training

<table>
<thead>
<tr>
<th>University</th>
<th>Graduate program</th>
<th>AM</th>
<th>PM</th>
<th>DD</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>UFPE/PE</td>
<td>Mathematics and Technological Education</td>
<td>15</td>
<td>-</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Education</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>PUC/SP</td>
<td>Mathematics Education</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>26</td>
</tr>
<tr>
<td>FURG/RS</td>
<td>Science Education: Chemistry of Life and Health</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>UNICSUL/SP</td>
<td>Teaching Science and Mathematics</td>
<td>-</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>UFTM/MG</td>
<td>Education</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>UESC/BA</td>
<td>Mathematics Education</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>UNICAMP/SP</td>
<td>Education</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>UEL/PR</td>
<td>Teaching Science and Mathematics Education</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>30</td>
<td>10</td>
<td>20</td>
<td>60</td>
</tr>
</tbody>
</table>

*AM: Academic Master's; PM: Professional Master's; DD: Doctorate degree.

Source: Prepared by the first author

Still, in Table 3, it is possible to note that the Postgraduate Program in Mathematics Education at the Pontifical Catholic University (PUC/SP), one of the oldest in Mathematics Education, greatly influences this study's publications. Furthermore, his works are distributed homogeneously between academic, professional, and doctoral master's programs, valuing the research focus of this paper across teaching modalities; that is, teacher training is discussed at all levels. The Postgraduate Program in Mathematics Education at this institution has stood out in producing professional master's degrees with nine publications from the perspective of teacher training in Statistical Education.

The Postgraduate Program in Mathematics and Technological Education linked to the Federal University of Pernambuco makes great contributions to the mapped theme. As some Postgraduate programs mentioned in the Table do not yet have a professional modality in their doctoral and master's programs, this explains the absence of work. Thus, within this suggested scope, only PUC/SP and Universidade Cruzeiro do Sul (UNICSUL/SP) presented work at the professional master's level within the focus of study in the last 20 years.

Given the expansion of statistical education in Brazil and the importance of this discipline in decision-making processes, it is visible that lines of research are being inserted into other programs that do not have mathematics education, statistical education, or education as their central focus for example. A particular case can be seen in the Postgraduate Program in Education and Sciences: Life Chemistry and Health at the Federal University of Rio Grande
Mapping of theses and dissertations on the formation of the mathematics teacher: A look at the production in statistical education

(FURG), which had a PhD. Suzi Samá is currently the leader of the Statistical Education Working Group – GT-12 of SBEM, as its master's degree supervisor.

Table 4 shows several of the works supervised by the group's researchers, among which we can highlight those whose thesis works were selected for this corpus of analysis, namely Ph.D. Admur Severino Pamplona, PhD. Celi Espasandin Lopes, PhD. Everton J. G. Estevam, PhD. Keli Cristina Conti and Ph.D. Paulo César Oliveira.

Table 4 – Number of works published per researcher

<table>
<thead>
<tr>
<th>Researchers</th>
<th>Institution</th>
<th>MD</th>
<th>DD</th>
<th>Inclusion</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ailton P. de O. Júnior</td>
<td>UFTM</td>
<td>2</td>
<td>0</td>
<td>-</td>
<td>2</td>
<td>3.3%</td>
</tr>
<tr>
<td>Admur S. Pamplona *</td>
<td>UNICAMP/SP</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1.7%</td>
</tr>
<tr>
<td>Carlos E. F. Monteiro</td>
<td>UFPE</td>
<td>6</td>
<td>2</td>
<td>-</td>
<td>8</td>
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<tr>
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<td>4</td>
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</tr>
<tr>
<td>Cileda de Q. S. Coutinho</td>
<td>PUC/SP</td>
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<td>8</td>
<td>-</td>
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</tr>
<tr>
<td>Everton J. G. Estevam*</td>
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<td>0</td>
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<tr>
<td>Irene Maurício Cazorla</td>
<td>UESC</td>
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<td>3.3%</td>
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<tr>
<td>Keli Cristina Conti*</td>
<td>UNICAMP/SP</td>
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<td>-</td>
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<tr>
<td>Liliane M. Teixeira Lima</td>
<td>UFPE</td>
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<td>-</td>
<td>2</td>
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</tr>
<tr>
<td>Paulo César Oliveira *</td>
<td>UNICAMP/SP</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Rute Borba</td>
<td>UFPE</td>
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<td>-</td>
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<td>8.3%</td>
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<tr>
<td>Sandra M. Pinto Magina</td>
<td>PUC/SP</td>
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<td>0</td>
<td>-</td>
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<tr>
<td>Suzi Samá</td>
<td>FURG</td>
<td>1</td>
<td>0</td>
<td>-</td>
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<tr>
<td>Verônica Gitirana</td>
<td>UFPE</td>
<td>1</td>
<td>0</td>
<td>-</td>
<td>1</td>
<td>1.7%</td>
</tr>
<tr>
<td><strong>Total (Dissertação e teses)</strong></td>
<td></td>
<td>40</td>
<td>15</td>
<td>5</td>
<td>60</td>
<td>100%</td>
</tr>
</tbody>
</table>

* Doctoral works of researchers that were included in the database for analysis. Acronyms: MD: Master's degree; DD: Doctorate degree.
Source: Prepared by the author

The Ph.D. Cileda de Queiroz e Silva Coutinho has made a significant contribution to research focusing on mathematics teacher training, with a focus on Statistical Education with 14 works at the master's level and 8 at the doctoral level, accounting for a total of 22 works. Her participation and contribution to increasing this production correspond to 36% of the production of the group analyzed. Soon afterward, my Ph.D. Carlos Eduardo Ferreira Monteiro appears in 8 (13.3%) of the works associated with the theme.
Thematic trends of selected works

The categorization of the selected works into thematic focuses and sub-focuses, based on the theoretical-methodological assumptions of Fiorentini (2002), as already highlighted in the methodology section, is a direct consequence of a careful analysis of the abstracts and keywords, and, at times, of some parts of the work, such as the methodological aspects for a better understanding of the summary. This grouping by focuses and sub-focuses emerged from the analyzed data without imposing an initial categorization. Therefore, this classification is not unique and largely depends on the researcher's perspective and his objectives. However, it is an attempt to organize the 60 works analyzed, from which six focuses and nine thematic sub-focuses emerged, as shown in Table 5.

Thus, by categorizing the research presented with defined thematic focuses and sub-focuses, we will describe the thematic focuses and provide a more general description of the objectives found in the work allocated to the sub-focuses.

Table 5 – Distribution of work into thematic focuses and sub-focuses

<table>
<thead>
<tr>
<th>Thematic Focus</th>
<th>Nº</th>
<th>Subfocuses</th>
<th>No.</th>
<th>Researchers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Studies that make use of narratives, ethnography and biography in teacher training</td>
<td>06</td>
<td>Early Childhood Education and Early Years</td>
<td>04</td>
<td>Oliveira (2013); Lira (2020); Conti (2015); Oliveira (2016)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Final years and High School</td>
<td>01</td>
<td>Souza (2019b)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Higher Education (trainer teacher)</td>
<td>01</td>
<td>Pamplona (2009)</td>
</tr>
<tr>
<td>Studies through collaborative groups, communities of practice</td>
<td>07</td>
<td>Early Childhood Education and Early Years</td>
<td>03</td>
<td>Bifi (2014); Lopes (2003); Veras (2010)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Final years</td>
<td>01</td>
<td>Costa (2017)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Final years and High School</td>
<td>01</td>
<td>Mendonça (2015)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Higher Education</td>
<td>01</td>
<td>Lima (2019)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Studies with Basic Education and Trainer</td>
<td>01</td>
<td>Estevam (2015)</td>
</tr>
<tr>
<td>Studies using didactic/technological resources in teaching and</td>
<td>14</td>
<td>Early Years</td>
<td>04</td>
<td>Amarante (2011); Oliveira (2014a); Martins (2014); Santos (2003)</td>
</tr>
</tbody>
</table>
The first thematic focus, denoted by “Studies that make use of narratives, ethnography, and biography in teacher training,” has three thematic sub-focuses: Early Childhood Education and Early Years, Final Years and Secondary Education, and Higher Education (trainer teacher). Among the studies that make use of narrative, we can mention the works of Pamplona (2009), Oliveira (2013), Conti (2015), Souza (2019b) and Lira (2020). These authors address issues such as the teaching of stochastics in Early Childhood Education, statistical literacy, investigative cycle, professional development, and training environments with a focus on pedagogical practices for teaching statistics in face-to-face and blended modes and the teaching of statistics through communities of practice (CoPs), respectively. Still, in this scenario of innovative methodologies, the work proposed by Oliveira (2016) uses ethnography to develop its research with teachers from an indigenous school.

Thus, in these studies, which focus on teacher training, researchers have shown an interest in methodologies that place teachers as the protagonists of their practice, giving a voice to this group of professionals silenced by methods focused on positivist hermeneutics.
According to Catani (2005, p. 32, our translation), in the “[…] specific field of the history of education, the inclusion of these sources participates in a movement to renew theoretical-methodological and thematic options, characteristics of the last two decades […]”. Nacarato et al. (2019) emphasize that the (auto)biographical method has been spreading in research on mathematics educators in the Brazilian context.

The second thematic focus, entitled “Studies through collaborative groups and communities of practice”, is formed by five thematic sub-focuses: Early Childhood Education and Early Years, Final Years and Secondary Education, Higher Education, and Basic Education (teachers and trainers). This last sub-focus had to be constructed to include a study that involves teachers from all basic education and teacher trainers in higher education. In this context, only the works of Estevam (2015) and Lima (2019) make use of teachers’ communities of practice to teach statistics, and the other researchers rely on collaborative groups. Some particularities are found in these works, such as using mathematical modeling for teaching, themes related to reading tables and graphs (Curcio and Wainer levels), statistical projects, and teaching stochastics.

The third thematic focus, named “Studies with the use of didactic/technological resources in teaching and research,” has three sub-focuses: Initial Years, Final Years, and/or Secondary Education and Higher Education. In general, researchers made use of technological resources in two main axes: one aimed at the use of these resources in the teacher’s teaching and learning process, using the following educational software: Software R, Tabletop, Fathom, Tinkerplots, and other computerized environments. Another focused on analyzing the data produced by these studies, with the Implicative and Cohesive Hierarchical Classification (C.H.I.C) being the analysis software most used by researchers. Still, in this context, only the work proposed by Queiroz (2015) uses the WebQDA software for its analyses. Martins (2014) proposed an interesting work, presenting Tinkerplots as an excellent alternative for teaching sampling, an important and recurring content in our society that needs to be explored in initial and continuing teacher training courses.

The fourth thematic focus, entitled “Studies on professional development, professional, didactic-pedagogical knowledge, and professional knowledge”, stands out with 20 selected works. From this group, three thematic sub-focuses emerged: Initial years, Final years, and Secondary Education and Higher Education. These studies, with a core focus on professional development, are based on the professional and didactic pedagogical knowledge of teachers at initial and continuing training levels, both for specialist and non-mathematics specialist
teachers. The knowledge discussed permeates not only aspects of statistical and probabilistic literacy and variability but also the importance of knowledge about Statistical Education, combinatorics, the way the teacher uses the textbook, and how statistics disciplines in undergraduate courses promote this professional development of the mathematics teacher who teaches statistics.

The fifth thematic focus, “Study on attitudes, conceptions, and perception of teachers,” has three thematic sub-focuses: Initial years, Final years, and Secondary and Higher Education. Thus, the studies that involve teachers’ attitudes, conceptions, and perceptions regarding the teaching of Statistics focus on objects related to teaching descriptive statistics, probability, modeling processes, combinatorics, reading graphs, and tables. These studies highlighted the need for training more focused on the students’ reality and the importance of continued training in statistical education so that training gaps can be filled.

The sixth and final thematic focus, called “Studies focused on public educational policies”, has two thematic sub-focuses: curriculum and large-scale assessments. The work of Nunes de Oliveira (2012) investigated the large-scale evaluation process of the Provinha Brasil5 regarding the information processing axis and how these contents were worked on by 124 educators who work in Natural Sciences and Mathematics of ProJovem Campo.

In general, the results of this study indicate that teachers have limitations or inaccuracies when working with statistical content, especially in tabular and graphical representations. The work developed by Silva (2014) investigated training for teaching Statistics and Probability, in the curricula of undergraduate mathematics courses in Brazil. The results indicate the persistence of teaching focused on mechanized practices, strongly based on the conceptual knowledge of statistics.

Final considerations

Map the Brazilian scientific production of theses and dissertations available at CAPES, BDTD and in the Lattes Curriculums of researchers from the working group on Statistical Education – GT-12 of SBEM, together with their advisors, coming from various Brazilian postgraduate programs in perspective of teacher training, made it possible to identify 60 master's and doctoral studies, 20 at doctoral level and 40 at dissertation level, of which 10 came
from professional master's degrees and 30 academic ones, published between 2000 and 2020.

When analyzing these productions, the interest of researchers in Statistical Education became evident, focusing on teacher training in different locations across the country and at different levels of education, ranging from Early Childhood Education to Higher Education in a scenario of continued training and initial training of specialized and non-specialized teachers in Mathematics. Within this scenario, it is worth highlighting the increase in the number of works produced over the last 20 years in Statistical Education, especially by the Pontifical Catholic University with its Postgraduate programs in Mathematics Education, which produced 43.3% of the studies and by Federal University of Pernambuco with its Postgraduate programs in Education and Technological Mathematics Education with 31.7% of the manuscripts evaluated, that is, both universities contributed with 75% of the entire corpus analyzed in this study.

Of the 60 works analyzed, it was possible to identify a greater preference among researchers for studies associated with the professional development of teachers to observe teachers' perceptions, conceptions, and attitudes regarding the teaching of statistics in a total of 22 works, that is, approximately 36.66% of total production. On the other hand, such research indicated gaps in teaching statistics, from more basic content associated with descriptive statistics (reading graphs and tables, measures of dispersion, and central tendency), for example, to advanced content such as sampling, Gaussian, and stochastic normal distribution.

Another important point seen in Table 5 concerns the low number of studies focused on teacher training in Early Childhood Education, with only seven works being identified that emerge from the thematic focuses. Studies that make use of narratives, ethnography, and biography in teacher training and those through collaborative groups and communities of practices (CoPs) with 11.66% of works produced. For Nacarato et al. (2014), in recent years, whether in individual research or forms of partnerships, the number of works in Mathematics Education that use this methodology has increased, mainly due to the importance of historicity, something highlighted in the narratives. However, in statistical education, researchers still have a long way to go to understand the need to look at other methodologies that place the teacher as the protagonist of their practice.

Regarding the strategies for the teaching and learning process that emerge from the analyzed works, we can mention the use of technological resources as an essential tool for teaching statistics and probability. The researchers not only used software, such as R, Tinkerplots, Tabletop, and Fathom, to assist teachers in teaching statistics but also used the
C.H.I.C software to analyze data from studies, especially those from postgraduate programs degree from PUC/SP.

Given this, we emphasize the need for more investigations to be carried out in Statistical Education with a focus on teacher training so that discussions can reverberate in improving the classroom practices of teachers who teach probability and statistics. Furthermore, it is important that other mappings can be carried out with different objectives and other sources so that research gaps can be recognized in this field of knowledge and that partnerships can be made with other researchers spread across Brazil so that other teachers can have access to Education Statistics and its benefits, especially in regions where no work was registered.

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**Ethical approval:** As it was a bibliographic study that did not involve research with human beings, the investigation was not submitted to the ethics council.

**Data and material availability:** Data are available in the analyzed references.

**Authors' contributions:** The article is the result of a doctoral thesis supervised by the article's second author.

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