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Teaching statistcs and probability in mathematics degree courses at the Federal Institutes of Education, Science and Technolog in Brazil

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***Abstract**:* This work is a documentary research study aiming to analyze the offering and syllabus of the disciplines of Statistics, Probability, and Statistical Education in the in-person Mathematics Degree courses at the Federal Institutes (FI) of Brazil, examining whether future Mathematics teachers receive training in Statistical Education. Of the 36 FIs existing at the time of the research, 30 offered the Mathematics Degree course in person. In total, 70 Course Pedagogical Projects (PPCs) and the syllabuses of the related disciplines were analyzed, along with the official documents that govern the training of Brazilian teachers. Thus, it was possible to map the contents addressed in the training of Mathematics teachers and to verify alignment with the demands of the official documents. A comparison was made between what is being taught about Statistical Education in the FIs and what teachers really need to know to develop their teaching activities in Basic Education.

Keywords: Mathematics Teacher Training. Teaching Statistics and Probability. Statistical Education. Federal Institutes of Brazil.

Enseñanza de estadística y probabilidade em las carreras de matemáticas en los Institutos Federales de Educación, Ciencia y Tecnología de Brasil

Resumen: Este trabajo es una investigación documental, con el objetivo de analizar la oferta y el programa de las disciplinas de Estadística, Probabilidad y Educación Estadística en los cursos presenciales de la Licenciatura en Matemática de los Institutos Federales (IF) de Brasil. Comprobar si los futuros profesores de Matemáticas tienen formación en Educación Estadística. De las 36 IF existentes en el momento de la investigación, 30 de ellas ofrecían la Licenciatura en Matemática en la modalidad presencial. De estos, se analizaron 70 Proyectos Pedagógicos de Curso (PPC) y los programas de las disciplinas relacionadas. También se analizaron los documentos oficiales que rigen la formación de los docentes brasileños. Así, se pudo mapear los contenidos que se han trabajado en la formación de los docentes de Matemáticas, verificando el cumplimiento de las exigencias de los documentos oficiales. Se realizó una comparación entre lo que se enseña sobre Educación Estadística en las IF y lo que realmente necesitan saber los docentes para desarrollar sus actividades docentes en Educación Básica.

Palabras clave: Formación de Profesores de Matemáticas. Enseñanza de Estadística y Probabilidad. Educación Estadística. Institutos Federales de Brasil.

O ensino da estatística e da probabilidade nos cursos de licenciatura em matemática dos Institutos Federais de Educação, Ciência e Tecnologia do

Brasil

Resumo: Este trabalho trata-se de uma pesquisa documental e tem, como objetivo, analisar a oferta e as ementas das disciplinas de estatística, probabilidade e educação estatística nos cursos presenciais de licenciatura em matemática dos Institutos Federais (IF) do Brasil, verificando se os futuros professores de matemática possuem formação em educação estatística. Dos 36 IF existentes no momento da pesquisa, 30 deles ofertavam o curso de licenciatura em matemática na modalidade presencial. Desses, foram analisados 70 Projetos Pedagógicos de Curso (PPC) e as ementas das disciplinas relacionadas, além dos documentos oficiais que regem a formação de professores brasileiros. Sendo assim, foi possível mapear os conteúdos que vêm sendo trabalhados na formação de professores de matemática e verificar o atendimento das demandas dos documentos oficiais. Elaborou-se uma comparação do que está sendo ensinado sobre educação estatística nos IF e o que realmente os professores necessitam saber para desenvolverem suas atividades docentes na educação básica.

Palavras-chave: Formação de professores de matemática. Ensino de estatística e probabilidade. Educação estatística. Institutos Federais do Brasil.

1 Introduction

The implementation of the Federal Institutes of Education, Science, and Technology in Brazil, hereinafter referred to as FI, had, as one of its objectives, to offer licentiate courses at the higher education level for training basic education teachers, mainly in the areas of science and mathematics, as provided for in Law No. 11,892 of December 29, 2008 (Brasil, 2008).

This article is a documentary research study with the primary objective of analyzing the Pedagogical Projects of Courses (PPCs) of the Mathematics Degree programs offered by the Federal Institutes (FI) of Brazil, examining whether the courses offer disciplines in Statistics, Probability, or Statistical Education (SE). This analysis is relevant because, according to the BNCC, Mathematics teachers are responsible for teaching both Statistics and Probability at the elementary and high school levels.

The Mathematics Degree programs offered by the FIs were chosen because they are courses that aim not only to teach content but also to train teachers concerned with the integration between school and community; they focus on understanding the local social reality of each institutional unit, consistently seeking interaction among institution, student, and community.

It is understood that these disciplines are essential for comprehensive teacher training and to meet the requirements of official documents governing basic education in Brazil, namely: the National Curriculum Parameters (PCN), published in 1999 and 2000, and the National Common Curriculum Base (BNCC), published in 2018. These documents define the content teachers must teach at each school level: early childhood education, elementary, and high school. Therefore, both Mathematics teachers and generalist teachers must teach content in Statistics, Probability, and Statistical Education to meet the skills and competencies established by these documents.

The article is structured into six sections. The first section provides a brief overview of the regulation of higher education courses in Brazil, particularly teacher training programs, known as licentiate degrees, including their current formats and the regulations governing Mathematics licentiate programs, as well as the role of the FIs in society with regard to teacher training.

In the second section, we describe the development of Statistical Education in Brazil

and abroad and how it has been addressed by Brazilian teacher-researchers.

In the third section, a mapping of all existing FIs in Brazil was conducted to verify the offering of Mathematics licentiate programs. Each educational institution was searched individually, and the PPC of each one was analyzed to confirm the presence of disciplines in Statistics, Probability, or Statistical Education.

In the discussion section, we analyze the PPCs of the Mathematics Degree courses offered by the FIs, focusing specifically on the offering of disciplines in Statistics, Probability, or Statistical Education. We discuss how these syllabuses are presented and aligned with the official documents governing basic education and the training of Mathematics teachers.

2 Analysis of the documents that govern basic education in brazil

In Brazil, the path taken for the educational regulation of higher education courses has gone through several phases and restructurings. The first law that regulated higher education courses for teachers in Brazil was Law No. 4,024 of December 20, 1961, known as the Law of Guidelines and Bases of National Education (LDBEN) (Junqueira & Manrique, 2015), debated for 13 years until finally being published in 1961. New amendments and adjustments to the text were made to implement developmental ideas, giving rise to a new law, Law No. 5,540/68, which became known as the University Reform Law.

After the University Reform Law of 1968, there was yet another regulation for national education in 1971, when Law No. 5,692/71 was sanctioned, considered the New Law of Brazilian Education. This law lasted until 1996, the year in which it was replaced by the Law of Guidelines and Bases (LDB) No. 9,394 of December 20, 1996 (Brasil, 1996).

Resolution No. 2 of July 1, 2015, defines the National Curriculum Guidelines (DCN) for initial training at the higher education level in undergraduate courses, pedagogical training for graduates, and second-degree training for continuing education. It also proposes that the DCN emphasize the implementation of inclusive education, taking into account the national evaluation systems (Brasil, 2015).

In line with Article 62 of the LDB, the Ministry of Education (MEC) issued Resolution CNE/CP No. 2 of December 20, 2019, establishing new National Curriculum Guidelines for Initial Teacher Training for Basic Education. Additionally, it introduces the National Common Base for the Initial Training of Basic Education Teachers (BNC – Formação) (Brasil, 2019). These DCNs reference the implementation of the BNCC, as stipulated in the LDB, which governs the curricula of teacher training courses.

It is observed that Resolution 02/2019 specifies that the competencies of licentiate students must be linked to the skills and competencies proposed by the BNCC. This led to a division of specific content according to the BNCC. However, in no resolution is there a list of specific Statistics and Probability content to be developed in Mathematics degrees. In addition, Resolution 02/2015 lacks specifications regarding content for the area of the Mathematics degree, as the BNCC had not yet been published, so the competencies presented in it are not included in this document.

The PCN already emphasized skills in describing and analyzing large amounts of data to develop statistical and probabilistic reasoning (Brasil, 2000). Even though these references existed long before the publication of the BNCC, the DCN proposed for Mathematics degree courses still did not provide for the teaching of Statistics and Probability in their curricular base.

When organizing the PPC of Mathematics degree courses, educational institutions base them on the DCN for Mathematics courses, both for the bachelor's degree and for the licentiate.

However, these documents lack provisions for developing and enhancing the statistical and probabilistic thinking of Mathematics undergraduates. The DCN also does not mandate the inclusion of these disciplines in the curriculum of Mathematics degrees.

In the DCN for Mathematics courses, where the Mathematics degree course is included, it states that, in specific areas, the courses must cover the following content: Differential and Integral Calculus, Linear Algebra, Fundamentals of Analysis, Fundamentals of Algebra, and Fundamentals of Geometry (Brasil, 2002). The DCN also establishes common Mathematics content for basic education in the areas of algebra, geometry, and analysis, as well as related areas considered sources of problems and applications of their theories. However, these official documents do not mention the development of statistical or probabilistic knowledge for undergraduates.

The FIs, created in 2009, aimed to offer professional, scientific, and technological education, with one of their objectives being to train teachers in the areas of science and mathematics, focusing on the local reality of each campus.

3 The history of statistical education

The teaching of statistics emerged to meet the need for people to interpret information and to contribute to the formation of citizens capable of dealing with data and transforming it into information. Historically, statistical education began within statistical associations, usually through congresses, led by movements that initiated worldwide discussions, such as the American Statistical Association (ASA), the International Statistical Institute (ISI), and the International Association of Statistical Education (IASE).

The ASA was created in the United States in 1839 to bring together the community of statisticians and promote statistical practices to support academia, industry, and government (Santos, 2015). Initially, the primary focus of these associations was technical matters among statisticians. Later, they recognized that achieving their goals required investment in statistical education.

The ISI was formally founded in June 1885, during a meeting to celebrate the jubilee of the Royal Statistical Society (RSS) of London. It resulted from a series of statistical meetings that began with the first International Congress of Statistics, held in Brussels in 1853. This congress was organized by the Belgian sociologist Lambert Adolphe Jacques Quetelet (1796–1874), a pioneer in statistical studies involving social data. Quetelet also motivated the creation of a statistics section within the British Association for the Advancement of Science, which later became the RSS. He became the first non-British member of the society in 1839. The ISI initially consisted of 81 elite statisticians working for government and academia (ISI, 2023).

IASE was established in 1991 by the ISI to promote statistical education at all levels and in diverse contexts (Ottaviani & Batanero, 1999). This establishment marked the conclusion of a movement that began shortly after World War II, when ISI created the Committee on Statistical Education (Vere-Jones, 1995). IASE is one of the seven sections of ISI, now termed associations, with the first section founded in 1973.

IASE organizes the International Conference on Teaching Statistics (ICOTS), the main international congress on the teaching of statistics. This event gathers participants from across the globe every four years. In addition to ICOTS, IASE sponsors statistical education sessions at each ISI World Statistical Congress (WSC), held every two years, and organizes satellite conferences, with the first one held in 1993. Another IASE event, the roundtables, brings together a select international group of experts to discuss specific topics and offer recommendations to benefit those interested in statistical education. These roundtables take

place just before the quadrennial conferences of the International Congress on Mathematical Education (ICME), where IASE also supports sessions on statistical education. Additionally, IASE oversees the Statistical Reasoning, Thinking, and Literacy (SRTL) meeting, which focuses on statistical reasoning and literacy. Though not directly organized by IASE, SRTL is coordinated by members of the association. IASE also publishes the Statistics Education Research Journal (SERJ), the International Statistical Literacy Project (ISLP), and the proceedings from various conferences, including ICOTS and IASE roundtables.

More recent movements have taken place in the twentieth century, during which statistics began to be recognized globally as a distinct discipline, spurring interest in its teaching. In 1978, the RSS of London established the first journal of statistical education, the Teaching Statistics Journal, launched in 1979. During this period, the first ICOTS was held in Sheffield, England, in 1982, organized by the ISI Education Committee (Ody, 2019).

In the 1970s, with the global recognition of the importance of probabilistic reasoning, many countries began incorporating the teaching of statistics in basic education, emphasizing the need to move beyond a deterministic approach in math classes to the political and ethical implications of using statistics (Batanero, 2001).

In response to these global movements, Brazil began implementing statistics in its curricula in the late nineteenth century for training military engineers. The discussion on the teaching of statistics gained momentum after the inclusion of statistics and probability in the PCN of 1997, which formalized its teaching in basic education. According to Cazorla (2002), statistical education in Brazil reached a milestone during an international conference held at the Federal University of Santa Catarina in 1999, which focused on the experiences and expectations for its teaching.

In Brazil, from 2000 onwards, the increase in research at the master's and doctoral levels, the establishment of research groups, the spread of events and publications, and the development of textbooks and book chapters led to a consolidation of scientific work in this field (Lopes, Santos, Barbosa & Scarlassari, 2023).

Brazilian mathematics educators, members of the Brazilian Society of Mathematics Education (SBEM), convened at the first congress called the I International Symposium on Research in Mathematics Education (SIPEM) in 2000, in Serra Negra, São Paulo. Their goal was to map and systematize scientific work in mathematics education (Lopes, Coutinho & Almouloud, 2010). During I SIPEM discussions, working groups (WGs) formed around various mathematics topics, giving rise to WG12, which focuses on teaching probability and statistics. WG12 promotes statistical education within academia and basic education by publishing books and papers aimed at expanding statistical education beyond the mathematics education community. This group discusses topics such as probability, combinatorics, and statistics education at various levels, with members from multiple Brazilian states and institutions (Lopes, Coutinho & Almouloud, 2010, p. 11).

Within the I SIPEM reports and discussions, WG12 was established to study and understand how people teach and learn statistics, covering the cognitive and affective aspects of teaching and learning, the epistemology of statistical concepts, and developing methods and materials to advance statistical literacy. To accomplish this, statistical education draws on theoretical and methodological resources from mathematics education, psychology, pedagogy, philosophy, and mathematics (SBEM, 2021).

WG12 has put forward numerous proposals for promoting statistical education. Today, the group has more than 200 members across Brazil, who are invested in teaching statistics in both academia and basic education. The group has grown annually, strengthening the field by

presenting diverse scientific research on various themes, areas of study, and methodologies (Lopes, Santos, Barbosa & Scarlassari, 2023).

It was found that, from the PCN to the BNCC, the teaching of statistics has been included in official documents. However, mathematics teacher training programs have not incorporated statistics instruction. Consequently, research and instructional materials that help teachers design effective and engaging statistical activities have been gaining a readership of educators committed to enhancing statistical education.

Currently, there are over 100 defended theses in the field in Brazil. In a study published in SERJ, Viali, Ody, Ballejo & Braga (2023) mapped all publications, examining topics, theoretical foundations, programs, advisors, and other aspects. They found that the first thesis in this area was defended in 1994, and that the year with the highest number of theses was 2019, with 15 studies completed. The findings indicated that research production has grown but remains irregular, and that Brazil ranks second globally in doctoral-level research output in the field, trailing only the United States.

4 Statistical Education

In view of what the PCN and the BNCC present about the teaching of statistics, it is understood that there is an urgency to implement statistical education in mathematics degree courses. Thus, the dissemination of research and didactic materials that help teachers develop statistical activities in a concrete and effective way has been gaining an audience of readers who are interested and concerned about education.

Some definitions are necessary to understand statistical education. Therefore, it is necessary to know what statistical literacy, or literacy, means. Some authors refer to statistical literacy as the study of arguments that use statistics as a reference, i.e., the ability to argue using statistical terminology correctly (Campos, Wodewotzki, & Jacobini, 2011).

Statistical literacy is also evaluated as knowing how to interpret and critically evaluate statistical information (Gal, 2002; Watson; Callingham, 2003). Considering Gal (2002), an adult who lives in society is considered statistically literate when he or she is able to interpret and critically evaluate statistical information, taking into account the arguments related to the data or phenomena presented to them, regardless of the context. “This person needs to be aware of the need to discuss or communicate their understanding of the information provided to them, so that they can issue opinions about its implications and make considerations about the acceptance of the conclusions” (Cazorla & Utsumi, 2010, p.11).

Additionally, for the specific knowledge of statistical education, it is necessary to understand the difference between statistical reasoning and statistical thinking, since "statistical reasoning also means understanding a statistical process and being able to explain it, in addition to fully interpreting the results of a problem based on real data" (Campos, Wodewotzki, & Jacobini, 2011).

Statistical thinking can be understood as the strategies to be developed that are associated with decision-making in all stages of an investigative cycle, starting with a statistical study in social practice in which the student is the participatory agent who will make the choices in the investigation (Wild; Pfannkuch, 1999).

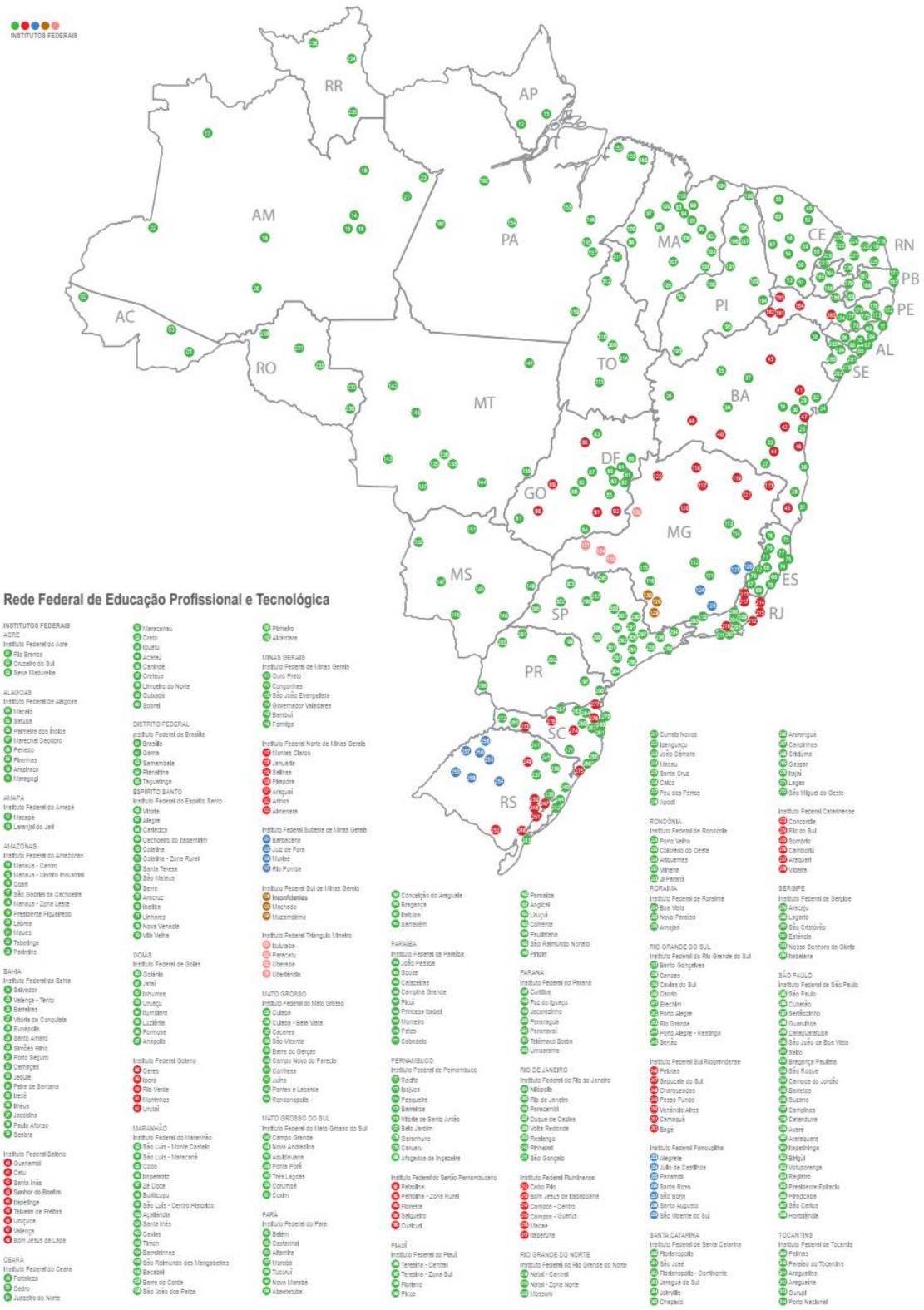
5 Methodology

The main objective of this article is to analyze the offering and syllabi of the disciplines of statistics, probability, and statistical education in the mathematics degree courses of the IFs in Brazil. To this end, it was sought to verify in the PPC of these courses whether they offer

these disciplines. The analysis aims to identify whether the PPC includes disciplines that enable future teachers to have knowledge about the teaching of statistics, in order to understand statistical reasoning and be able to teach their mathematics classes in order to develop the statistical and probabilistic skills and abilities specified in the BNCC. To this end, it is intended to identify the disciplines related to them, their workloads, and their methodologies. It also aims to identify whether in any degree there is already an offering of disciplines related to statistical and probabilistic education.

The data used for the analysis were obtained from the official website of the MEC. First, all FIs in Brazil were searched, as shown in Figure 1. A mapping of each FI was made in order to verify which of them offer the degree course in mathematics. Then, the official website of each educational institution was searched for the units that offer the course. In each campus, the course page and the respective PPC were searched. Once this was done, it was then sought to verify the availability of disciplines in statistics, probability, or statistical education, to then carry out the analysis and, in this way, conclude whether what is being offered allows the future teacher to have the knowledge to develop what is recommended in the BNCC.

Figure 1 – Distribution of Federal Institutes in the country



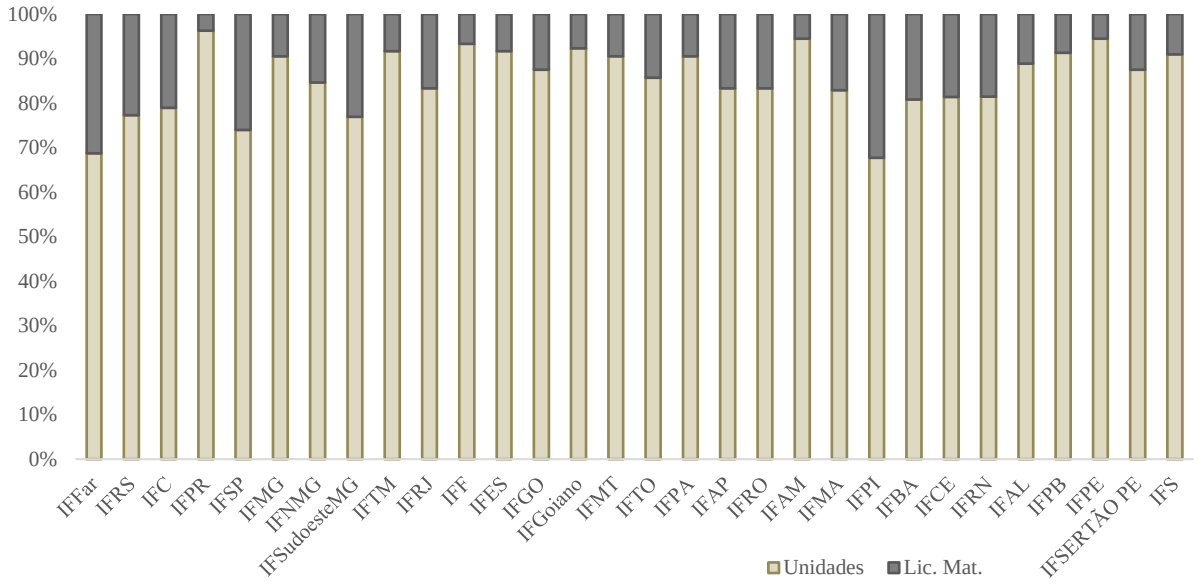
Source: Ministry of Education and Culture. (Brasil, 2022)

The FIs are composed of several units, that is, each institution is composed of decentralized units, which offer courses according to the local reality in which they are inserted. In addition, each unit can develop its PPC, however, some institutions maintain unique PPC for the same courses in different units.

The search for the PPC of the mathematics degree courses was carried out in the 30 FIs,

which represent 83% of these institutions. They are subdivided into 584 *campuses*, and 96 of these offer the degree course in mathematics in the face-to-face modality, that is, 16%. Figure 2 shows the FIs and the units that offer the face-to-face degree course in mathematics.

Figure 2 – FIs and the offer of face-to-face courses in mathematics



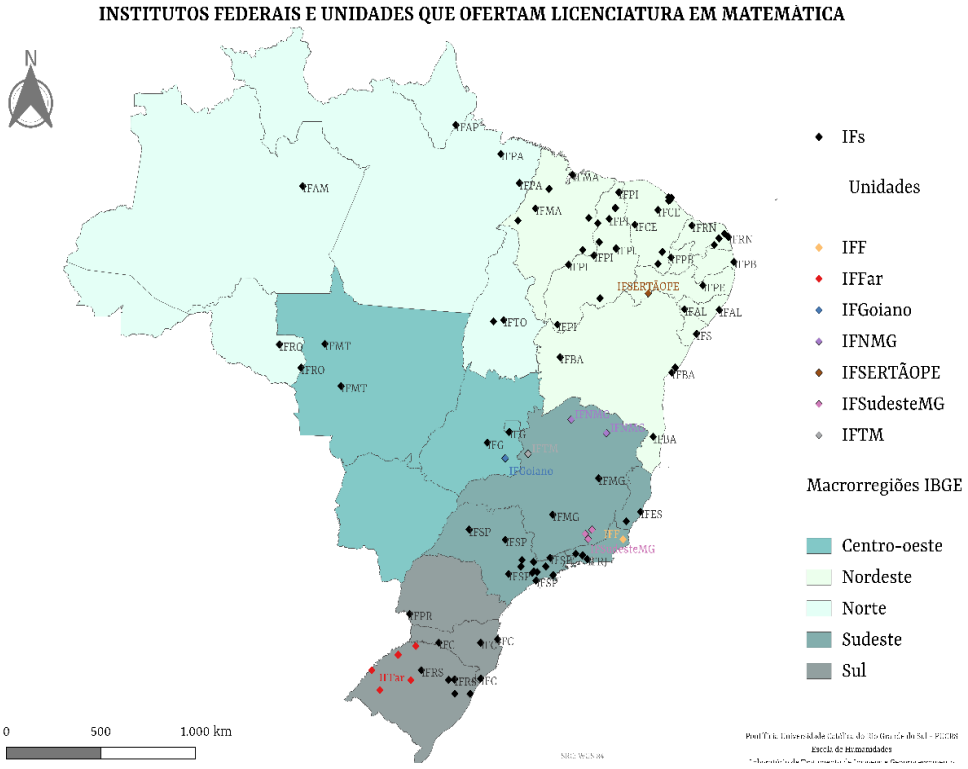
Source: The authors.

In Figure 2, each column represents an institution and its multiple campuses, but the course in question is only offered in some units, which are represented by the dark part of the column.

To verify whether there was a provision of disciplines in statistics, probability, or statistical education, the PPC of each of these 96 units was examined. It was observed that, in some units, statistical and probabilistic education is included in the pedagogical practice part. However, in most units, there is no specification of how statistical education is implemented.

Figure 3 shows the distribution, in the national territory, of FIs and units that offer the degree course in mathematics in the face-to-face modality.

Figure 3 – FI and the *campuses* that offer the degree in mathematics in the face-to-face modality



Source: The authors.

Observing, on the map, the distribution of the teaching degree courses in mathematics of the FIs, it is possible to verify that there is a concentration in the Northeast region, which accounts for 43% of the offers, followed by the Southeast region, with 28% of the courses, the South region, with 15%, the Midwest region, with 8%, and finally the North region, with 6%. It can be observed that the FIs in the states of Roraima, Acre, and Mato Grosso do Sul do not offer the courses.

In six teaching units, the PPC was not found on the course website and, therefore, these units were discarded. It was found that three FIs have the same PPC for courses offered on different campuses, called single PPC. For example, the Federal Institute of Education, Science and Technology Farroupilha, located in the central-west region of Rio Grande do Sul, has a single PPC for the five mathematics degree courses offered in the municipalities of Alegrete, Júlio de Castilhos, Santa Rosa, Frederico Westphalen, and São Borja.

One of the institutions offers a single PPC in three of its units; that is, three campuses have the same degree, and one of the campuses has a differentiated PPC. This institution is the Federal Institute of Santa Catarina, which has the PPC of the mathematics degree course common to the campuses of Sombrio, Concórdia, and Rio do Sul, and presents a different PPC in the Camboriú unit. The other 26 FIs provide different PPCs for each of their units. Considering this situation, 70 PPCs of the 96 units identified were analyzed.

During the analyses, it was found that all PPCs have statistical or probability disciplines, found in various forms. The main configuration presented refers to 35 pedagogical projects, which correspond to 50% of the documents analyzed. It was possible to observe that, in half of the courses analyzed, the discipline of statistics or probability is taught as a single discipline; that is, it includes both the statistical contents to be developed and the probabilistic ones.

It was observed that, among the 50% of the courses that include the disciplines of statistics and probability separately, three of them do not have the discipline of probability. Thus, 32 mathematics degree courses offered by the FIs present, in the PPC, the discipline of

probability separate from the discipline of statistics, and three courses have only the discipline of statistics.

It was also possible to observe that 27 courses offer the discipline of probability plus one discipline of combinatorial analysis; two courses present the discipline of probability plus one of statistical inference; and only three courses feature a specific probability discipline. These disciplines are provided for in the mandatory curriculum, and some courses offer the discipline of probability in the elective or optional modality.

Of the 35 courses that present the disciplines of statistics and probability separately, only one of them does not include the discipline of statistics, but this course presents a discipline of statistical education that exclusively includes contents of descriptive statistics.

One of the courses that offers the discipline of statistics separate from the discipline of probability includes, in its syllabus, statistical content together with content of financial mathematics. The other 34 courses present content as follows: seven of them contain basic statistics content plus probability content; the other 26 courses offer only statistics content, and some have more than one discipline focused on statistics.

In relation to the disciplines that involve statistical education, it was observed that only four courses, that is, 6%, offer a specific discipline on the subject, and one of these is the one that did not present a discipline of statistics, only one called statistical education, but which, in fact, encompasses only basic statistics content.

It was possible to verify that among the 26 courses that present statistics content, some mention the educational practice focused on basic education; that is, in some way, they address something of statistical education. However, in none of the courses was a discipline of statistical education found as an elective or optional.

It was also observed that only 13 courses, that is, 19% of the total, offer elective or optional courses in statistics or probability, and ten of them have an applied statistics course. One of the courses has a discipline with advanced statistical and probabilistic content, and the other two present a probability discipline with specific concepts.

After this analysis of the PPCs of the mathematics degree courses offered by the FIs, it is possible to verify that none of them fails to include statistics or probability in some way. Most of the PPCs, that is, 61% of them, were updated based on Resolution No. 2 of 2015, which made educational practices possible. These practices encompass statistical and probabilistic content for basic education; however, it was not specified which contents or how they should be addressed. It was noted that, in the PPC, the syllabuses of educational practices are broad, suggesting that statistical or probabilistic education content can be taught, but not in a mandatory way.

6 Discussion

Although the DCN of the mathematics degree courses did not explicitly include statistics and probability disciplines, it was still observed that, in all the PPC of the courses investigated, content from these areas was included. This was done in the form of a discipline of statistics or probability or, for the most part, in the form of a single discipline involving both statistics and probability. In addition, in a small number of courses, the discipline of statistical education was included. Chart 1 presents the syllabi of disciplines of statistical education, probability or statistics.

Table 1 – Syllabus of education (teaching) disciplines of statistics or probability

Name of the Discipline	Syllabus

Teaching probability and statistics.	Reading and interpreting data and information presented in different languages and representations, including tables, graphs and infographics, is one of the objectives of teaching mathematics in basic education. Therefore, the focus of the component is on the development of statistical thinking intrinsically related to the citizenship of students. For this, the different stages of a statistical research will be explored in order to reflect on the teaching of statistics that allows inference from data and issuance of judgments about information. In addition, the focus of the component will be the concepts and teaching of probability. The component also discusses the way in which mathematics can contribute positively to overcoming socio-environmental issues and to scientific and technological development. The workload of practice, as a curricular component, should be dedicated to discussions and the elaboration of projects on the teaching and learning of statistics and probability in basic education.
Teaching statistics and financial mathematics.	The course aims to promote discussions on the teaching of statistics, probability and financial mathematics from the perspective of mathematics education, enabling the future teacher to address concepts, facts and procedures present in problem situations of daily life, science and technology, which involve skills to collect, organize, represent, interpret and analyze data in order to make well-founded judgments and make appropriate decisions in their social context, cultural, political and economic. To this end, the following themes will be discussed with future teachers: stochastic education and its importance for the training of teachers who teach mathematics; perspectives of statistical education as an area of research in mathematics education; the teaching of financial mathematics, statistics and probability in basic education; statistical modeling activities aimed at the classroom; financial education in elementary and high school; financial mathematics, statistics and probability curriculum in basic education; financial mathematics, statistics and probability in the initial and continuing training of mathematics teachers; research on financial education as a line of research in mathematics education; and financial education and consumer society.
Teaching probability and statistics.	The basic school statistics and mathematical science curricula; analysis of textbooks (with priority given to textbooks approved in the National Textbook Program) and other didactic and paradidactic materials; analysis of official curricular proposals related to the teaching of probability and statistics in elementary and secondary education, seeking to identify points of difficulty for both teaching and learning; preparation and execution of didactic material, also seeking to include technology; evaluation of experiences related to the practice of the future teacher.
Statistics for basic education.	Basic concepts of descriptive statistics: attributes and variables, statistical series, frequency distribution, median, mode, standard deviation, statistical graphs, random variables. Use of electronic spreadsheets.

Source: The authors based on the PPC analyzed.

When analyzing the proposals of the statistical education disciplines, it was observed that they cannot be characterized as syllabus, since it is understood that the syllabus involves

only the summary of the contents to be taught. The proposals established and registered by the PPC are composed of texts that go further, including objectives and methodology. The exception was the discipline of "Statistics for basic education", which is presented as a discipline of statistical education, but, in its description, presents only contents referring to descriptive statistics. The author of the text mistakenly included the concept of random variable, which corresponds to a content of probability, not of statistics.

By observing the proposals of the disciplines of statistical or probabilistic education, it was possible to verify that only the first includes the development of statistical thinking, according to the excerpt: "Therefore, the focus of the component is on the development of statistical thinking intrinsically related to the citizenship of students". Thus, it is understood that there was an attempt to include statistical education in the training of mathematics teachers, but there is still a failure in the understanding of what statistical education is and how it is done.

As already mentioned in the methodological section, it was observed that the units that propose educational practices as disciplines request that statistical and probabilistic education be worked on in basic education, as provided in Chart 2.

Chart 2 – Syllabi of statistics or probability disciplines interconnected to educational practices

Discipline	Syllabus
Basic Statistics	Exploratory analysis of data in descriptive statistics: construction and analysis of graphs; understanding and use of the concepts of measurements; summary of central tendency and dispersion with a view to the organization, synthesis, description, investigation and analysis of collected data that help in decision making, as well as reading; interpretation and analysis of statistical information conveyed by the media and journals of scientific dissemination; understanding of the variability and uncertainties present in physical and social phenomena; distribution of probability, symmetry, rare or atypical events, intervals created from means and standard deviations, and their connection between descriptive and inferential statistics; notions of statistical inference: Central Limit Theorem. Reflections on the didactics of the teaching of statistics.
Combinatorics and probability	Contextualization and applications of the fundamental concepts of combinatorial analysis and probability theory , subsidizing discussions on the methodology of teaching mathematics and making applications with issues related to issues of social urgency such as the environment, diversity, socioeconomic issues, among others.
Statistics	Presentation and contextualization of the fundamental concepts of statistics and probability, especially for the organization of data, with the use of graphical representations of tables, measures of central tendency and measures of dispersion and understanding of counting techniques. It is intended, in this curricular component, to also discuss the teaching of statistics as an activity related to practice as a curricular component and the applications of statistics in environmental issues.
Combinatorics and probability	Presentation and contextualization of the fundamental concepts of combinatorics and probability, as well as the use of probability calculus applied to environmental issues. To this end, it is proposed the development of problem situations as Practices as Curricular Components (PCC).

Source: The authors based on the PPC analyzed.

In When 2, syllabuses of two teaching units are observed, in which it was found that the mathematics degree courses that have practices as curricular components intertwine statistical

and probabilistic contents with educational practice, a fact that does not characterize statistical education, since at no time is it mentioned that the student must develop the critical analysis of the contents studied, In other words, there is no statistical literacy in a specific mandatory way. It is understood that it is possible to develop statistical literacy when the student is able to understand the importance of learning statistics and probability developed in basic education.

During the analysis of the PPC, it was possible to verify that the mathematics degree courses included statistics or probability as a mandatory subject in the specific area of mathematics. They include the specific part of mathematical content to be developed in mathematics teacher training courses. If, on the one hand, this is desirable and positive, on the other hand, it results in a confusion between statistics and mathematics, because it leads the student to believe that statistics is a part of mathematics when, in fact, this is not the case.

It was also observed that the curricula are in transformation, seeking to adapt to the competencies and skills proposed by the BNCC. This finding was perceived through the year of publication of the PPC analyzed, considering that, during the research period, the process of adapting the curricula according to the 2019 DCN was in force.

Many of the PPCs analyzed came into force before the BNCC. This was not an impediment for them to seek an educational proposal in the area of statistical and probabilistic education contemplating the social reality of basic education, considering that the PCN already emphasized the skills of describing and analyzing data in order to make inferences and make predictions based on a sample extracted from a population, thus applying concepts of combinatorics, statistics and probability to natural and everyday phenomena (Viali, 2008).

Even considering that the PPC found were built before the BNCC, this would not prevent this construction from remaining a space for statistical education, as the PCN already characterized the importance of this area. It is possible to perceive, in the words of Viali (2008), that the PCN characterize three structuring axes that should be developed in the three grades of high school: "(1) algebra: numbers and functions; (2) geometry and measurements and (3) Data analysis". Viali himself details the data analysis as follows:

> it is proposed that it constitutes the third axis or structuring theme of education. This theme can be organized into three thematic units: Statistics, Counting and Probability. As a product of these contents, it is stated that: '... The student at this stage of schooling is expected to go beyond reading information and critically reflect on its meanings. Thus, the proposed theme must go beyond the simple description and representation of data, reaching the investigation of these data and decision-making (Viali, 2008, p.3).

Even before the BNCC was published, the PCN already provided for the inclusion of statistics and probability content in mathematics teacher training courses, giving indications that an introduction to statistical education would be expected from student learning in basic education to be implemented in mathematics degree courses.

When the BNCC was published, it was found that one of the units refers to probability and statistics, which proposes that the student should develop, from the early years, the ability to understand probabilistic and statistical reasoning. In order for learning to occur according to the objects of knowledge pre-established by the BNCC, the student must learn as a citizen capable of collecting, organizing, representing, interpreting and analyzing data from a context variable in a way that can make appropriate decisions, in addition to being able to reason and use concepts, representations and indices to describe, explain and predict phenomena (Brasil, 2018).

When the document determines that students must be able to "reason and use concepts," it is already inferred that the teacher must develop statistical thinking in accordance with statistical literacy. Therefore, the mathematics teacher must be qualified to teach statistical and probabilistic content in order to develop, in students, statistical criticality.

Campos, Wodewotzki and Jacobini describe statistical thinking as:

> [...] being the ability to relate quantitative data with concrete situations, admitting the presence of variability and uncertainty, explaining what the data can *say* about the problem in focus. Statistical thinking occurs when mathematical models are associated with the contextual nature of the problem in question, that is, when the identification of the analyzed situation arises and an appropriate choice of the statistical tools necessary for its description and interpretation is made (Campos, Wodewotzki & Jacobini, 2011, p. 38).

Even considering the analysis made in the PPC, at no time was any content found in the syllabus that refers to statistical education, not even when talking about literacy, thinking and statistical reasoning. Considering the PCN and the BNCC, it is possible to verify that these documents that guide the competencies and skills to be developed by basic education students should also serve as a basis for the construction of the DCN for the training of mathematics teachers. However, this has not yet been the case, since there is no mention of statistical, probabilistic or combinatorial content in these documents.

For official teacher training documents, there is no obligation, in the training of graduates in mathematics, to include statistics, probability or statistical education content. In this way, higher education institutions feel exempt from offering these disciplines that are included in both the PCN and the BNCC.

It is agreed with Batanero, Ottaviani and Truran (2000) that there are still many problems in the development of contents related to the teaching of statistics and probability in the training of mathematics teachers (Brasil, 2000). It is understood that this reality will not yet be resolved, as there is little training offered in the area, as can be observed in the PPC of the courses analyzed. Despite some progress, they are still clearly insufficient.

7 Conclusions

When analyzing the PPC of the mathematics degree courses of the Brazilian FIs in search of the offer of statistics, probability, and statistical education disciplines, it was noticed that, even though there are many units that make up the FIs, there are few offers of mathematics degree courses in the face-to-face modality. Of the courses offered, almost all make the PPC available for viewing. By analyzing the PPC found, it was possible to perceive that all courses offer statistics or probability disciplines. It was found that the courses that offer the practices as curricular components, based on Resolution No. 2 of 2015, contemplate statistical education not specifically as a discipline, but as part of the educational practice.

As for the training of mathematics teachers who need to be prepared to work with statistics and probability in basic education, it is believed that there is still a lot of study and understanding of statistical and probabilistic concepts, especially when it comes to establishing relationships between statistics and probability taught in undergraduate courses and statistical and probabilistic education taught by mathematics teachers in basic education. An analysis is sufficient to verify that these disciplines occupy a tiny portion of the curriculum of future teachers; that is, one or at most two disciplines of four credits in a list of about 200 credits that must be taken by a future student in mathematics.

Few courses presented statistical education as a discipline, and in some courses, it is contained in the disciplines of educational practices. It was noticed that there is still no proposal for the construction of statistical and probabilistic education that meets what should be taught in basic education. It is understood that, with the restructuring of mathematics degree courses, there is room for the educational development of academics so that they can understand the competencies and skills proposed by the BNCC. However, a necessary condition for this to occur is the inclusion, in the DCN, of these disciplines as mandatory contents in mathematics degree courses. The sufficient condition will be the qualification of teachers by offering licentiate courses that, in fact, contemplate, in addition to specific content of statistics and probability with sufficient workloads, disciplines of statistical education. After all, the set of knowledge in the area is already sufficient for this to be incorporated into mathematics courses, as has been happening in several countries.

In order for the problem to be satisfactorily addressed, the official documents must be in agreement; that is, if there is an obligation to teach these subjects in the BNCC, the same should occur in the DCN of the mathematics degree courses. Otherwise, if this is not done, we will continue to depend only on isolated efforts of a few courses, movements, or groups of teachers who are willing to disseminate statistical education, which is meritorious but of little effectiveness in a continental country like Brazil.

In all the mathematics degree courses in which the PPC was accessed, it was possible to verify the offer of statistics or probability disciplines. However, not all courses present a discipline of statistical education, and the courses that present this discipline maintain a mistaken interpretation of what it is and the way it should be taught. It was observed that the courses that present practices as curricular components try, in some way, to contemplate statistical education.

References

Batanero, C. (2001). *Didáctica de la Estadística*. Reprografia de la Facultad de Ciencias, Universidade de Granada.

Batanero, C., Ottaviani, G., & Truran, J. (2000). Investigación en educación estadística: Algunas cuestones prioritárias. *1*(2).

Brasil. (1996). *Lei de Diretrizes e Bases da Educação Nacional (LDB)*. Coordenação de Técnicas.

Brasil. (2000). *Ciências da Natureza, Matemática e suas Tecnologias: Parâmetros Curriculares Nacionais - Ensino Médio*.

Brasil. (2002). *PCN ensino médio: Orientações educacionais complementares aos parâmetros curriculares nacionais: Ciência da Natureza, Matemática e suas Tecnologias*. MEC/SEMTEC.

Brasil. (2002, janeiro 18). Diretrizes Curriculares Nacional para a Formação de Professores da Educação Básica.

Brasil. (2008, dezembro 29). *Lei nº 11.892*.

Brasil. (2015, julho 1). Diretrizes Curriculares Nacionais para a formação inicial em nível superior e para a formação continuada. Resolução Nº 2. Ministério da Educação.

Brasil. (2019, dezembro 20). Diretriz curricular nacional para a formação inicial de professores para a Educação Básica e institui a Base Nacional Comum para a formação inicial de professores da Educação Básica.

Brasil. (2022). Ministério da Educação e Cultura. Disponível em http://portal.mec.gov.br/rede-federal-inicial/apresentacao-rede-federal

Brasil, M. D. (2018). *Base Nacional Comum Curricular*.

Campos, C. R., Wodewotzki, M. L., & Jacobini, O. R. (2011). *Educação Estatística: Teoria e prática em ambientes de modelagem matemática*. Autêntica.

Cazorla, I. M. (2002). A relação entre a habilidade viso-pictórica e o domínio de conceitos estatísticos na leitura de gráficos (Tese de doutorado). Universidade Estadual de Campinas.

Cazorla, I. M., & Utsumi, M. C. (2010). Reflexões sobre o ensino de estatística na educação básica. Em C. Irene & E. Santana (Eds.), *Do tratamento da informação ao letramento estatístico* (Vol. 1, pp. 9-18). Via Litterarum.

Gal, I. (2002, abril). Adults' statistical literacy: Meanings responsibilities. *70*(1), 1-25.

ISI. (2023, junho). International Statistical Institute. Disponível em http://isi-web.org

Junqueira, S. D., & Manrique, A. (2015). Reformas curriculares em cursos de licenciatura de matemática: Intenções necessárias e insuficientes. *21*, 623-635.

Lopes, C. E., Coutinho, C. d., & Almouloud, S. (2010). *Estudos e Reflexões em Educação Estatística*. Mercado de Letras.

Lopes, C. E., Santos, S. S., Barbosa, G., & Scarlassari, N. T. (2023). Um histórico da produção científica brasileira em Educação Estatística. Em C. C. Giordano & M. A. Kistemann Jr. (Eds.), *História da Educação Estatística Brasileira: Pesquisa e pesquisadores* (Vol. 2, pp. 15-42). Akademy.

Ody, M. (2019). Desenvolvimento e perspectivas da educação estatística: Narrativas de educadores estatísticos no contexto ibero-americano (Tese de doutorado). Pontifícia Universidade Católica do Rio Grande do Sul.

Ottaviani, M. G., & Batanero, C. (1999). The role of the IASE in developing statistical education.

Santos, R. O. (2015). Estudo da arte e a história da pesquisa em educação estatística em programas brasileiros de pós-graduação (Tese de doutorado). Universidade Estadual de Campinas.

SBEM. (2021). Grupo de Trabalho - Educação Estatística. Disponível em http://www.sbembrasil.org.br/sbembrasil/index.php/grupo-de-trabalho/gt/gt-12

Watson, J. M., & Callighan, R. (2003). Statistical literacy: A complex hierarchical construct. *Statistics Education Research Journal, 2*, 3-46.

Wild, C. J., & Pfannkuch, M. (1999). Statistical thinking in empirical enquiry. *International Statistical Review, 69*(3), 223-265.

Vere-Jones, D. (1995). *International Statistical Review, 63*(1), 3-23.

Viali, L. (2008). O ensino de estatística e probabilidade nos cursos de licenciatura em matemática. *18º SINAPE - Simpósio Nacional de Probabilidade e Estatística*, 1-7.