

Initial and continuing education of teachers who teach mathematics: Some possibilities in statistical education

Formación inicial y continua de profesores que enseñan matemáticas: Algunas posibilidades en educación estadística

Formation initiale et continue des enseignants qui enseignent les mathématiques: quelques possibilités en éducation statistique

Formação inicial e continuada de professores que ensinam matemática: Algumas possibilidades em educação estatística

Thatiany Rodrigues Ferreira¹

Universidade Federal de Pernambuco - UFPE
Mestra em Educação Matemática e Tecnológica
<https://orcid.org/0000-0002-2428-6424>

Maria Niedja Pereira Martins²

Universidade Federal de Pernambuco - UFPE
Doutora em Educação
<https://orcid.org/0000-0001-7288-9206>

Wanessa Mayara Silva da Rocha³

Universidade Federal de Pernambuco - UFPE
Mestra em Educação Matemática e Tecnológica
<https://orcid.org/0000-0003-0282-9739>

Abstract

The present article aims to discuss possibilities for statistical education, focusing on the initial and continuing education of teachers who teach mathematics. To this end, reflections and discussions arising from master's and doctoral research developed within the Graduate Program in Mathematical and Technological Education (PPGEduMATEC) at the Federal University of Pernambuco (UFPE) and affiliated with the Research Group in Mathematics and Statistics Education (GPEME), in the field of statistical education, are presented. The studies address the education of in-service K-1 to K-5 and K-6 to K-8 teachers, as well as the initial education of teachers holding a pedagogy degree, K-6 to K-8 mathematics teachers, and prospective mathematics

¹ thatiany.ferreira@ufpe.br

² niedja.martins@ufpe.br

³ wanessa.mayara@ufpe.br

teachers. The research is grounded in the theoretical model of statistical literacy and discusses possibilities for the teaching of statistics, while also highlighting needs and gaps in initial and continuing teacher education processes. The results indicate pathways for pedagogical approaches to the teaching and learning of statistics, particularly for specific concepts such as sampling, the arithmetic mean, and the box-plot, and emphasize the importance of teacher education programs that foster critical reflection on teaching practice and the constitutive elements of statistical literacy. Furthermore, the use of technology proved an ally in the teaching and learning of Statistics, highlighting the need to articulate statistical knowledge with data-informed critical positioning, thereby contributing to critical and contextualized teacher education.

Keywords: Statistical education, Teacher education, Statistical literacy, Educational technologies.

Resumen

El presente trabajo tiene como objetivo discutir posibilidades en educación estadística orientadas a la formación inicial y continua de docentes que enseñan matemáticas. Para ello, se presentan reflexiones y discusiones derivadas de investigaciones de maestría y doctorado desarrolladas en el Programa de Posgrado en Educación Matemática y Tecnológica (PPGEduamatec) de la Universidad Federal de Pernambuco (UFPE) y vinculadas al Grupo de Investigación en Educación Matemática y Estadística (GPEME), en el ámbito de la educación estadística. Las investigaciones contemplan la formación de docentes de los primeros y últimos años de la Educación Primaria, así como la formación inicial de profesores de matemáticas, involucrando como participantes a docentes pedagogos, profesores de matemáticas de los últimos años y estudiantes de profesorado en matemáticas. Los estudios se fundamentan en el modelo teórico de la alfabetización estadística y abordan posibilidades para la enseñanza de la estadística, además de evidenciar necesidades y vacíos presentes en los procesos de formación inicial y continua. Los resultados señalan caminos para enfoques pedagógicos en la enseñanza y el aprendizaje de la estadística, en particular de conceptos específicos como el muestreo, la media aritmética y el gráfico de caja (boxplot), destacando la importancia de formaciones que promuevan la reflexión crítica sobre la práctica docente y sobre los elementos constitutivos de la alfabetización estadística. Asimismo, el uso de tecnologías se mostró como un aliado en la enseñanza y el aprendizaje de la estadística, evidenciando la necesidad de articular los conocimientos estadísticos con

posicionamientos críticos fundamentados en datos, lo que contribuye a una formación docente crítica y contextualizada. resumo

Palabras clave: Educación estadística, Formación de profesores, Alfabetización estadística, Tecnologías educativas.

Résumé

Le présent travail a pour objectif de discuter des possibilités en Éducation Statistique orientées vers la formation initiale et continue des enseignants qui enseignent les mathématiques. À cette fin, sont présentées des réflexions et des discussions issues de recherches de master et de doctorat développées dans le cadre du Programme de Troisième Cycle en Éducation Mathématique et Technologique (PPGE_{edumatec}) de Universidade Federal de Pernambuco (UFPE) et affiliés au Groupe de Recherche en Éducation Mathématique et Statistique (GPEME), dans le domaine de l'Éducation Statistique. Les recherches portent sur la formation des enseignants des premières et dernières années de l'enseignement fondamental, ainsi que sur la formation initiale des enseignants de mathématiques, impliquant comme participants des enseignants pédagogues, des enseignants de mathématiques des dernières années et des étudiants en formation initiale en mathématiques. Les études s'appuient sur le modèle théorique de la Littératie Statistique et abordent des possibilités pour l'enseignement de la statistique, tout en mettant en évidence les besoins et les lacunes présents dans les processus de formation initiale et continue. Les résultats indiquent des pistes pour des approches pédagogiques dans l'enseignement et l'apprentissage de la statistique, notamment en ce qui concerne des concepts spécifiques tels que l'échantillonnage, la moyenne arithmétique et le diagramme en boîte (box-plot), soulignant l'importance de formations favorisant une réflexion critique sur la pratique enseignante et sur les éléments constitutifs de la Littératie Statistique. En outre, l'utilisation des technologies s'est révélée être un allié dans l'enseignement et l'apprentissage de la statistique, mettant en évidence la nécessité d'articuler les connaissances statistiques à des positionnements critiques fondés sur des données, contribuant ainsi à une formation enseignante critique et contextualisée.

Mots-clés: Éducation statistique, Formation des enseignants, Littératie Statistique, Technologies éducatives.

Resumo

O presente artigo tem como objetivo discutir possibilidades em educação estatística voltadas à formação inicial e continuada de professores que ensinam matemática. Para isso, são apresentadas reflexões e discussões provenientes de pesquisas de mestrado e doutorado desenvolvidas no Programa de Pós-Graduação em Educação Matemática e Tecnológica (PPGEduamatec) da Universidade Federal de Pernambuco (UFPE), no campo da educação estatística, e vinculadas ao Grupo de Pesquisa em Educação Matemática e Estatística (GPEME). As pesquisas contemplam a formação de professores dos anos iniciais e finais do ensino fundamental, bem como a formação inicial de professores de matemática, envolvendo como participantes professores pedagogos, professores de matemática dos anos finais e licenciandos em matemática. Os estudos fundamentam-se no modelo teórico do letramento estatístico e abordam possibilidades para o ensino de estatística, além de evidenciar necessidades e lacunas nos processos de formação inicial e continuada. Os resultados indicam caminhos para abordagens pedagógicas no ensino e na aprendizagem da estatística de conceitos específicos como amostragem, média aritmética e o gráfico box-plot, destacando a importância de formações que promovam a reflexão crítica sobre a prática docente e sobre os elementos que constituem o letramento estatístico. Além disso, a utilização de tecnologias mostrou-se aliada ao ensino e à aprendizagem da estatística, evidenciando a necessidade de articular conhecimentos estatísticos a posicionamentos críticos fundamentados em dados, contribuindo para uma formação docente crítica e contextualizada.

Palavras-chave: Educação estatística, Formação de professores, Letramento estatístico, Tecnologias educacionais.

Initial and continuing education of teachers who teach mathematics: Some possibilities in statistical education

Introduction

In the context of mathematics education, studies on teacher education, either mathematics licensees or pedagogy graduates, are recurrent, since the strengthening of teacher education is a central objective to contribute to teaching and learning. In this scenario, the development of new technologies highlights the need for investigations that not only elucidate teaching processes but also offer pedagogical alternatives aligned with current demands.

Regarding statistical education, Gautério and Porciúncula (2025) reinforce the importance of formative processes that focus on statistical knowledge beyond mere data manipulation, implying that the formative process should prioritize discussion, reflection, and the construction of data-based arguments to articulate, in an integrated way, the constituent elements of statistical literacy (Gal, 2002).

The current scenario of the widespread dissemination of information and misinformation, combined with the emergence of artificial intelligence (AI) in content creation, imposes on teachers' initial and continuing education the need to foster discussions on these themes and to promote critical dialogue with technological and informational advances in statistical education.

Borba et al. (2011) argue that initial and continuing mathematics teacher education should cover the effective use of didactic resources available for teaching statistics and encourage research with students. Based on these ideas, we can understand that initial and continuing teacher education should favor investigative and reflective pedagogical practices aligned with the demands of statistical literacy to articulate the elements involved in understanding, interpreting, and analyzing statistical information.

In this sense, the objective of this article is to present and discuss possibilities *for* and *in* statistics education aimed at the initial and continuing education of teachers who teach mathematics. To this end, reflections and discussions are articulated from master's and doctoral research developed in the Postgraduate Program in Mathematics and Technological Education (PPGEduMatec) of the Federal University of Pernambuco (UFPE), linked to the Research Group on Mathematics and Statistics Education (GPEME). The investigations highlighted here cover formative processes of the early

years (K-1 to K-5) and late years (K-6 to K-8) teachers of elementary school, as well as the prospective mathematics teachers' initial education, and comprise research by Martins (2014; 2018), Rocha (2023), and Ferreira (2025). Although they have different objectives, these studies were grounded in a common theoretical framework: Gal's statistical literacy (2002).

Structurally, the text is organized into five sections that systematize the proposed discussions. The first is based on the theoretical framework of statistical literacy (Gal, 2002), and the other two are dedicated to the education of teachers who teach K-1 through K-8. Finally, the fourth section addresses the initial education, followed by the final considerations that close the work.

The theoretical model of statistical literacy

The contemporary context of the widespread dissemination of information, whether real or not, based on statistical data demands that the citizen reader adopt a critical and analytical attitude toward news, headlines, and messages conveyed across different media. In this scenario, it is not enough to know how to read statistics; an effective understanding of these data is necessary, as is adopting a critical posture, to interpret information that is often permeated by bias or misinformation.

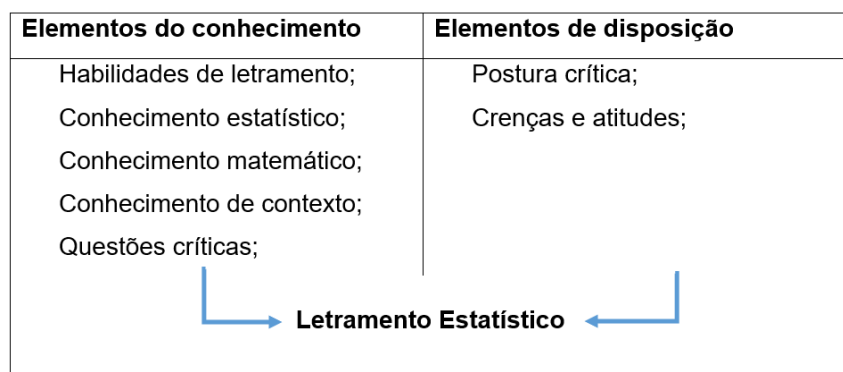
Gal (2002) argues that citizens should be able to understand, discuss, analyze, and argue using information grounded in statistical data. To this end, it is necessary to mobilize cognitive, knowledge-based, and attitudinal-dispositional elements that converge on statistical literacy (SL). For Gal (2002, p. 2-3), statistical literacy involves two interrelated components, which are:

(a) the ability to interpret and critically evaluate statistical information, data-backed arguments, or stochastic phenomena that people may encounter in diverse contexts, including the media, but not limited to, and (b) the ability to discuss or communicate their views regarding such statistical information when they are relevant.

Although formulated in the early 2000s, the statistical literacy model proposed by Gal (2002) remains current and is widely mobilized in recent research in the area (Monteiro and Carvalho 2021). Figure 1 displays the statistical literacy model based on Gal's (2002) ideas.

Figure 1

Statistical Literacy Model



Note. Adapted from Gal, 2002, p. 4, our translation

Based on the model proposed by Gal (2002), the elements of knowledge are: literacy skills, related to the reader's reading ability in the mother tongue; statistical knowledge, referring to statistical concepts and their meanings; mathematical knowledge, linked to mathematical operations; context knowledge, which concerns knowledge about current events and social, regional and political contexts, among others; and critical issues, associated with the skills of questioning and critical analysis in the face of statistical data.

Regarding the elements of disposition, the critical posture is essential to avoid the appropriation of misinformation as truth, and is necessary in any situation that requires understanding and interpreting information. As for beliefs and attitudes, Gal (2002) notes that these factors influence the interpretation of statistical data, a finding corroborated by Ferreira's (2025) study.

Gal's (2002) contributions are fundamental for understanding the influence of statistical literacy elements on data interpretation and coherent decision-making. According to Watson and Callingham (2003), attitudes based on interpretations of statistical data can have repercussions in broader contexts, such as the processes of choosing political representatives. This relationship between interpretations, effects, and consequences highlights the importance of developing statistical literacy.

In the context of teacher education, statistical literacy is an essential aspect of both teaching practice and daily personal actions. When working in the classroom, teachers must promote students' civic-critical stance, thereby fostering their statistical literacy. From this perspective, Lopes (2008) highlighted that the teaching profession

demands an active stance toward social problems. Thus, initial and continuing teacher education is expected to meet social and pedagogical demands.

From this perspective, Cazorla and Castro (2008) emphasized that mathematics teachers and teachers who teach mathematics must promote teaching that is close to students' realities, moving beyond an approach restricted to the application of formulas and algorithms. This understanding aligns with the reflections of Rodrigues and Pontes (2020), who argue that the development of statistical literacy is not effective through a teaching centered exclusively on formal procedures disconnected from real data, as such an approach contributes little to the critical formation of the individual.

In light of these discussions, the relevance of statistical literacy is evident for both civic education and the professional education of mathematics teachers, as it enables the development of skills fundamental to teaching practice and the exercise of citizenship. This work presents opportunities to articulate statistical literacy and the initial and continuing education of teachers who teach mathematics.

The education of K-1 through K-5 teachers and the statistical education

From K-1 to K-5, the teaching of statistics is central to developing students' critical thinking, enabling them to interpret, analyze, and question information across diverse social contexts. From an early age, children are exposed to graphs, tables, opinion polls, indices, and data-driven news, underscoring the need to develop statistical literacy as part of basic education. Working with data collection, organization, representation, and interpretation at this stage contributes to the development of investigative thinking, the notion of variability, and the understanding of uncertainty, in addition to favoring the articulation between mathematics and students' daily situations (Gal, 2002; Batanero, 2004).

In this sense, statistics in the first years of elementary school should not be seen only as a set of techniques but as a body of knowledge that allows children to understand the world around them, make informed decisions, and participate more critically in social life. For this to happen, the mathematics teacher must have conceptual, didactic, and pedagogical knowledge to plan contextualized, investigation-based learning situations aligned with the principles of statistical education.

Given the centrality of statistics in the first years and the need to promote statistical literacy from the earliest stages of schooling, it is essential to examine how teachers who teach mathematics understand and mobilize this field of knowledge in their pedagogical practices. These teachers' conceptions, attitudes, and didactic choices

directly influence the learning opportunities offered to students. In this sense, Martins' research (2014; 2018) contributes to understanding how K-1 to K-5 teachers relate to statistical content, highlighting challenges and possibilities for teacher education in statistics.

Martins' (2014) master's thesis research analyzed the conceptions of three K-1 to K-5 teachers regarding sampling, focusing on aspects such as representativeness, sample size, and type, using the educational software TinkerPlots 2.0 as a pedagogical mediation tool. The qualitative study involved four teachers from a public school in the Metropolitan Region of Recife. The data were collected through semi-structured interviews, moments of familiarization with the software, and three exploratory activities involving sampling situations.

The results showed that the teachers had fragmented conceptions of sampling, with difficulties understanding the relationship between sample selection and the possibility of inferring population characteristics. The representativeness and sample size, for example, were often interpreted intuitively, without a consistent articulation with statistical principles. However, the interaction with TinkerPlots facilitated the construction of new meanings, especially through dynamic data visualization and the manipulation of different samples. The teachers began to recognize, albeit briefly, the importance of variability and the sampling process in interpreting results.

Martins (2014) points out that the use of computational environments favors the exploration of statistical ideas in an investigative way, but that such experiences need to be accompanied by intentional pedagogical mediation to promote more solid conceptual advances. The study thus points to the need for continuing education that integrates technology, conceptual reflection, and contextualized didactic practices to strengthen K-1 to K-5 teachers' statistical knowledge.

In the doctoral thesis, in turn, Martins (2018) expanded this discussion by investigating the attitudes of K-1 to K-5 teachers toward statistics and their influence on the choices and construction of statistical graphs. The study adopted a mixed-methods approach comprising two phases: a quantitative phase involving 201 teachers from the public school networks of Camaragibe and Igarassu, Pernambuco, and a qualitative phase involving 22 teachers selected for interviews and specific tasks.

In the quantitative study, instruments such as the Scale of Attitudes Towards Statistics (Escala de Atitudes em Relação à Estatística—EAEE) (Estrada, 2002) and a

questionnaire on the use and choice of statistical graphs were used. The results indicated significant differences in teachers' attitudes, driven by variables such as gender, professional experience, and education. Teachers with more favorable attitudes toward statistics demonstrated greater confidence in teaching this content and used a wider variety of graphical representations. On the other hand, most teachers tended to favor bar graphs, even when other types of graphs would have been more appropriate.

The qualitative step revealed that although teachers recognized the importance of statistics in the curriculum, many had conceptual and didactic limitations that prevented them from properly exploring the graphs in the classroom. The choices of representations were often based on familiarity and personal safety rather than on pedagogical or statistical criteria. In addition, the absence of technological resources in the school routine was observed, which restricted the possibilities of visual and investigative exploration of the data.

Martins (2018) concludes that teachers' attitudes towards statistics directly influence their pedagogical practices, affecting both content selection and teaching strategies. Teachers with more positive attitudes tend to propose more diverse, contextualized activities aligned with the principles of statistical education, whereas negative or insecure attitudes limit students' learning experiences.

These findings align with the literature on statistical literacy, which emphasizes the importance of developing it from the early years of schooling (Gal, 2002; Batanero, 2004). Statistical literacy involves not only technical skills but also the ability to critically interpret data-driven information, understand variability, and make informed decisions. For this process to occur, teachers must have solid conceptual knowledge and favorable attitudes towards statistics.

In addition, studies on teacher education indicate that teaching knowledge is constructed in a situated way, grounded in the interplay among theoretical knowledge, practical experience, and contexts of action (Tardif, 2014; Nóvoa, 2017). In this sense, Martins' research (2014; 2018) reinforces the importance of continuing education that promotes reflection on practice, the pedagogical use of educational technologies, and the deepening of conceptual understanding in statistics.

By articulating these findings in the Brazilian context, specifically regarding the role of the teacher who teaches mathematics in the early years, we realize that many challenges remain in achieving significant learning in statistics at this stage of instruction. Despite the strong trend of research aimed at teacher education in the Northeast region (Lira & Andrade, 2025), in the view of Mello et al. (2024, p. 170), it

is still “important to investigate more about what knowledge teachers who teach mathematics in the early years of elementary school need to mobilize so that they can develop the skills necessary for statistical literacy in students”.

Thus, the education of K-1 to K-5 teachers in statistics education should be understood as a continuous process that involves the development of conceptual knowledge, didactic skills, and positive attitudes towards teaching statistics. Martins’ research (2014; 2018) shows that investing in teacher qualification, especially through contextualized, reflective, and technology-mediated formative practices, is a fundamental condition for promoting more substantial and socially relevant statistical learning for students at this stage of instruction.

The education of the teacher who teaches K-1 through K-5 and the statistics education

Continuing education is a central element of teacher professional development, as it enables the updating and improvement of pedagogical practices in light of advances in statistics education (Silva, Oliveira, & Nóbrega, 2024). Therefore, Rocha’s master’s thesis (2023) presents formative lived experiences of K-6 to K-8 teachers as they mobilized the concept of the arithmetic mean from the perspective of statistical literacy. The overall objective of this study was to analyze mathematics teachers’ understanding of arithmetic mean in the final years of elementary school and to identify possibilities for teaching this concept from a Statistical Literacy perspective. Specifically, the study aimed to: (a) investigate teachers’ prior knowledge of situations involving arithmetic mean; (b) examine how they teach this concept; and (c) explore, together with teachers, possibilities for teaching arithmetic mean from a Statistical Literacy perspective. This research used a qualitative approach, with data collected through a virtual questionnaire and a focus group discussion.

Rocha’s (2023) questionnaire addressed several situations involving the arithmetic mean to analyze 14 teachers’ understanding of this concept. In general, the results indicate that most teachers’ understanding of the concept of arithmetic mean is limited to the definition of the simple mean, despite their claims to use everyday resources and examples in their practice.

Regarding the properties of the mean proposed by Strauss and Bichler (1988), most teachers found it difficult, especially the idea that the mean may not reflect physical reality. The data also suggest that many teachers confuse this concept with the mode. Regarding inferences and interpretations of averages in graphs, the results reveal that teachers, in fact, have difficulties.

To understand the experiences of the research participants, a focus group was organized to explore and reflect on the average from a statistical literacy perspective with four teachers who had answered the virtual questionnaire and decided to continue in Rocha's research. For the moment of problematization, two problems and their responses were selected from four pairs of 9th-grade students participating in Eugenio's research (2013), which were also included in the teachers' initial virtual questionnaire.

During theorization, they discussed statistical literacy using the texts of Gal (2002) and Carvalho, Carvalho, and Carvalho (2021). Then, the teachers, in pairs (Pairs 1 and 2), were asked to develop a proposal for teaching the arithmetic mean from a statistical literacy perspective. Although only one proposal was requested, each pair submitted two; however, one of them was not considered in Rocha's dissertation (2023) due to the presence of for-profit interests and copyright issues.

In problematization, teachers' analysis of the types of errors in problems involving the average, based on Eugenio's (2013) research, revealed that they prioritized the technical aspects (procedures) and the structure of the problems, suggesting the inclusion of more data to facilitate resolution. Teachers made errors similar to those of students, demonstrating difficulty in interpreting the average as representative of the data set, since it does not necessarily reflect most values; it is the role of fashion to reflect this majority. They also recognized that the average is an approximation of the calculated data (Rocha, 2023).

The three teaching proposals prepared by the pairs include: a survey of students' reality themes (Pair 1) for 8th or 9th grade; bullying (Pair 2, activity 1) for 7th grade; and a financial profile (Pair 2, activity 2) for 8th or 9th grade. The proposal of Pair 1 suggests collecting statistical data on themes that are part of the students' realities; however, as structured, the activity will use discrete (empirical) variables, allowing only counting, not averaging. The first activity of Pair 2 prompts reflection on bullying at

school, in the classroom, and in people's lives, and proposes organizing teams and delegating different functions to each. However, this proposal generates only discrete variables, as with the Pair 1 proposal.

The second proposal of Pair 2 involves analyzing the financial profiles and recommends that students conduct statistical research on the interviewees' financial profiles, classifying the results into care, congratulations, and attention. Although this is the only proposal that could generate conceptual variables for calculating the average, the idea of categorizing the results prevents calculating the average from the data obtained through this activity (Rocha, 2023).

Therefore, Rocha (2023) concludes that the discussion in the focus group, in terms of organization and timing, proved satisfactory. The teaching approaches presented by the teachers are suitable for K-6 to K-8 contexts, and the themes must be of interest to students. However, the teachers indicated that they did not know the concept of mean in relation to its properties and meanings, nor did they identify the variables that generate the mean. Thus, this study recognizes the need to examine the nature of variables as a key concept for teachers to understand when calculating averages and, thus, to develop proposals from a statistical literacy perspective.

In conclusion, Rocha's research (2023) emphasizes the importance of problematizing this discussion with mathematics teachers to reflect on teaching practice. In addition, it is important to elaborate teaching proposals on the average from the perspective of statistical literacy, focusing on critical and conceptual issues, and on formative processes that serve as a model for working with the arithmetic mean in the final years of elementary school.

Interfaces of mathematics teachers' initial education and statistics education

In statistics education, Costa Júnior's study (2019) highlights that academic productions have prioritized the cognitive elements of statistical knowledge to the detriment of the dispositional elements proposed by Gal (2002). The results of the activities developed in Costa Júnior's (2019) work show the need to promote, in initial teacher education, the development of critical skills related to the use, interpretation, and communication of statistical information, as Gal (2002) defends.

Statistical literacy (SL) presupposes processes of interaction, cooperation, and collective reflection, implying that initial teacher education must go beyond teaching that is restricted to calculation procedures and isolated statistical notions. From this perspective, Ferreira's (2025) research offered reflections on the elements of knowledge and disposition of mathematics licensees through contextualized statistical activities, including an exploration of a box-plot graph.

Ferreira's (2025) research objective was to analyze how mathematics licensees can mobilize the elements of statistical literacy in the interpretation and construction of box-plot graphs. The research took a qualitative approach, with formative meetings conducted in the extension course modality with mathematics prospective teachers during the 5th to the 9th periods at a public university in the Agreste region of Pernambuco. During these online meetings held on Google Meet, a diagnostic questionnaire, discussions on statistical literacy, a box-plot chart, and statistical activities were developed with the licensees.

The diagnostic questionnaire included questions to identify participants' profiles, their statistical literacy, and their ability to read and interpret box-plot graphs in contextualized situations. The questionnaire was administered via Google Forms, and participants answered online. Its application enabled the identification of low familiarity among the participating undergraduates with this statistical representation, even after completing the statistics curriculum component of the degree course.

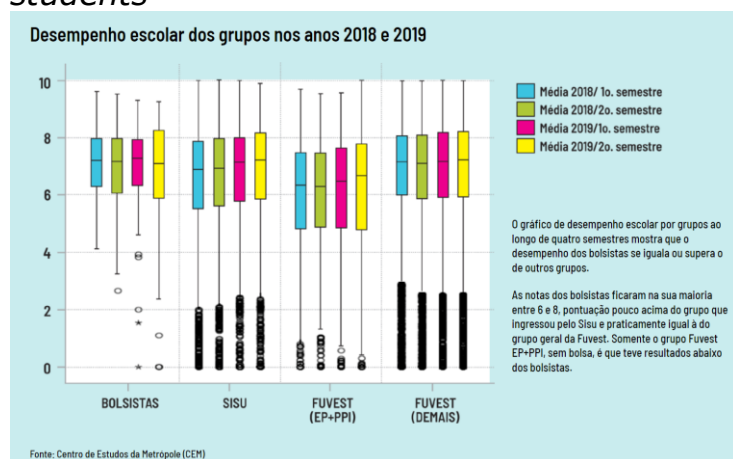
Ferreira's (2025) questionnaire results also show an incipient approach to box plots in the mathematics teaching degree course in which the participants were enrolled. The absence or insufficiency of answers to certain questions corroborates the considerations of Edwards, Özgün-Koca, and Barr (2017), who point out that the box plot is not an intuitive representation. In this sense, the relevance of systematically working with this type of graph in initial teacher education is reaffirmed, to develop understanding and interpretation of statistical data.

Given most participants' limited familiarity with box plots, an introduction to this statistical representation was provided in the context of energy consumption. Given this initial approach, Ferreira (2025) discussed the relationships among the statistical measures of median, quartiles, maximum and minimum values, and the identification of outliers in the box plot, in addition to central aspects of its interpretation. Such discussions proved fundamental to the development of subsequent activities, as they were based on the analysis and interpretation of news that used box plots to represent data.

The statistical activities developed totaled three and addressed, respectively: the cost-benefit analysis of yogurts based on sugar content, the bonus policy for the entrance exam scores of the University of São Paulo (USP) aimed at minorities, and the academic performance of USP scholarship students. The activities proposed by Ferreira (2025) were carried out in pairs or threesomes, promoting discussions and reflections on statistical literacy, with an emphasis on interpreting and analyzing box plots. For example, Figure 2 displays graphs of the academic performance of USP scholarship students.

Figure 2

Box-plots of statistical activity on the academic performance of USP scholarship students



Note. Ferreira (2025, p. 168)

The activities based on real contexts enhanced the quality of the discussions, fostering reflections that extrapolated statistical concepts and addressed social aspects related to decision-making. In the yogurt activity, the pair of licensees problematized excessive sugar consumption in daily life and the criteria used to choose products associated with health risks. In turn, in activities involving USP students, the undergraduates mobilized relevant debates on social justice, particularly regarding quota policies and the granting of scholarships to historically marginalized groups.

The exploration of interpretation activities enabled the mobilization of elements of knowledge and dispositions related to statistical literacy, ranging from statistical knowledge to critical thinking and decision-making, through the interpretation of box plots. In this sense, Ferreira (2025) points out that the articulation of these elements in the study of the box plot is fundamental for the understanding of the graph from a critical perspective.

According to the researcher, in the yogurt activity, for example, the licensees explained their personal preferences and decision-making based on the analysis of the results, especially regarding the relationship between prices and yogurt types. On the other hand, in activities related to university quota and scholarship policies, undergraduates expressed their critical positions and beliefs in response to the analyzed situations, which, as Gal (2002) emphasizes, influence interpretations.

Considering the results presented by Ferreira (2025) and his recommendations for the teaching of box plots in basic education, based on the National Common Curriculum Base (BNCC) (Brasil, 2018), initial education for mathematics teachers must promote discussions about this graph, preferably through contextualized explorations. The data produced in the author's research show the potential of the investigated contexts and indicate that, in this way, future teachers may contribute to school education and to the critical evaluation of students' interpretations and analyses of statistical data.

In summary, Ferreira's (2025) results show the need for the effective integration of the box plot into the curricula of initial mathematics teacher education, so that these prospective teachers are prepared to mobilize this knowledge in the context of basic education. In addition, the study highlights the importance of using context as a fundamental strategy for learning and interpreting box plots, both in initial licensee education and in school education. Such perspectives reinforce the importance of formative practices that articulate statistical knowledge and critical reflection, contributing to the development of teachers' statistical literacy and, consequently, that of their future students.

Final considerations

The studies presented here provide evidence of various approaches to discussing the initial and continuing education of teachers who teach mathematics. The studies point to ways to improve pedagogical approaches to teaching and learning statistics, and highlight the need for initial and continuing education that promotes critical reflection on teaching practice and the constituent elements of statistical literacy.

The research highlights the importance of the pedagogical use of educational technologies and formative practices that articulate statistical knowledge with critical positioning, grounded in reflections and attitudes informed by a critical and active consciousness, aimed at developing the statistical literacy of teachers and prospective teachers. Despite differences in approaches to initial and continuing education, as well

as across the different stages of teaching, research shows the need to address the elements of disposition in the construction of statistical knowledge.

The investigations analyzed show that teacher education in statistical education still faces significant challenges, especially regarding the conceptual domain of statistical content, teaching attitudes, and didactic choices in the classroom. Martins' studies (2014; 2018) reveal that many teachers hold fragmented conceptions of fundamental concepts, such as sampling, and have difficulty interpreting and pedagogically using different graphic representations, which may limit the development of students' statistical literacy.

In addition, teachers' attitudes towards statistics proved to be decisive for the quality of pedagogical practices. Teachers with more favorable attitudes tend to propose more diverse, investigative, and context-based activities, whereas attitudes marked by insecurity or ignorance limit the formative potential of this field of knowledge. The presence or absence of technological resources also influences the possibilities for visual, dynamic, and investigative data exploration in the classroom.

Another important aspect observed from continuing education research is that, although teachers have presented contextualized and potentially relevant teaching approaches to students in the final years of elementary school (K-6 to K-8), there are still important conceptual gaps related to the understanding of the properties, meanings, and conditions of applicability of the arithmetic mean, especially about the nature of the variables.

In this sense, Rocha's study (2023) highlights the need to problematize these issues in teacher education processes to promote reflection on teaching practice and support the elaboration of teaching proposals from the perspective of statistical literacy, with a critical and conceptual focus, contributing to the improvement of work with an arithmetic mean at this level of education.

Drawing on Ferreira's research (2025), we note that activities conducted in real, socially relevant contexts facilitated the integrated mobilization of statistical literacy elements, enabling licensees not only to conceptualize the box plot but also to take critical positions based on data. The discussions demonstrated that interpreting statistical graphs, when contextualized, expands students' formative potential by articulating statistical knowledge, critical dispositions, and decision-making, essential aspects of statistical education.

Given this scenario, the initial and continuing education of teachers who teach mathematics in the early years (K-1 to K-8) should be understood as a continuous process that articulates statistical concepts, reflection on practice, and the pedagogical use of educational technologies. The development of contextualized, collaborative, and reflective training proposals is fundamental to strengthening statistical literacy from the early years of schooling, thereby contributing to the formation of more critical, autonomous students prepared to interpret and use data-based information in social life.

Therefore, the works presented in this article reinforce the importance of formative practices that value socially relevant contexts in the initial and continuing education of mathematics teachers, contributing to the development of a current or future teaching practice, committed to students' critical reading of reality and civic education.

Acknowledgements

We thank the funding bodies for the research developed at GPEME, in particular the Fundação de Amparo à Ciência e Tecnologia de Pernambuco (FACEPE) and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).

References

- Batanero, C. (2004). Statistics education as a field for research and practice. *International Statistical Review*, 72(1), 1–14.
- BRASIL. Ministério da Educação. Base Nacional Comum Curricular. Brasília: MEC/SEB, 2018.
- Borba, R. et al. (2011). Educação Estatística no ensino básico: currículo, pesquisa e prática em sala de aula. *EM TEIA - Revista de Educação Matemática e Tecnológica Ibero-americana*, 2(2).
- Cazorla, I. M., & Castro, F. C. (2008). O papel da estatística na leitura do mundo: O letramento estatístico. *Publicatio UEPG: Ciências Sociais Aplicadas*, 16(1). <https://revistas2.uepg.br/index.php/sociais/article/view/2834>.
- Costa Junior, J. R. (2019). *Compreensões de letramento estatístico entre licenciandos de matemática: Explorando dimensões críticas em situação de formação* [Tese de doutorado em Educação Matemática e Tecnológica, Universidade Federal de Pernambuco]. <https://repositorio.ufpe.br/handle/123456789/37704>.
- Edwards, T. G.Özgün-Koca, A., & Barr, J. (2017) Interpretations of box-plots: helping middle school students to think outside the box. *Journal of Statistics Education*, 25(1), 21-28. <https://doi.org/10.1080/10691898.2017.1288556>.
- Estrada, A. (2002). Actitudes hacia la estadística: Un estudio con profesores en formación y en ejercicio [Tese de doutorado, Universitat de Barcelona].

- Eugênio, R. S. (2013). *Explorações sobre a média no software TinkerPlots 2.0 por estudantes do ensino fundamental* [Dissertação de mestrado em Educação Matemática e Tecnológica, Universidade Federal de Pernambuco]. https://repositorio.ufpe.br/jspui/handle/123456789/13298?locale=pt_BR.
- Ferreira, T. R. (2025). *Letramento estatístico na licenciatura em matemática: Interpretação e construção do gráfico box-plot por licenciandos(as)* [Dissertação de mestrado em Educação Matemática e Tecnológica, Universidade Federal de Pernambuco]. https://repositorio.ufpe.br/jspui/handle/123456789/63413?locale=pt_BR.
- Gal, I. (2002). Adult statistical literacy: Meanings, components, responsibilities. *International Statistical Review*, 1(70), 1-25.
- Gautério, T. da S., & Porciúncula, M. (2025). A estatística na formação inicial de professores de matemática: produção acadêmica no âmbito nacional e internacional. *Revista Foco*, 18(8), e9593. <https://doi.org/10.54751/revistafoco.v18n8-146>.
- Lira, L. T. de O., & Andrade, V. L. V. X. de. (2025). Letramento estatístico nos anos iniciais do Ensino Fundamental: tendências na produção científica brasileira usando a Análise Estatística Implicativa. *Revista Semiárido De Visu*, 13(2), 170–188. <https://doi.org/10.31416/rsdv.v13i2.1126>.
- Lopes, C. E. (2008). O ensino da estatística e da probabilidade na educação básica e a formação dos professores. *Cadernos CEDES*, 28(74), 57–73. <https://www.scielo.br/j/ccedes/a/gwfkW9py5dMccvmbqyPP8bk/>.
- Martins, M. N. P. (2014). Concepções de professoras dos Anos Iniciais sobre o conceito de amostragem mediadas pelo software TinkerPlots 2.0 [Dissertação de mestrado em Educação Matemática e Tecnológica, Universidade Federal de Pernambuco]. <https://attena.ufpe.br/handle/123456789/13055?locale=en>.
- Martins, M. N. P. (2018). Atitudes de professores dos Anos Iniciais em relação à Estatística e suas influências na construção e escolha de gráficos estatísticos [Tese de doutorado, Instituto de Educação da Universidade de Lisboa]. <https://repositorio.ulisboa.pt/entities/publication/ee71da04-649b-4e52-9917-99a4b5a5440e>.
- Mello, L. de S., Machado, C. C., Pereira, E. C., Antiqueira, L. S. de, & Silva, M. P. M. da. (2024). Letramento estatístico nos anos iniciais do ensino fundamental: Um mapeamento sobre o que mostram as pesquisas. *Paidéi@: Revista Científica de Educação à Distância*. 16(30), 54-72. <https://doi.org/10.5281/zenodo.12706694>.
- Monteiro, C. E. F., & Carvalho, L. M. T. L. (2021). *Statistics education from the perspective of statistical literacy: Reflections taken from studies with teachers*. *The Mathematics Enthusiast*, 18(3), 612–640. <https://doi.org/10.54870/1551-3440.1538>
- Nóvoa, A. (2017). Firmar a posição como professor, afirmar a profissão docente. *Cadernos de Pesquisa*, 47(166), 1106–1133.
- Rocha, W. M. S. (2023). Média aritmética na perspectiva do letramento estatístico nos anos finais: Compreensão de professores e possibilidades de ensino [Dissertação de mestrado em Educação Matemática e Tecnológica, Universidade Federal de Pernambuco]. <https://repositorio.ufpe.br/handle/123456789/50616>.
- Strauss, S., & Bichler, E. (1988). The development of children's concepts of the arithmetic average. *Journal for Research in Mathematics Education*, 19(1), 64–80.

Tardif, M. (2014). Saberes docentes e formação profissional (17ª ed.). Vozes.

Watson, J. M., & Callingham, R. A. (2003). Statistical literacy: A complex hierarchical construct. *Statistics Education Research Journal*, 2(2), 3–46. [https://iase-web.org/documents/SERJ/SERJ2\(2\)_Watson_Callingham.pdf](https://iase-web.org/documents/SERJ/SERJ2(2)_Watson_Callingham.pdf)