

# A subversively responsible analysis of some curricular guidelines for Statistical Education<sup>1</sup>

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## ABSTRACT

Statistical education plays an important role in developing students' critical thinking, as it enables discussion of topics related to gender, race, ethnicity, environment, among other social problems. This article discusses, from a Freirean perspective, methodological guidelines indicated in the Brazilian, Portuguese, and Australian curriculum guidelines for the teaching and learning process of statistics and probability for students aged 6 to 14 years. The aim is to answer the following question: which methodological aspects indicated for Statistical Education, for students aged 6 to 14 years, favor the development of critical and creative thinking? Official websites of the Ministries of Education of Australia, Brazil and Portugal were used to map the mathematics curricula that present the thematic unit of study of probability and statistics and based on the organization of these documents. Documentary research is developed using thematic analysis with a reflective approach in the interpretation and construction of syntheses from the perspective of critical and creative thinking in Statistical Education. As results, the following stand out: significant indications for the elaboration of future curricular orientations of mathematics in which probabilistic and statistical literacies are considered that dialogue with a critical and creative education, in which the problematization and questioning of real problems are prioritized, in

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addition to the mobilization of procedures and possible solutions. With this, possibilities of contributions are indicated for the expansion of research on curricular guidelines, within the field of statistical education; and indicators that guide initial and continuing education programs for teachers who teach mathematics.

**KEYWORDS:** Curriculum Guidelines. Thematic analysis. Statistical Education. Elementary and Middle School.

*Uma análise subversivamente responsável de orientações metodológicas de algumas diretrizes curriculares para Educação Estatística*

**RESUMO**

A Educação Estatística tem um papel importante para o desenvolvimento da criticidade dos estudantes, pois, a partir dela, é possível promover a discussão de temas relacionados a gênero, raça, etnia, meio ambiente, dentre outros problemas sociais. Neste artigo discute-se sob a ótica freiriana, orientações metodológicas indicadas nas diretrizes curriculares brasileira, portuguesa e australiana para o processo de ensino e de aprendizagem de estatística e probabilidade para os alunos na faixa etária de 6 a 14 anos. Busca-se responder à seguinte questão: quais aspectos metodológicos indicados para Educação Estatística, dos alunos na faixa etária de 6 a 14 anos, favorecem o desenvolvimento dos pensamentos crítico e criativo? Foram utilizados sites oficiais dos Ministérios da Educação da Austrália, Brasil e Portugal para mapear os currículos de matemática que apresentam a unidade temática de estudo da probabilidade e da estatística. Desenvolve-se uma pesquisa documental utilizando a análise temática com abordagem reflexiva na interpretação e construção de sínteses na perspectiva do pensamento crítico e criativo em Educação Estatística. Como resultados destacam-se: indícios significativos para a elaboração de futuras orientações curriculares de matemática nas quais se considerem os letramentos probabilístico e estatístico que dialoguem com uma educação crítica e criativa, na qual se priorize a problematização e o questionamento de problemas reais, além da mobilização de procedimentos e possíveis soluções. Com isso, indica-se possibilidades de contribuições para a ampliação da pesquisa sobre diretrizes curriculares, dentro do campo da Educação Estatística; e

indicadores que sejam norteadores para programas de formação inicial e continuada de professores que ensinam matemática.

**PALAVRAS-CHAVE:** Diretrizes Curriculares. Análise temática. Educação Estatística. Ensino Fundamental.

*Un análisis subversivo responsable de algunos lineamientos curriculares de la Educación Estadística*

**RESUMEN**

La educación estadística juega un papel importante en el desarrollo del pensamiento crítico de los estudiantes, ya que permite la discusión de temas relacionados con el género, la raza, la etnia, el medio ambiente, entre otros problemas sociales. Este artículo discute, bajo la óptica freireana, las orientaciones metodológicas indicadas en las orientaciones curriculares brasileña, portuguesa y australiana para el proceso de enseñanza y aprendizaje de la estadística y la probabilidad para alumnos de 6 a 14 años. El objetivo es responder a la siguiente pregunta: ¿qué aspectos metodológicos indicados para la Educación Estadística, para estudiantes de 6 a 14 años, favorecen el desarrollo del pensamiento crítico y creativo? Se utilizaron los sitios web oficiales de los Ministerios de Educación de Australia, Brasil y Portugal para mapear los currículos de matemáticas que presentan la unidad temática de estudio de probabilidad y estadística y, a partir de la organización de estos documentos. La investigación documental se desarrolla utilizando el análisis temático con un enfoque reflexivo en la interpretación y construcción de síntesis desde la perspectiva del pensamiento crítico y creativo en la Educación Estadística. Como resultados se destacan los siguientes: indicios significativos para la elaboración de futuras orientaciones curriculares de matemáticas en las que se consideren alfabetizaciones probabilísticas y estadísticas que dialoguen con una educación crítica y creativa, en las que se priorice la problematización y cuestionamiento de problemas reales, además a la movilización de procedimientos y posibles soluciones. Con ello, se señalan posibilidades de aportes para la ampliación de investigaciones sobre lineamientos curriculares, en el campo de la educación estadística; e indicadores que orientan los programas de formación inicial y continua de los docentes que enseñan matemáticas.

**PALABRAS CLAVE:** Lineamientos Curriculares. Análisis temático. Educação Estatística. Educación primaria. Comienzo de la educación secundaria.

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*There would be no creativity without that drives us and makes us patiently impatient in the face of the world we haven't made, adding to it something we have made.*  
Paulo Freire

## Introduction

A curriculum guide is a structured document that outlines the philosophy and/or epistemology, goals, objectives, learning experiences, instructional resources, and assessments that make up a particular educational program. It may provide ideas, suggestions, and recommendations to help teachers make informed decisions, or it may be more prescriptive and detailed, specifying the content, activities, tasks, and materials to be used by teachers.

The analysis of curriculum guidelines for the teaching and learning of mathematics, particularly statistics and probability, has been the focus of studies by many researchers (BANSILAL, 2023; FRANKLIN, 2023; KAZAK, 2023; PFANNKUCH; ARNOLD, 2023; PODWORNÝ, 2023; RESTON, 2023; SOUZA, 2023).

Recently, ALMEIDA (2023, p. 91) conducted research on the curriculum documents of Australia, Brazil, Spain, New Zealand, and Portugal. The author pointed out that the study of probability and statistics was justified by the possibility of educating students based on knowledge that would allow them to "live citizenship more fully", emphasizing the importance of breaking with the system of a list of repetitive skills.

Based on these assumptions, we set out to discuss the methodological guidelines indicated in the Brazilian, Portuguese, and Australian curriculum

guidelines for the teaching and learning process of Statistics and Probability for students aged between 6 and 14, from a subversively responsible perspective, with Freirean foundations. These countries were selected because their documents provide guidelines for teaching statistics and probability. Brazil was chosen due to its current document in effect in the authors' country of residence, while Portugal and Australia were selected for their more recent documents.

To achieve the outlined objective, we carried out documentary research with thematic analysis and a reflexive approach. In this text, methodological guidelines are understood as a set of focuses and strategies related to the teaching and learning process that are used to guide teaching practice. The aim of methodological guidelines is to indicate to teachers the conceptual and procedural content to be considered in their teaching to achieve the educational objectives indicated in the curriculum guidelines.

This article is organized as follows: we present the methodology of the study, discuss Freirean perspectives on criticality and creativity, reflect on the development of critical and creative thinking in statistics and probability, present the methodological guidelines in the Brazilian, Portuguese and Australian curriculum guidelines, analyze these guidelines from a subversively responsible perspective, and express some reflections based on our reflexivity.

## **Methodology**

In the search for a discussion of the methodological guidelines indicated in the Brazilian, Portuguese and Australian curricular guidelines for the teaching and learning process of statistics and probability, we pursued the following question: Which methodological aspects indicated for statistics education, for students in the 6-14 age group, favor the development of critical and creative thinking?

To answer this question, we used the official websites of the Ministries of Education of Australia, Brazil, and Portugal to map the mathematics curricula specifically in the thematic unit of study of probability and statistics and, based on the organization of these documents, we developed a documentary research with an interpretative analytical process from the Freirean perspective of education as a practice of freedom.

After selecting the documents, we carried out a reading and interpretation in which we opted for a thematic analysis because of its versatility, which allows researchers to use this approach for many types of studies and to select the research design that corresponds to their interests and areas of specialization (BRAUN; CLARKE, 2006). There are three perspectives for conducting thematic analysis, one of which is the “reflexive” approach, which is based on a qualitative paradigm, in part because it emphasizes that the researcher's subjectivity is a resource rather than a problem. In a qualitative research approach, the researcher's biases are not considered a problem because all research is seen as influenced. One of the ways to use researcher subjectivity as a tool is to be reflexive. Researchers can be reflexive by considering how their opinions and feelings have influenced their findings (BRAUN; CLARKE, 2013).

According to Morgan (2022), reflexivity is related to the values, characteristics, and decisions of researchers. This aspect of qualitative research requires researchers to reflect on their thinking patterns to interpret the data, investigate their interpretations and pay attention to the social, political, cultural and economic factors that influence their perspectives.

Given these assumptions, we considered the Freirean perspective, regarding criticality and creativity, in order to carry out a thematic analysis with a reflexive approach. Linked to this theoretical dimension, we also considered Hooks (2020) and D'Ambrosio and Lopes (2014) who also take on Freirean ideas in their productions.

## **Freirean perspective on criticality and creativity**

Freire (2015) sees criticality as the ability of students and teachers to critically reflect on the reality in which they find themselves so that they can identify, understand, and intervene to transform it. For the author, it is through criticality that naïve curiosity becomes epistemological curiosity so that we begin to see the world not as something to be simply accepted as it is, but as something to be problematized in order to be transformed.

The awareness that we are incomplete, inconclusive, and unfinished beings, and that it is in our relationship with others that we construct knowledge, shows us a path that requires humility, generosity, and solidarity to learn. This is a special moment in the transition from naïve to critical awareness.

Naïve curiosity is spontaneous and characterized by common sense. It is the same curiosity that, when criticized by an increasingly methodologically rigorous form of the object of knowledge, becomes epistemological curiosity, changing in quality but not in essence. It is epistemological curiosity that will lead us to right-thinking.

This process of transition from naïve curiosity to epistemological curiosity requires an investment in problematization, in the use of questioning, of investigative and challenging questions. Freire (2015) defends spontaneity by saying no to spontaneity. For the author, it is in the real conditions of learning that students become real subjects in the construction and reconstruction of the knowledge taught. Considering this, the teacher must stimulate in the teaching process the critical capacity of the student, without blind submission to what they receive as information. To achieve this, they use problematization to reveal the relations of oppression that take place inside and outside the classroom, experiencing a process of conscientization.

Conscientization is the movement of human nature that makes it possible to perceive its "inconclusiveness," but which necessarily implies provoking a permanent movement searching for being more (FREIRE, 2015).

Conscientization is the pedagogical process that seeks to give human beings the opportunity to discover themselves through reflection on their existence. It consists of critically inserting human beings into the transformative action of reality, implying, on the one hand, the unveiling of the oppressive reality and, on the other, action on it to change it (GADOTTI, 2016, p. 17).

From Freire's perspective, the learning process is creative and creative because it begins with the observation of the world and each being in the world. Therefore, an emancipatory pedagogical action makes it possible to open up new visions and possibilities by challenging and stimulating students to think beyond the obvious, triggering learning actions in which they overcome their naive curiosity and become increasingly creative.

Creativity, from Freire's perspective, results from critical and collective reflection on the world, self-awareness, and a knowledge of reality that allows us to transcend it. However, this creativity will only be liberating if the dimension of reflection is transformed or subverted into transformative action. There would be no creativity without the curiosity that moves us and makes us patiently impatient in the face of the world we didn't make, adding to it something we did make (FREIRE, 2015).

Obviously, learning does not take place in a process of knowledge transfer, but in a process of construction that begins with the learner and is consolidated in interaction with others. Learning, from Freire's perspective, is a restless movement of constructing, reconstructing and verifying in order to transform. It is putting oneself at risk and living the



adventure of the mind, it is experiencing freedom and making choices, being original and authentic, learning creatively.

## **Development of critical and creative thinking in Statistics and Probability**

Currently, there is a growing movement in the international context to revise curriculum guidelines for basic education that emphasize the importance of developing critical and creative thinking in teaching and learning processes in all fields of knowledge.

The Organization for Economic Cooperation and Development (OECD) works to build better policies for a better life, advocating policies that promote prosperity, equality, opportunity, and well-being for all. When it comes to education, it seeks to help individuals and nations identify and develop the knowledge and skills that lead to better jobs and lives, and promote social inclusion. As such, this international organization has argued that skills related to creativity and critical thinking need to be articulated in visible and tangible ways by teachers, students and curriculum makers.

Halpern (2006) reminds us that specific knowledge of a content area is fundamental to critical thinking because no one can think critically about any subject without the necessary information. He also reminds us that facts alone are not enough. In this way, he emphasizes that critical thinking

is used to describe thinking that is intentional, reasoned, and goal directed. The kind of thinking involved in problem-solving, formulating inferences, calculating probabilities, and making decisions, when the thinker is using skills that are thoughtful and effective for the specific context and type of thinking task. (HALPERN, p. 6)

From the same perspective, Hooks (2020, p. 33) defends the importance of students developing critical thinking, pointing out the need for it to be an ongoing process.

Students [teachers and researchers] don't become critical thinkers overnight. First, they need to learn to accept the joy and power of thinking itself. Engaged pedagogy is a teaching strategy that aims to activate students' will to think and their will to achieve total self-realization.

Considering this, if the development of critical thinking is to take place in a guided manner, since its core is the desire to know, to understand the workings of life and the uninterrupted movement of our multiple realities, it is necessary to consider its intrinsic relationship with the concepts and procedures of statistical and probabilistic study. Critical thinking

involves first discovering the "who", the "what", the "when", the "where" and the "how" of things - discovering answers to the endless questions of the curious child - and then using [mathematical] knowledge in such a way as to be able to determine what is most important (HOOKS, 2020, p.33).

Critical thinking therefore involves looking for different ways to solve problems. Criticality allows for the analysis of possibilities, the need to take on different roles, to identify different perspectives, and to outline multiple paths to solutions. To this end, critical thinking is directly linked to creative thinking, which seeks to build, to create other paths, to "think outside the box" (HOOKS, 2020).

Creative thinking, or even "creativity" for Kohan (2007, p. 26), refers to a word that has been trivialized by market discourse. "The simple and seductive discourse of advertising, servile to the logic of the

market or to a certain technical didacticism, no less agreeing with the market. I'm not quite sure: what is creativity?" The author defends peculiar ways of thinking, in an exercise of free thinking, of space for leisure, of personal experience, without time control. It is not something that can be "developed or shaped" in others. For Fisher (2013), the creative person is willing to consider different ideas or plans at different moments in the development of activities. For the author, creativity is a way of using the imagination to produce something original in a personal sense and with collective and social significance.

The development of critical and creative thinking in students can be facilitated by problematizing ways of approaching mathematics. Curriculum guidelines in different countries advocate the teaching of mathematics from the perspective of problematization and the formation of critical and creative students. This is evident when we analyze the discourses in the texts of the curriculum guidelines. However, these guidelines are not always clear when the program for the school years is presented. This allows committed and activist teachers to adopt a rebellious and creative attitude towards the prescribed curriculum.

Buehring (2021, author's emphasis) points out how statistics enabled her to be a creatively insubordinate teacher

I began to realize the advantages of creatively subordinating myself when I encountered statistics education and with it, I began to connect with the workplace, with the students, with their needs and their reality. It was a connection through statistics and listening, through intergenerational and cultural dialog, precisely because they give a rise to different ways of seeing things or different "truths". (BUEHRING, 2021, p. 80)

For the researcher Professor Buehring (2021), Statistics Education makes it possible to act in favor of students' learning and, moreover, it allows ways to promote teaching in which they know and (re)know themselves as agents of change in relation to what they investigate, analyze, produce, such as the statistical research they conduct or take as an object of study.

When envisioning the implementation of statistics education in elementary school, it is necessary to emphasize the importance of developing statistical and probabilistic literacy. We consider the perspective of Gould (2017) when he argues that statistical literacy requires: understanding who collects the data and why and how it is collected; knowing how to analyze and interpret data from random and non-random samples; understanding what data privacy and ownership consists of; knowing how to create basic descriptive representations of data to answer questions about real processes; understanding the importance of data origin; understanding how data is stored; understanding how computer representations can vary and why data is sometimes altered before analysis; and finally, understanding some aspects of predictive modeling.

Gal (2005) considers statistical literacy to be a prerequisite for the development of probabilistic literacy because students need certain skills to build it during their schooling process to appropriate conceptual aspects related to chance, uncertainty, communicating/calculating probabilities, language, the context of the concept, and critical issues related to different probability situations.

Gal (2005) points to the cognitive elements of probabilistic literacy, which refer to the ability to interpret and evaluate probabilistic ideas and random phenomena, emphasizing the importance of the context in which the ideas are presented. The essential skills for students to develop probabilistic literacy are: understanding the meaning and language of basic probability concepts and arguing appropriately in real-world debates.

By providing students with statistical and probabilistic literacy from the beginning of their schooling, statistics education plays an important role in improving students' critical thinking skills, as it can be used to promote discussion of sensitive issues related to gender, race, ethnicity, the environment, and other social problems. Encouraging the development of statistical projects at school, with the production, analysis, and dissemination of data on these issues, enables students to become self-aware, aware of their place in the world and the possible ways of acting in it, to achieve a citizenship education.

This teaching and learning perspective emphasizes critical thinking as Lipman (2001) notes that critical thinking involves creative judgment and creative thinking encompasses critical judgment, which represents a higher level of thinking that incorporates cognition, rationality, and creativity. The author considers that when critical and creative thinking interpenetrate, they generate higher-order cognition that leads to ways of thinking that are not algorithmic; they are complex, offer multiple solutions, and lead to interpretations that allow for an understanding of the uncertainty and self-regulation of the thinking process. It also implies the imposition of meanings derived from cognitive movements such as deduction and inference.

We believe that methodological guidelines, as well as certain content, encourage critical thinking and even the development of creative thinking in students, including those from disadvantaged or minority social groups, so that they can understand their living conditions and their place in the world, in society, and develop forms and strategies of struggle and resistance to reduce social inequalities. Teachers who recognize these possibilities and their social role in the education of these students are increasingly creatively resisting the prescribed curricula and finding in statistics and probability education a mathematical field fertile for these approaches.

We advocate and believe that critical and creative work in Mathematics classes, with an emphasis on Statistics and Probability Education, can foster the human and conscious development of our students. With this in mind, we looked at the curriculum documents of Australia, Brazil, and Portugal.

### **Methodological guidelines in Statistics and Probability Education in the Brazilian, Portuguese, and Australian curriculum guidelines**

The teaching of statistics and probability has been part of the Brazilian educational scenario since the publication of the National Curriculum Parameters (PCN), in the area of mathematics, at that time belonging to the content block called "Treatment of Information" (Brazil, 1998). In 2018, this integration was corrected by the Common National Curriculum Base (BNCC) (Brazil, 2018), and now belongs to the thematic unit of Probability and Statistics.

The BNCC (Brasil, 2018) is a normative document that defines the organic and progressive set of essential learning that all students should develop throughout the stages and modalities of basic education. Mathematical knowledge is considered necessary due to its wide application in contemporary society, and its potential to train critical citizens who are aware of their social responsibilities.

The document points out that mathematics is not limited to the quantification of deterministic phenomena and calculation techniques using numbers and quantities, but that it also studies the uncertainty arising from random phenomena. In this way, it points out that, although it is a hypothetical-deductive science, it is fundamental to consider the heuristic role of experimentation in the learning of mathematics. He believes that the study of mathematics for all students between the ages of 6 and 14 must articulate its various domains, which are arithmetic, algebra, geometry, statistics, and probability, in order to provide students

with empirical observations of the real world and its representations, making inductions and conjectures.

This document does not explicitly present methodological guidelines for teachers of mathematics in primary schools. It contains a list of specific competencies, among which we would like to highlight the recommendations to provide opportunities for students to make systematic observations of quantitative and qualitative aspects present in social and cultural practices in order to investigate, organize, represent and communicate relevant information, to interpret and evaluate it critically and ethically, and to construct convincing arguments; use mathematical processes and tools, including available digital technologies, to model and solve every day, social and other knowledge problems, validating strategies and results; and confront problem situations in different contexts, including imaginary situations not directly related to practical use, expressing their responses and summarizing their conclusions, using different registers and languages (graphs, tables, diagrams, as well as written text in the mother tongue and other languages to describe algorithms such as flowcharts and data).

The Brazilian curriculum document also recommends developing projects that address, above all, issues of social urgency, based on ethical, democratic, sustainable and solidarity principles, valuing the diversity of opinions of individuals and social groups, without prejudice of any kind; as well as promoting interaction between peers in a cooperative way, working together in the planning and development of research to answer questions and find solutions to problems, to identify consensual or non-consensual aspects in the discussion of a given issue, respecting the way of thinking of colleagues and learning from them. (BRASIL, 2018). We note that some of these recommended competencies are related to the study of uncertainty and data processing. Thus, students should develop skills in collecting, organizing, representing, interpreting, and analyzing data in different contexts to make informed judgments and appropriate decisions. In addition,

they must reason and use statistical concepts, representations, and indices to describe, explain, and predict phenomena.

The gap in the Brazilian curriculum guidelines is due to the lack of methodological guidelines and the lack of references and materials to support the work of teachers. We would also like to point out that there are repeated references to skills, concepts, and procedures throughout the years of basic schooling about statistical and probabilistic teaching and learning, which does not favor the gradual development of statistical and probabilistic literacy.

In the context of Portugal (2018), the school levels consist of nine years, for students aged 6 to 14. The mathematics curriculum document is structured by essential learning and emphasizes respect for the principles of equity and quality, aiming at relevant and sustainable mathematical learning for all students. In this way, it focuses on learning mathematics with understanding, as well as developing students' ability to use it in mathematical and non-mathematical contexts throughout their schooling and in different subject areas, in order to contribute not only to their self-realization as students, but also to their future personal, professional and social lives.

The mathematics curriculum document in Portugal is organized by learning content, essential learning objectives (knowledge, skills, and attitudes) and essential learning practices. With regard to statistics and probability for the first cycle, which covers the 6-9 age group, it is recommended to invest in the development of children's ability to deal with data, with the aim of gaining a deeper understanding of their environment, justifying decisions, asking new questions and dealing with uncertainty. There is an emphasis on working with statistical literacy, and it is pointed out that it is important for children to have the opportunity to develop two different types of work, one focused on the study of real concrete situations of interest, in which they regularly make connections with other curricular areas, involving the formulation of



questions with qualitative variables, the collection, and analysis of data, supported by the production of various graphs with technological resources. Another type of work consists of analyzing real graphs and infographics found in publications or in the media, which children should be able to read and progressively evaluate critically. It is also worth stressing the importance of probabilistic reasoning from the 3rd grade.

For Cycle 2, it is recommended that skills related to the collection and processing of data using continuous quantitative variables and appropriate graphical representations be developed, as well as the use of statistical measures, including mean and modal in this cycle. The development of statistical literacy should promote critical thinking and the interpretation and communication of results. The quantification of probability in relation to relative frequency is also emphasized (PORTUGAL, 2018).

We note that the Portuguese curriculum guidelines clearly state the importance of the progressive development of statistical and probabilistic literacy throughout the 1st and 2nd cycles. Cycles, pointing out the link between statistics and probability, with greater emphasis from the 5th. Year.

The Australian Curriculum for the 5-14 age group refers to the Foundation - Year 10 (F-10), with general and specific recommendations for teaching and learning in all areas. In mathematics, it is recommended that students develop essential skills and knowledge in number and algebra, measurement and geometry, and statistics and probability.

For the study of statistics, it is recommended that students learn how to collect, understand, and describe data and their distribution. Statistical literacy should provide the means to support or challenge an argument and enable exploratory data analysis that supports decision-making and informed judgment. Statistical literacy is indicated as essential for providing an understanding of statistical information and processes, including an awareness of data and the ability to estimate, interpret, evaluate, and communicate regarding variation in the real

world. It is believed that the effective use of data requires the recognition and expectation of variation in the collection, analysis, and interpretation of categorical and numerical variables. Statistics is used in business, government, research, sports, health, and the media for critical and informed evaluation of issues, arguments, and decisions.

Probabilistic knowledge is recommended for developing ways of dealing with uncertainty and expectation, making predictions, and characterizing the chance of events or the probability of events occurring on an empirical and theoretical basis. It provides a means for considering, analyzing, and exploiting the chance of events, and for recognizing random phenomena for which it is impossible to precisely determine the next observed outcome before it occurs.

In scenarios where chance holds a significant role, probability provides experimental and theoretical ways to quantify the likelihood of a particular outcome occurring. Such an approach enables students to build mathematical models around risk and decision making in various areas of human endeavor: finance, science, business management, epidemiology, gambling, computer science, and artificial intelligence (AUSTRALIA, 2018).

Like the Portuguese curriculum guidelines, the Australian curriculum guidelines place greater emphasis on working with statistical and probabilistic literacy, with the difference that they more clearly explain the significant proximity of this process to the development of critical and creative thinking.

### **Responsible subversion in the analysis of methodological guidelines of curriculum directives**

In relation to the recommendations for the study of statistics and probability presented in the curriculum documents discussed here, we can see that there is an explicit concern with the development of statistical literacy

and probabilistic literacy in the Australian and Portuguese curricula, which does not occur in the Brazilian guidelines.

In the methodological guidelines described in the Australian and Portuguese documents, there is a gradual emphasis on developing the ability to make decisions, interpret, formulate, model and investigate problem situations, and communicate solutions in ways that are appropriate to the problem situation. It is stated that throughout their schooling, students should develop increasingly sophisticated thinking skills and logical actions, such as analyzing, proving, evaluating, explaining, arguing, anticipating, inferring, justifying and generalizing, through access to the power of statistical and probabilistic reasoning, which favors the development of critical and creative thinking.

The Australian curriculum places a significant emphasis on developing critical and creative thinking skills as demonstrated through the proficiency strands of comprehension, fluency, problem-solving, and reasoning. These strands define the approach to exploring and developing mathematical content, showcasing the thinking and problem-solving involved. There is a set of actions that can foster critical and creative proficiencies, including questioning, clarifying ideas, organizing information, connecting concepts, considering alternatives, implementing solutions, practicing metacognition, reflecting on processes, applying logic and reasoning, drawing conclusions, planning actions, and evaluating procedures and outcomes. These actions may arise during problem-solving processes. Therefore, it is important to encourage students to comprehend their ethical and social obligations, which are crucial to attaining equity. This teaching perspective takes the form of didactic actions that examine actual issues that affect communities, societies, and the world.

On the contrary, it is imperative to acknowledge that, in addition to adhering to curriculum guidelines, teachers often implement innovative approaches in their classroom practices. Some Brazilian educators

creatively deviate from the curriculum guidelines (BRASIL, 2018) by presenting statistical and probabilistic issues, fostering children's listening skills, and promoting problem-solving strategies. They also encourage children to approach statistical problems from a social practice lens. By proposing innovative solutions to everyday problems, these individuals foster an investigative classroom environment that encourages children to critically analyze, question, and reflect. In this way, statistical and probabilistic learning becomes more meaningful for students (GRANDO; LOPES, 2020). This critical thinking that these teachers make possible for children promotes engagement and emancipatory practices, offering them the conditions to recognize themselves as subjects belonging to a particular social group, class and/or minority, and who, by recognizing themselves in their time and space, can act collectively for their emancipation and that of the community to which they belong.

We can see from the explicit and/or implicit methodological guidelines the need to promote teaching that combines statistical literacy with critical and creative thinking in educational spaces. We understand that these aspects prioritize an education for freedom, enabling an education in which people can intervene in their realities to contribute to the quality of human life (LOPES, 2021). Engaged and activist teachers take a rebellious and creative stance in order to educate students in these perspectives, as indicated in the curriculum guidelines.

Considering Freire's perspective of a concept of collectively constructed knowledge that transforms naive curiosity into epistemological curiosity and promotes criticality (Freire, 2015), we advocate a mathematical and statistical approach that definitively breaks with teaching by rules. To accomplish this, we need to look for proposals that allow us to confront problems that come from different contexts and real-life situations, and to encourage daring teaching in the search for new mathematical and statistical procedures.

Freirian assumptions have guided D'Ambrosio and Lopes (2014) in their discussion of creative insubordination as a concept that, when mobilized in teaching actions, allows them to oppose established procedures and guidelines as long as they benefit their students. To do so, they need to be clear about when, how, and why to act, recognizing themselves as

subversively responsible [which] requires assuming oneself as an inconclusive being, who takes curiosity as the foundation of the production of knowledge and makes his unfinishedness a permanent movement of search. (D'AMBROSIO; LOPES, 2014, p. 29)

Externalizing this approach to pedagogical work will make it possible to do mathematics and statistics in a way that contributes to the development of creative and critical thinking. Lipman (2001) sees creativity as the guiding principle of practices that are sensitive to context and that consider the results of valid construction processes to be significant. Thus, stimulating students' creativity from a subversive perspective requires rethinking what success in mathematics and statistics looks like (D'AMBROSIO; LOPES, 2015).

## **Final considerations**

With the aim of discussing the methodological guidelines indicated in the Brazilian, Portuguese, and Australian curriculum guidelines for the teaching and learning process of statistics and probability for students aged 6–14 years, from a subversively responsible perspective with a Freirean foundation, we analyzed the three curriculum documents published in 2018 through the lens of reflexivity.

We consider that the analyzed documents show a significant proximity between the Portuguese and Australian teaching guidelines,

distancing themselves from the Brazilian indications, which are limited to the description of objects of knowledge and lists of skills. However, our quest to discuss the methodological aspects indicated for the teaching of statistics to students between the ages of 6 and 14 leads us to consider that, in general, the documents describe, directly or indirectly, the promotion of the development of critical and creative thinking, since indicating statistical and probabilistic studies from the beginning of schooling means encouraging argumentation, construction, and solution of real problems, anticipation, collaboration and meaningful statistical and probabilistic practices, skills to be developed and promoted in school practices, in a critical and creative way.

Based on the analytical movement, we highlight the importance of considering statistical and probabilistic literacy in future mathematics curriculum guidelines, in dialogue with critical and creative education, in which the problematization and questioning of real problems is prioritized, as well as the mobilization of procedures and possible solutions. This pedagogical perspective should guide initial and continuing education programs for teachers who teach mathematics because, as D'Ambrosio and Lopes (2015) consider, human creativity, like criticality, should be composed of positive actions aimed at human well-being, considering ethics and respect for others.

A subversively responsible teacher, sometimes, aiming to promote student learning, breaks with the prescribed curriculum. It also places the student at the heart of the educational process, considers children's development when planning their actions, challenges students to identify problems and create proposed solutions, transcends the school environment, creates opportunities for children to experience a problem, expanding their reading of the world and experiencing its actions. D'Ambrosio (2015) also highlights the importance of supporting students, in a subversive and responsible way, to attribute meaning and carry out a collaboratively constructed reading of the world.

Pursuing these indications from the author requires taking as a reference a humanizing education, which, for Freire (2014), means following a path through which men and women can become aware of their presence in the world – the way they act and think when they develop all their capabilities, considering their needs, but also the needs and aspirations of others.

In view of this, teacher education must be based on “the exercise of criticality that implies the promotion of naive curiosity to epistemological curiosity” and, also, consider teaching practice as “an aesthetic and ethical test”. (FREIRE, 2015, p. 51).

Thus, we understand that Statistical Education, when approached from a Freirean perspective, aiming, in its educational approach, at equity, solidarity and respect for diversity – essential values for society projects with humanist nuances –, will contribute to the resignification of ethical values and social.

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