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Educação Matemática Debate

Mathematical tasks on Probability in 6th-grade Middle School textbooks approved by the PNLD 2024

Abstract: Mathematical tasks (TM) are present in teaching materials and are widely used by teachers. They come in various types and serve different purposes during class. The study aimed to understand the role of TM proposed by textbooks (LD) for teaching Probability in the 6th grade of Middle School, as approved by the PNLD 2024. Using a qualitative approach, thirteen collections were examined, identifying the number of TM on Probability and analyzing the potential (or lack thereof) of some of them. The results reveal the predominance of TM with low cognitive demand, with a scarce presence of open proposals and an absence of investigative TM. The analysis highlights conceptual and methodological gaps that limit the development of students' probabilistic literacy. As a result, there is a need to reconfigure the tasks in the textbooks, with greater emphasis on contextualized and investigative proposals.

Keywords: Mathematical Tasks. Probability. Textbooks. Middle School.

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ARTICLE

Tareas matemáticas sobre Probabilidad en libros de texto de 6º grado de la Enseñanza Fundamental aprobados en el PNLD 2024

Resumen: Las tareas matemáticas (TM) están presentes en los materiales didácticos y son ampliamente utilizadas por los docentes. Son de diversos tipos y tienen propósitos distintos durante la clase. El estudio tuvo como objetivo comprender el papel de las TM propuestas por libros de texto (LD) para la enseñanza de la Probabilidad en el 6º grado de la Enseñanza Fundamental, aprobados en el PNLD 2024. A través de un enfoque cualitativo, se examinaron trece colecciones, identificando la cantidad de TM relacionadas con la Probabilidad y analizando el potencial (o su ausencia) de algunos ejemplos seleccionados. Los resultados revelan una predominancia de TM de baja demanda cognitiva, con escasa presencia de propuestas abiertas y ausencia de TM investigativas. El análisis evidencia lagunas conceptuales y metodológicas que limitan el desarrollo del alfabetismo probabilístico de los estudiantes. Como resultado, se identifica la necesidad de reconfigurar las tareas en los LD, con mayor énfasis en propuestas contextualizadas e investigativas.

Palabras clave: Tareas Matemáticas. Probabilidad. Libros de Texto. Enseñanza Fundamental.

Tarefas matemáticas sobre Probabilidade em livros didáticos do 6º ano do Ensino Fundamental aprovados no PNLD 2024

Resumo: As tarefas matemáticas (TM) estão presentes nos materiais didáticos e são amplamente usadas por professores. Elas são de diversos tipos e têm propósitos distintos durante a aula. O estudo visou compreender o papel das TM propostas por livros didáticos (LD) para o ensino de Probabilidade no 6º ano do Ensino Fundamental aprovados no PNLD 2024. Com abordagem qualitativa, foram examinadas treze coleções, identificando a quantidade de TM sobre Probabilidade e uma análise das potencialidades (ou não) de algumas delas. Os resultados revelam a predominância de TM de baixa demanda cognitiva, com escassa presença de propostas abertas e ausência de TM de investigação. A análise evidencia lacunas conceituais e metodológicas que limitam o desenvolvimento do letramento probabilístico dos estudantes. Como resultado, há necessidade de reconfiguração das tarefas nos LD, com maior ênfase em propostas contextualizadas e investigativas.

Palavras-chave: Tarefas Matemáticas. Probabilidade. Livros Didáticos. Ensino Fundamental.

1 Introduction

The *Base Nacional Comum Curricular* [National Common Core Curriculum — BNCC] (Brasil, 2017) has brought about a series of changes to school curricula and teaching practices. In the case of mathematics, the BNCC organizes the curriculum into Thematic Units (UT): Numbers, Algebra, Quantities and Measurements, Geometry, and Probability and Statistics. The production of teaching materials, especially textbooks (LD), has undergone changes to meet the new curriculum guidelines.

One of the changes proposed by the BNCC was the creation of the Probability and Statistics UT, an advance over the *Parâmetros Curriculares Nacionais* [National Curriculum Parameters — PCN] which included the Information Processing block (Giordano, Araújo, and Coutinho, 2019). These changes also raised concerns about the teaching and learning of Probability and Statistics from the beginning of schooling (Lopes, Almeida, and Santos, 2024). These concerns relate to the mismatch between curriculum recommendations and teaching practice in schools, especially due to the lack of clear guidelines on how to translate competencies and skills into concrete actions in teaching planning.

Teachers' lesson planning is often guided by what the LD proposes. In this context, LD play a prominent role not only as instructional resources but also as instruments of mediation between curriculum requirements and teaching practice. In many cases, LD implicitly determine the concepts worked on, the methodologies employed, and the type of mathematical task used in the classroom. Thus, understanding how these materials present the content of Probability becomes essential to assess the consistency between what is proposed in the curriculum and what actually reaches the classroom through teaching activities.

The mathematical tasks proposed by the LD are fundamental for the development of probabilistic reasoning, as they create opportunities for students to mobilize knowledge, formulate conjectures, make decisions, and reflect on situations involving uncertainty. In this sense, the way the tasks are formulated, the contexts used, the degree of complexity involved, and the connections with different meanings of Probability — classical, frequentist, subjective — have a direct impact on the construction of meaning by students. Well-designed tasks favor probabilistic literacy (Gal, 2005), while those focused only on repetitive procedures or examples can limit the development of a critical and comprehensive understanding of the topic (Burkhardt and Swan, 2013).

Given this scenario, the study presented in this article[1] aimed to understand the role of mathematical tasks proposed by LD (Language Learning) for teaching Probability in the 6th grade of Middle School. To achieve this objective, the following research questions are proposed: a) What mathematical tasks are proposed by LD for teaching Probability in the 6th grade of Middle School? b) How do these tasks articulate with the conceptual approach proposed by LD itself?

This paper is organized into sections that present theoretical contributions on probabilistic literacy and mathematical tasks. Next, the methodological contributions that

[1] This article is part of a master's thesis defended in the Postgraduate Program in Mathematics at the Federal University of Western Bahia, organized in multipaper format, written by the first author and supervised by the second and third authors.

guided the research are presented, followed by the presentation of the data. Finally, discussions and considerations are presented. In this way, the research aims to contribute to a critical reflection on the teaching of Probability in the Middle School and on the potential and limitations of LD as mediators of pedagogical practice.

2 Probabilistic literacy

The concept of probabilistic literacy proposed by Gal (2005) is part of a broader discussion on literacy, numeracy, and statistical literacy (Gal, 2022). Lopes, Almeida, and Santos (2024) mention that academic production on probabilistic literacy is still limited, and the topic has not received due attention in research in the field, especially when compared to statistical literacy. Gal (2005) starts from the premise that, in a society permeated by random phenomena, probabilistic messages, and decision-making in contexts of uncertainty, it is essential that all citizens develop specific skills to interpret and act critically in such situations. The author proposes a model of probabilistic literacy composed of elements of knowledge and disposition, highlighting the need for an educational approach that goes beyond formal calculations and encompasses real contexts and judgments.

According to Gal (2005), Probability, more than a formal mathematical field, is a language for dealing with chance and uncertainty that manifest themselves in various spheres of everyday life, such as health, economics, the environment, and politics. Therefore, the proposal for probabilistic literacy is aimed not only at mastering mathematical techniques, but mainly at developing a critical ability to understand, evaluate, and react to probabilistic messages present in everyday life, often expressed in verbal or visual language.

Gal's (2005) model consists of five elements of knowledge and three of disposition. The knowledge elements are: (1) big ideas (such as variability, randomness, independence, predictability, and uncertainty); (2) ways of calculating or estimating probabilities; (3) the language of chance and its meanings; (4) contextual understanding of probabilistic messages; and (5) critical questions that allow reflection on these messages. The disposition elements involve: (1) critical stance; (2) beliefs and attitudes toward Probability; and (3) personal feelings related to uncertainty and risk. These components are organized in Table 1.

Table 1: Elements of probabilistic literacy

Elements of knowledge:
1. Big ideas: variability, randomness, independence, predictability/uncertainty
2. Ways to calculate or estimate probabilities
3. Language: terms and forms of communication about chance
4. Context: understanding the roles and implications of probabilistic messages
5. Critical questions: questions to reflect on probabilistic statements
Layout elements:
1. Critical stance
2. Beliefs and attitudes
3. Personal feelings about uncertainty and risk (e.g., risk aversion)

Source: Gal (2005, p. 51)

Big ideas are central concepts that underpin probabilistic reasoning. Randomness, for example, refers to the absence of determinism in certain phenomena, while independence refers to the lack of mutual influence between events. Variability emphasizes the difference between expected and observed results, which is essential for understanding frequency and risk. These concepts are not trivial and should be introduced intuitively, allowing students to perceive their application in different contexts.

In addition to big ideas, Gal (2005) highlights the importance of individuals understanding different ways of estimating or calculating probabilities. Although school curricula tend to favor the classical approach, many real-life situations require frequentist or subjective interpretations. Thus, probabilistic literacy requires individuals to know how to integrate information from various sources and evaluate the quality of this evidence in order to make reasonable judgments about the likelihood of events occurring.

Language is another essential component. Probabilistic messages are expressed by terms such as *likely*, *almost certain*, or *50% chance*, which can be ambiguous and interpreted in different ways. Mastering this language involves both familiarity with technical terms and the ability to translate between verbal, fractional, decimal, and percentage forms. Clear communication about the chance of events is vital for informed decision-making.

The fourth element is context. For Gal (2005), contextual knowledge makes it possible to understand where and how Probability manifests itself in everyday life: from weather forecasting to medical or financial decisions. The teaching of Probability should explore different areas — such as health, justice, public policy, games, among others — in order to make learning more meaningful and connected to the reality of students.

Finally, critical questions are fundamental to developing a reflective attitude toward probabilistic messages. When analyzing a statement such as *the risk is twice as high for war veterans,* for example, it is necessary to question the source of the information, the data collection process, the interests involved, and the actual meaning of the terms used. This exercise strengthens critical thinking and helps individuals not to be passive in the face of quantitative arguments.

Gal's (2005) model also incorporates disposition factors, recognizing that behavior in probabilistic situations depends not only on technical knowledge but also on the beliefs, attitudes, and feelings of the individual. A risk-averse person, for example, may make different decisions than someone who is more likely to assume uncertainty, even when faced with the same quantitative evidence.

Probabilistic literacy involves much more than knowing how to solve school problems with equiprobable data. According to Batanero, Gea, and Álvarez-Arroyo (2023), probabilistic reasoning is a cognitive process that is indispensable to everyday life and professional performance, allowing individuals to interpret and make decisions in situations of uncertainty, often based on statistical data. It is an essential skill for citizenship, requiring individuals to be able to understand and critically judge information involving uncertainty. To this end, it is necessary to rethink school practices and curricula so that they encompass all dimensions of literacy proposed by Gal (2005), especially in a world increasingly guided by data and probabilistic decisions.

3 Mathematical tasks

The debate surrounding mathematical tasks has gained prominence in mathematics education research due to its centrality in the teaching and learning process — e.g., Mescouto, Lucena, and Barbosa, 2021; Homa, Groenwald, and Llinhares, 2023; Scheja and Rott, 2024; Barbosa, Vale, and Gualandi, 2025. It is important to distinguish between the concepts of task and activity, which are often used as synonyms. For Ponte (2005, 2014), activity refers to what the student actually does; it is the concrete and mental action in the learning context. The task, in turn, corresponds to the objective of the action: it is the proposal presented by the teacher that triggers the student's activity. Thus, a task can give rise to several different activities, depending on the interpretations, experiences, and interactions of the subjects involved.

In the context of mathematics teaching, tasks are elements that organize student activity.

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According to Stein and Smith (1998, 2009), it is the tasks that determine the type of reasoning that students will develop: tasks with low cognitive demand tend to generate mechanical actions, while those with high cognitive demand provoke reflection, exploration, and the construction of mathematical meanings. In this sense, the selection and proposal of mathematical tasks should not be seen as a neutral act, but as a fundamental pedagogical decision in teaching planning.

Authors such as Smith and Stein (1998) and Ponte (2005) and Swan (2017, 2018) have categorized the types of mathematical tasks from different perspectives. Smith and Stein (1998) propose a distinction between memorization tasks, disconnected procedural tasks, connected tasks, and complex problem-solving tasks. Each type of task promotes different ways of engaging students with mathematical knowledge. Connected tasks, for example, encourage the use of different representations, justifications, and arguments.

According to Smith and Stein (1998), it is the teacher's role to maintain the cognitive demand of the tasks throughout the lesson. This means that even if a task has the potential to promote more elaborate mathematical reasoning, the way it is implemented in the classroom can reduce its level of challenge. Therefore, teacher mediation is essential to ensure the quality of learning experiences.

The design of tasks should also consider the context and nature of the proposed mathematical challenge. Ponte (2005) presents a classification that crosses the degree of challenge (low or high) with the degree of structure (closed or open), resulting in four types: exercise, problem, investigation, and exploration. The following figure illustrates this classification.

Figure 1: Relationship between different types of tasks in terms of their degree of challenge and openness (Ponte, 2005, p. 8)

The selection of tasks is one of the most important decisions a teacher makes. In addition to the degree of challenge and structure, the duration, context, and potential for interdisciplinary connections must be considered. For this reason, Ponte (2005) argues that it is not just a matter of proposing isolated tasks, but of organizing coherent sequences of tasks that support the progressive development of learning.

For Swan (2017, 2018), teaching through mathematical tasks should be guided by four main objectives that guide the development of student learning. The first is to develop *knowledge of facts and fluency in basic procedures*, promoting understanding and meaningful practice of fundamental mathematical algorithms and techniques. The second is *conceptual competence*, encouraging the construction of meanings, connections, and relationships between ideas. The third objective is to develop problem-solving skills, called *strategic competence,* through tasks that require varied strategies, logical reasoning, and intellectual autonomy. Finally, the fourth objective is to develop mathematical research skills, encouraging students to explore, formulate hypotheses, generalize results, and construct mathematical arguments, that is, the development of critical competence. These four axes guide the design of tasks that articulate procedures, concepts, resolution, and investigation, constituting balanced and intentional teaching.

Table 2: Characterization of mathematical tasks

Examples of Tasks	**Features**
Solve the equation: 2x + 5 = 7	▪ Reduced degree of challenge; exercise (Ponte, 2005); ▪ Low cognitive demand task, prioritizes memorization (Stein and Smith, 1998); ▪ Develop procedural fluency (Swan, 2017, 2018)
During a birthday celebration at school, a rectangular cake was served and divided equally into 12 pieces. At the end of the party, 5 pieces of cake remained. a) Reduced degree of challenge; exercise (Ponte, 2005); b) Low cognitive demand task, prioritizes memorization (Stein and Smith, 1998); c) Develop procedural fluency (Swan, 2017, 2018)	▪ High degree of challenge, enabling different resolution strategies; problem-type task (Ponte, 2005); ▪ Procedures with connections, intermediate cognitive demand (Stein and Smith, 1998); ▪ Focus on strategy (Swan, 2017, 2018);
What is the average height of the students in your class?	▪ Reduced degree of challenge, enabling different resolution strategies; exploration-type task (Ponte, 2005); ▪ Procedures with connections, intermediate cognitive demand (Stein and Smith, 1998); ▪ Focus on strategy (Swan, 2017, 2018);
Joana has a rectangular plot of land and wants to divide the space for different purposes: planting fruit trees, building a vegetable garden, leaving an area for leisure, and another for circulation. She wants to use fractions of the land to plan the distribution of space, but has not yet decided exactly how to do it. Help Joana think of at least three different ways to divide the plot, using fractions that together complete the entire plot. In each proposal: a) Specify what portion will be allocated to each purpose (fruit, vegetable garden, leisure, circulation); b) Make a representation (drawing, table, diagram, etc.) that helps visualize your proposal; c) Explain why your division is appropriate.	▪ High degree of challenge, enabling different solution strategies; investigation-type task (Ponte, 2005); ▪ Doing math, high cognitive demand (Stein and Smith, 1998); ▪ Focus on conceptual competence, strategy, and criticism (Swan, 2017, 2018);

Source: Own elaboration

Another relevant point is the relationship between task and representation. Goldin and Shteingold (2001) state that different types of representation — graphs, tables, equations, diagrams — should be articulated in task-based work. These representations promote students' mathematical understanding and communication, which is essential in more complex tasks. The teacher's role is not limited to selection: they are also responsible for transforming LD tasks into richer problems. To do this, they can modify the statement, broaden the context, explore different solutions, and promote collective discussions. According to Ponte (2005), the transformation of a task is a highly relevant didactic act.

Mathematical tasks, therefore, are not only instruments for assessing student performance, but are at the heart of learning experiences. They should be challenging, contextualized, diversified, and planned according to learning objectives. In this sense, teachers must assume the role of planner, mediator, and analyst of the tasks they propose. It is up to them to ensure that the tasks are aligned with the curriculum objectives and the needs of their students, favoring the development of mathematical reasoning, autonomy, and critical thinking.

4 Methodological contributions

The present study aimed to understand the role of mathematical tasks proposed by LD for teaching Probability in the 6th grade of Middle School. To this end, a qualitative approach (Bogdan and Biklen, 1994) was adopted, with documentary research (Gil, 2008) using the descriptive method (Gil, 2008). The analysis method used was content analysis proposed by Bardin (2016), which allowed the identification and interpretation of patterns, categories, and trends related to the teaching of Probability.

The research corpus consisted of thirteen collections of LD Mathematics, totaling 13 volumes for the 6th grade, which were analyzed in their entirety for the presence and treatment of the topic of Probability. The choice of materials took into account their approval in the PNLD 2024-2027, ensuring their representativeness in Brazilian public school systems.

The methodology adopted for data analysis was *content analysis*, as proposed by Bardin (2016), which is structured in three phases: i) pre-analysis, ii) exploration of the material, and iii) treatment of results, inference, and interpretation. The research questions guided the entire process: a) what mathematical tasks are proposed by LD for teaching Probability in the 6th grade of Middle School? b) how do these tasks relate to the conceptual approach proposed by the LD themselves?

In the *pre-analysis*, a cursory reading of all the material was carried out, with the aim of identifying textual and graphic units related to the teaching of Probability. Based on this initial reading and supported by the literature (Smith and Stein, 1998; Ponte, 2005; Swan, 2017; Gal, 2005), the following categories of analysis were defined: a) quantitative analysis of the types of mathematical tasks on Probability in LD; and b) qualitative analysis of some tasks with a focus on literature.

During the exploration of the material, all mathematical tasks related to Probability were extracted. These tasks were organized into a table containing each type of task: exercise, problem, exploration, investigation, and projects. Images of some mathematical tasks of each type present in the LD were also extracted, in addition to the elaboration of an investigative task, not found in the LD, for further analysis based on the literature on mathematical tasks.

In the phase of treatment of results, inference, and interpretation, the data were systematized in summary tables and described based on the proposed categories. The tasks were discussed using references on mathematical tasks and probabilistic literacy — e.g., Stein and Smith, 1998; Gal, 2005; Ponte, 2005, Swan, 2017, 2018 —, seeking to understand the role they play in the process of teaching Probability.

This methodological process allowed us to identify regularities, gaps, and potentialities in the didactic proposals of the LD analyzed, contributing to the discussion on the teaching of Probability in Middle School.

5 Presentation of data

For the analysis of the tasks, the 13 LD approved by PNLD 2024-2027 were selected. Immediately afterwards, we conducted a thorough reading of the Probability and Statistics UT in these LD. For the sake of ease of terminology, the nomenclatures shown in Table 3 were adopted.

Table 2: Distribution of collections and their nomenclatures

Code	Nome da coleção	Edition	Publisher	Year
LD01	A Conquista da Matemática [The Conquest of Mathematics]	4th	FTD	2018
LD02	Araribá Conecta [Araribá Connects]	1st	Moderna	2022
LD03	Os Desafios da Matemática [The Challenges of Mathematics]	1st	Moderna	2022
LD04	Matemática Bianchini [Bianchini Mathematics]	10th	Moderna	2022
LD05	Superação [Overcoming]	1st	Moderna	2022
LD06	Geração Alpha [Alpha Generation]	4th	SM	2022
LD07	Matemática e Realidade [Mathematics and Reality]	10th	Saraiva	2022
LD08	Teláris Essencial [Teláris Essential]	1st	Ática	2022
LD09	Jornadas Novos Caminhos [Journeys New Paths]	1st	Saraiva	2022
LD10	Amplitude	1st	Brasil	2022
LD11	Matemática em Sena [Mathematics in Sena]	1st	Escala Educacional	2022
LD 12	Matemática nos dias de hoje [Mathematics Today]	1st	SEI	2022
LD13	Conexões e Vivências [Connections and Experiences]	1st	Brasil	2022

Source: Own elaboration

5.1 Quantity of types of mathematical tasks on Probability in LD

We also read the summaries, which allowed us to locate the chapters related to the Probability and Statistics UT. The results and presentation of the data found can be seen in Table 4.

After locating the relevant chapters, we proceeded with the analysis. This analysis consisted of a thorough reading of the chapters found and selection of those that deal with tasks for teaching Probability. There are several chapters related to the study of Probability, some specifically intended for teaching Probability, others related to the Probability and Statistics UT.

Table 3: Distribution of the Probability and Statistics field in the summaries

Textbook	Total Chapters	Number of Chapters on Probability and Statistics	Chapters on Probability and Statistics
LD01	09	01	08
LD02	12	12	01 ao 12
LD03	12	01	12
LD04	12	02	08 e 10
LD05	12	01	11
LD06	16	01	07
LD07	24	02	23 e 24
LD08	10	01	10
LD09	12	01	12
LD10	12	01	08
LD11	12	01	08
LD12	12	02	11 e 12
LD13	12	01	12

Source: Own elaboration

Next, we cataloged the tasks designed to work with Probability in the LD under analysis, using the approach and record of the tasks presented to teach this content as a starting point. After that, we read each task, classifying them into one of the five types found in our theoretical framework: exercise, problem, exploration, investigation, and project. The data related to the cataloging of tasks can be seen in Table 5.

Table 5: Distribution of tasks in the field Probability

Book	Exercise	Problem	Exploration	Investigation	Project	Total
LD01	07	10	00	00	00	17
LD02	08	13	00	00	00	21
LD03	07	12	02	00	00	21
LD04	03	05	00	00	00	08
LD05	03	05	00	00	00	08
LD06	06	10	00	00	00	16
LD07	05	12	01	00	00	18
LD08	04	07	01	00	00	12
LD09	05	08	00	00	00	13
LD10	04	08	00	00	00	12
LD11	03	09	00	00	00	12
LD12	04	08	00	00	00	12
LD13	05	07	00	00	00	12
Total	64	114	04	00	00	182

Source: Own elaboration

An analysis of the table quantifying the types of mathematical tasks in the Mathematics

LD approved by PNLD 2024, aimed at teaching Probability in the 6th grade of Middle School, shows a marked predominance of exercises and problems. Of the 182 tasks identified in the thirteen collections analyzed, 64 are classified as exercises and 114 as problems, representing approximately 35% and 63% of the total, respectively. This indicates that the LD prioritize structured, single-answer tasks, which tend to require the direct application of already known procedures, without necessarily stimulating the construction of broader meanings or the mobilization of diverse strategies.

On the other hand, the number of tasks classified as explorations is extremely low: only four tasks in the entire corpus analyzed, representing about 2% of the total. Furthermore, no examples of investigation or project-type tasks were identified. This data reveals a significant gap in the presence of more open, creative proposals that favor critical thinking, student autonomy, and hypothesis formulation — characteristics associated with the development of probabilistic literacy and more complex mathematical reasoning.

The collections analyzed show homogeneity in terms of the profile of the tasks proposed. Even those with a greater number of tasks, such as LD02, LD03, and LD07, maintain a predominance of exercises and problems, without breaking with the traditional logic of curriculum organization. This homogeneity suggests that the culture of teaching material production still relies heavily on pedagogical models centered on mechanical practice and the resolution of closed tasks.

This concentration on tasks of low cognitive demand has relevant implications for student learning. The almost total absence of explorations, investigations, and projects limits the development of skills expected by the BNCC (Brasil, 2017), such as the ability to argue, apply knowledge in varied contexts, and solve complex problems creatively. In addition, it weakens the formative role of tasks, as it restricts opportunities for students to develop a broader and more contextualized understanding of Probability.

The data therefore show a strong tendency to reproduce traditional teaching practices, which compromises the diversity of learning experiences provided by LD. This reinforces the importance of the teacher's role as a critical mediator, capable of selecting, adapting, and transforming the tasks proposed in the LD in order to create more meaningful and challenging opportunities for their students. Transforming routine tasks into investigative or open-ended situations can be an effective strategy for enhancing the teaching of Probability and developing skills associated with probabilistic literacy, as proposed by Gal (2005).

5.2 Qualitative analysis of some tasks with a focus on literature

Task: exercise type. This type of task appears in all the LD analyzed, but in order not to prolong our work too much or be repetitive, we will present a type of exercise that appeared most frequently. We will also present the respective suggested solution (Figures 2 and 3).

2. In a basket there are 12 volleyballs, 2 of which are white, 6 are yellow, and 4 are red. From this basket, at random, without looking, a ball is removed. What is the probability that the ball removed will be:

a) white? $\frac{2}{12}$ ou $\frac{1}{6}$.

b) yellow? **b)** $\frac{6}{12}$ ou $\frac{1}{2}$.

c) red? $\frac{4}{12}$ ou $\frac{1}{3}$.

Figure 1: Exercise-type task presented in LD01 (Giovanni Jr. and Castrucci, 2018, p. 165)

2. a) The probability of drawing a white ball is 2 to 12, or $\frac{2}{12}=\frac{1}{6}$.

b) The probability of drawing a yellow ball is 6 to 12, or $\frac{6}{12}=\frac{1}{2}$.

c)The probability of drawing a red ball is 4 to 12, or $\frac{4}{12}=\frac{1}{3}$.

Figure 2**:** Suggested answer — Task type exercise LD01 (Giovanni Jr. and Castrucci, 2018, p. 311)

From Ponte's (2005) point of view, this task is an *exercise*, since it has a closed structure and a low level of cognitive challenge. The solution is unique, the context is simple, and there is no room for different resolution strategies. According to Ponte (2014), the exercise is characterized by being repetitive, with the aim of consolidating previously taught techniques, which seems to be the case with the task under analysis.

From the perspective of Stein and Smith (1998, 2009), this task falls into the category of *unconnected procedural tasks*, that is, it is an exercise that requires the application of a known formula, without the need to justify or explore concepts in a meaningful way. Tasks of this type do not encourage deep mathematical reasoning or promote connections between ideas, representations, or contexts. The absence of questions about the reason for the expression or about different ways of representing the problem corroborates this classification.

According to Swan (2017), effective tasks for mathematical learning should mobilize students to explore structures, formulate conjectures, argue, and solve problems actively. The task presented, on the other hand, is limited to the mechanical application of an algorithm in a simple and artificial context, without involving investigative or higher-order reasoning skills. There is no incentive for discussion, comparison of strategies, or reflection on the concept of Probability, elements that the author considers fundamental in tasks with greater educational potential.

From the perspective of Gal's (2005) probabilistic literacy model, the task also reveals important limitations. First, although it is based on a situation involving randomness, it does not explore the *Big Ideas* of Probability, such as *variability*, *uncertainty*, *independence*, or *predictability.* In addition, the literacy elements proposed by Gal (2005), such as *probabilistic language*, *context*, and *critical questions*, are absent. The task does not invite students to critically interpret the situation, question the method used, or reflect on the applicability of the results. It is a proposal that favors the classical conception of Probability, disregarding other relevant interpretations, such as the frequentist or subjective ones.

The task illustrated in Figures 2 and 3, although technically correct, does not favor the development of broad mathematical skills nor does it contribute to probabilistic literacy as a whole. Its closed structure, lack of meaningful context, exclusive focus on technique, and low stimulus for argumentation or critical analysis position it as a task with limited pedagogical potential. For such tasks to truly contribute to the learning of Probability, it would be necessary to reformulate them, incorporating more open, contextualized, and challenging elements, as proposed by authors who research the topic.

Task: problem type. Problem-type tasks are widely prevalent in LD, standing out as one of the most recurrent approaches within the selection of tasks. Below (Figure 4), we present a representative task of this type, which occurs frequently in LD, accompanied by a suggested solution that seeks to illustrate its pedagogical potential.

3. Ronaldo and 24 other classmates will participate in a lottery to present their work on the history of mathematics. The teacher intends to select four students at a time for the presentation. Considering that all students have the same probability of being selected, what is the probability that Ronaldo will be one of the students selected? **3.** $\frac{4}{25}$ **or 0.16 or 16%.**

3. The teacher intends to select 4 students at random from the 25 students in the class. Therefore, the probability of Ronaldo being one of the students selected is: $\frac{4}{25}$ or 0.16 or 16%.

Figure 3: Problem-type task and its solution — LD02 (Gay, 2022, p. 274, p. XCVIII)

This proposal differs from traditional exercises in that it involves a narrative situation that requires interpretation of the statement, mobilization of mathematical knowledge, and application of the classical definition of Probability. However, although the presentation takes the form of a problem, the task maintains a closed structure, with a single correct solution, and implicitly directs the type of reasoning to be mobilized, which reduces its investigative potential. For Ponte (2005), this task is classified as a problem because it has a statement that requires the mobilization of concepts for its resolution, with an explicit question and a greater degree of challenge than an exercise. However, the problem presented has low openness, with no room for different paths to resolution or alternative conceptual discussions. There is no room to justify, compare representations, or even represent the situation in different ways — such as with diagrams, graphs, or simulations (Swan, 2017).

In dialogue with Stein and Smith (1998, 2009), the task is similar to tasks with connections, in that it provides a meaningful context and requires the student to relate information from the statement to the mathematical concept of Probability. However, the solution suggested in the LD itself reduces the reflective potential of the task by specifying a direct algorithmic procedure: identify the total number of elements (25), the favorable cases (4), and apply the classic expression $P = \frac{4}{25}$. This can lead to a mechanized approach on the part of the student, which, in the authors' view, transforms the task into a procedural activity with a fragile connection if there is no teacher mediation to stimulate greater reflection.

From the perspective of probabilistic literacy conceptualized by Gal (2005), the task represents an example of the application of Probability in a realistic context, which is positive. However, it is still limited in terms of the five elements of literacy. The task partially mobilizes conceptual knowledge by involving the calculation of classical Probability, but it does not activate probabilistic language in a broad way — terms such as *randomness* or *uncertainty* are not discussed —, nor does it encourage students to reflect critically on the situation — for example, whether the draw is really fair, or whether all students have the same chances. It also does not explore critical issues or allow for the questioning of information.

Task: exploration type. This type of task is rare in the mathematics LD analyzed. Only four appear, as can be seen in Table 5. We will continue to follow the same criteria and present one that appeared in a similar form in three LD. We will also present the respective suggested solution (Figures 5 and 6).

The above task exemplifies a teaching approach that breaks with the traditional logic of closed exercises and problems, promoting an environment of experimentation, data collection, and analysis of regularities through concrete action by students. The structure of the task invites students to perform successive rolls of a die and record the results in a table, promoting the empirical survey of frequencies and comparison with theoretical probabilities. The proposal also incorporates coin tosses and the development of justifications based on the data collected, allowing for multiple answers, interpretations, and arguments.

Participate — Complete the activities in your notebook.

I. Use a die to perform this experiment with a classmate.

Procedure

Roll the die (one student at a time) and write down the number of points on the side facing up.
Repeat this procedure many times (we suggest 100 times) and record the information in a table in your notebook.
Then determine what percentage of the total rolls corresponds to

a) "2 points" on the side facing up, Answer:

b) "even number" on the side facing up, Answer:

Compare these percentages to the probabilities calculated in activity **10**. They are not expected to be equal, but they should be approximate values of the calculated probabilities. The more rolls are made, the closer these percentages will be to the calculated probabilities. Remember: In probability theory, we assume an unbiased die.

II. Design an experiment to estimate the probability of getting heads when tossing a $1 coin.
After conducting the experiment, write your conclusion: do both sides of the coin have equal probabilities of occurring when tossing the coin, or is one clearly more likely than the other?

Figure 4: Exploration task — LD07 (Iezzi, Dolce and Machado, 2022, p. 309)

I. a) It is expected that the number of times the die landed with the number 2 facing up is around one sixth of all throws. For example, if there were 96 throws, the number 2 should have landed facing up approximately 16 times, so the probability will be: $\frac{16}{96} = \frac{1}{6}$

b) Since the die has 3 sides with even numbers (2, 4, 6), the probability of an even number appearing on the side facing up should be 50%. For example, if there were 96 rolls, the even number side must have been up approximately 48 times, so the probability will be: $\frac{48}{96} = \frac{1}{2} = 50\%$

II. The experiment is expected to involve tossing the coin many times and noting how many times the result is heads and how many times it is tails. It is also expected that the probability of each side of the coin coming up is approximately $\frac{1}{2}$.

Figure 5: Resolution of the exploration task — LD07 (Iezzi, Dolce and Machado, 2022, p. CXXVIII)

We observe a clear consistency with the theoretical assumptions of Ponte (2005), Stein and Smith (1998, 2009), and Swan (2017), who defend the centrality of tasks in the process of constructing mathematical knowledge.

The proposal presented requires students to conduct experiments with data and coins, collect and analyze results, compare observed frequencies with expected values, and develop justifications based on empirical evidence. This configuration is in line with Ponte's (2005) perspective, as it presents a high degree of openness and cognitive challenge, encouraging hypothesis formulation, decision-making, and investigative reasoning.

For Stein and Smith (2009), this is a highly cognitively demanding task, as it is not limited to the application of mechanical procedures but requires reflection on the observed variability and randomness, in addition to maintaining reasoning potential during classroom implementation.

Swan (2017) also contributes to this reading by stating that effective tasks should promote conceptual understanding through the comparison of representations and argumentation. The task in question meets this criterion by allowing students to record data in tables, express probabilities in different forms — fractional, decimal, and percentage —, and reflect on the discrepancies between empirical results and theoretical values.

For Gal (2005), the teaching proposal highlights fundamental elements for the development of probabilistic literacy. The task mobilizes conceptual knowledge (notions of classical and frequentist Probability), specific language — terms such as *chance*, *percentage*, *approximately* —, as well as contextual elements and predictability. By involving students in a practical experience with uncertainty and variability, the task enables intuitive and critical understanding of probabilistic notions, which is at the heart of the literacy advocated by Gal (2005). The invitation to develop justifications also brings students closer to critical issues, such as pattern recognition, method evaluation, and data-based argument validation.

Task: investigation type. This type of task was not found in the Mathematics LD approved by PNLD 2024. So, we decided to transform the task in Figure 2, which is an exercise type, into an investigation task (Figure 7).

Task

To teach probability in a diverse way, a teacher placed several colored balls in an urn. Then, democratically, he asked the class to choose a student to go to the urn and randomly remove a ball. At that moment, he asked the other students, gathered in small groups, to answer:

1. What is the probability of removing a red ball from the urn? Justify your answer.
2. Now, represent the initial situation you thought of by placing the number of balls in the urn and repeating the removal, noting the absolute and relative frequency in a table for the following situations:
   a) 10 removals
   b) 30 removals
   c) 50 removals
3. What do you observe between your answer to the first question and the withdrawals in the second question? Justify your answer.

Figure 7: Investigation-type task (Own elaboration)

The task presented exemplifies a didactic proposal that mobilizes, in an integrated manner, conceptual, empirical, and reflective dimensions of Probability teaching. The task invites students to estimate, represent, experiment, and compare results, favoring the active construction of knowledge based on the analysis of random situations. This configuration is in line with the references of Ponte (2005), Stein and Smith (1998, 2009), and Swan (2017), as it breaks with traditional models of closed and procedural tasks and proposes an investigative environment that values mathematical reasoning, argumentation, and decision-making. The task requires students not only to use procedures, but also to formulate hypotheses, conduct experiments, record frequencies, and analyze trends as the number of repetitions increases. This structure allows for the observation of patterns and the approximation between empirical and theoretical Probability, which, from Stein and Smith's perspective, characterizes a task with high cognitive demand and the potential to maintain this level throughout the lesson.

The presence of different representations — absolute and relative frequency —, the comparison between predictions and observed results, and the encouragement of justification support the type of task that Swan (2017) advocates as promoting conceptual understanding. In addition, the proposal is strongly linked to the notion of probabilistic literacy discussed by Gal (2005), as it articulates elements such as variability, randomness, technical language, context, and criticality, all of which are mobilized in the development of the activity. The invitation to reflect on the differences between initial predictions and results obtained from experimentation reinforces the importance of understanding the notions of uncertainty and predictability, concepts central to literacy. Thus, the task provides a rich, situated, and collaborative experience capable of promoting meaningful learning in Probability and developing mathematical and critical skills in students.

6 Discussion and results

The analysis of the LD approved by PNLD 2024 showed a strong predominance of exercise and problem-type tasks, with a reduced presence of more open tasks, such as exploration, and a complete absence of research or project-type tasks. This configuration points to a teaching model centered on the practice of algorithms and procedures, limiting opportunities for the development of more complex mathematical reasoning and critical skills associated with probabilistic literacy.

The tasks classified as exercises (64 in total) have a closed structure, focus on the application of previously taught techniques, and low cognitive demand, which is in line with the typology proposed by Ponte (2005) and Stein and Smith (1998). These tasks prioritize memorization and automation and are common in all the LD analyzed.

Their high frequency reinforces a teaching practice based on repetition and mechanical resolution of situations, with no room for reflection, interpretation of context, or argumentation. Problem-type tasks (114 in total) outnumber the others and indicate, in part, an attempt at contextualization and mobilization of knowledge through narrative statements.

However, we observe that, in many cases, these problems maintain a closed structure, with a single solution and a direct resolution procedure. Although they have greater potential than exercises, these problems often do not explore connections with different meanings of Probability, nor do they require justifications or comparisons of strategies, which brings them closer, in terms of cognitive demand, to procedural tasks with a fragile connection.

The scarcity of exploration-type tasks (only 4 out of 182 analyzed) and the lack of investigation and project tasks indicate that LD have not yet effectively incorporated pedagogical proposals that value experimentation, hypothesis formulation, analysis of regularities, and active knowledge construction. This gap is concerning, as already presented in the literature (Cunha and Ferreira, 2022; Santos and Ferreira, 2023; Cruz, Ferreira and Costa, 2024), considering the guidelines of the BNCC, which highlights the importance of developing students' ability to argue, model, solve problems, and interpret information in contexts of uncertainty.

When relating the empirical data to the probabilistic literacy model proposed by Gal (2005), we observe that most of the tasks present in the LD do not include the five elements of knowledge — big ideas, ways of calculating, language, context, and critical questions — or the three elements of disposition — critical stance, beliefs, and feelings in the face of uncertainty. The approach to Probability remains strongly anchored in the classical interpretation, disregarding the frequentist and subjective approaches, which are fundamental for dealing with everyday phenomena (Lima, 2020; Lima and Borba, 2022; Silva and Guimarães, 2024).

The low investment in open-ended tasks compromises the development of skills such as critical analysis of probabilistic messages, the formulation of data-based arguments, and informed decision-making; central aspects for probabilistic literacy and the formation of active citizens. The absence of investigative tasks, for example, prevents students from understanding variability and uncertainty experientially, through simulations, records, and frequency analyses, as argued by Ponte (2005) and Swan (2017).

More open-ended tasks, even when rare, proved to be powerful in developing the skills outlined in the BNCC (Brasil, 2017) and Gal's (2005) model. The exploration-type task analyzed (Figure 5), for example, allowed for the collection and analysis of empirical data, the comparison between observed and theoretical results, the use of multiple representations, and the collective construction of meanings. According to Swan (2017), these elements characterize tasks that promote conceptual understanding and intellectual autonomy, which reinforces the need to expand this type of task in LD. According to Ponte, Brocardo, and Oliveira (2006), in tasks of this type, students act as professional mathematicians, going through processes of formulating questions and conjectures, testing and conducting tests, as well as discussing the results with their peers and teacher.

The analyses also showed that even tasks initially classified as exercises or problems can be transformed into richer and more investigative situations, depending on the teacher's mediation. This aspect reinforces the central role of the teacher in transforming tasks (Ponte, 2005), capable of adapting teaching materials to the reality of their class, expanding the educational potential of the proposed tasks.

Thus, it can be concluded that the LD analyzed still present a limited treatment of the topic of Probability, with a predominance of tasks of low or medium cognitive demand and with little diversity of approaches. This compromises the development of full and critical probabilistic literacy, as required for the training of students capable of interpreting and acting in contexts marked by uncertainty and data complexity.

We therefore recommend that the PNLD guidelines for mathematics establish a reduced percentage of closed tasks in the LD and expand the space for more open, contextualized, and challenging task proposals. In addition, we highlight the importance of continuing education policies that support teachers in the critical analysis of teaching materials and in the construction of pedagogical practices that articulate curriculum, content, and learning in a reflective and meaningful way.

7 Final thoughts

The study aimed to understand the role of mathematical tasks proposed by LD for teaching Probability in the 6th grade of Middle School. To achieve this goal, the following research questions were proposed: a) What mathematical tasks are proposed by LD for teaching Probability in the 6th grade of Middle School? b) How do these tasks relate to the conceptual approach proposed by LD itself?

In response to the first question, the tasks proposed for the 6th grade focus on exercises and problems, representing almost the entirety of the tasks. The exercise-type tasks (64) are predominantly closed, with low cognitive demand and focused on the application of algorithms, without promoting reflection or argumentation. The problem-type tasks (114), although more contextualized, also maintain a rigid structure and a single solution, which limits the development of probabilistic reasoning and prevents the exploration of different meanings of Probability. In contrast, there is a scarcity of exploration tasks (only 4) and a complete absence of investigation or project tasks, which reveals teaching that is still centered on procedures and poorly aligned with the BNCC (Brasil, 2017) guidelines, which advocate the active construction of knowledge and the confrontation of situations of uncertainty.

With regard to the articulation between the tasks and the conceptual approach proposed by the LD themselves, we observe a misalignment. Most tasks do not include the elements of Gal's (2005) probabilistic literacy model — such as big ideas, language, context, and critical questions — nor do they encourage dispositions such as reflective posture or critical thinking in the face of uncertainty. Probability is treated in a predominantly classical manner, without valuing frequentist and subjective approaches, which are fundamental to understanding everyday phenomena. The few open-ended tasks showed potential for promoting autonomy, argumentation, and data analysis, but they are exceptions. Thus, we conclude that the approach of the LD analyzed remains limited, compromising the development of broader probabilistic skills and the formation of probabilistic literacy.

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Conflicts of Interest

The author declares that there are no conflicts of interest that could influence the results of the research presented in this article.

Data Availability Declaration

The data collected and analyzed in this article will be made available to the author upon request.

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