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Proposal for a project-based learning activity to raise awareness about betting apps

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ABSTRACT

This article presents a concise review of the fundamental concepts of Project-Based Learning (PBL), integrated within a proposed teaching sequence designed to explore the foundational principles of probability theory. It has been posited that, despite its absence from practical implementation, this proposal possesses the capacity to engender an engaging learning environment by virtue of its foundation in a contemporary guiding question: for what reason are casino games and analogous pastimes designated as games of chance? Problem-Based Learning (PBL) is a pedagogical approach that incorporates a range of important tools, including brainstorming, webquests, rubrics and portfolios. The centrality of student-centered learning serves to enhance the efficacy of these tools in two key ways. Firstly, they function as promoters of ideas and discussions, and secondly, they play a pivotal role in the organization of the search for knowledge. In addition, the fabrication of artefacts through the utilization of 3D printing is introduced, thereby situating the present didactic proposal within the conceptual framework of STEAM education: interdisciplinarity, emphasis on the development of critical thinking and problem solving, innovation and creativity, the use of digital technologies and tools, and the encouragement of collaborative teamwork.
KEYWORDS: STEAM; Problem Based Learning; Statistical Probability.

Proposta de uma atividade baseada em projetos para a conscientização sobre aplicativos de apostas (bets)

RESUMO

Neste artigo apresenta-se uma breve revisão dos principais conceitos da Aprendizagem Baseada em Projetos (ABP), combinados na proposta de uma sequência didática direcionada ao estudo dos conceitos básicos da teoria das probabilidades. Argumenta-se que essa proposta, embora não aplicada na prática, possa tornar o aprendizado engajador ao partir de uma questão norteadora bastante atual: porque jogos de cassino ou similares são chamados jogos de azar? Da ABP traz-se a utilização de importantes ferramentas pedagógicas, tais como, o uso de *brainstormings*, *webquests*, rubricas e portfólios. A centralidade da aprendizagem no aluno, potencializa essas ferramentas tanto como elementos promotores de ideias e discussões como organizadores da busca por conhecimento. Também, introduz-se a criação de artefatos via impressão 3D, enquadrando a presente proposta didática nos conceitos da educação STEAM: a interdisciplinaridade, ênfase no desenvolvimento do pensamento crítico e resolução de problemas, a inovação e criatividade, o uso de tecnologias e ferramentas digitais e o incentivo do trabalho colaborativo em equipe.
PALAVRAS-CHAVE: STEAM; Aprendizagem Baseada em Problemas; Probabilidade Estatística.

Following the publication of the *Base Nacional Comum Curricular* (BNCC) (BRASIL, MEC/CONSED/UNDIME, 2017), teaching and learning mechanisms in Brazil came to be viewed as part of a major educational reform. The document defends the argument that there is an excess of "uninteresting content" for students and that a new educational model should focus on developing skills and competencies that better prepare them for the labor market. Since its creation, the BNCC has received numerous criticisms, including those concerning the strong influence of the private sector (dos Santos & Silva, 2017; Urbini, 2015), biased discourses on diversity and inclusion (de Fátima Cóssio, 2014; Limaverde, 2015), and the possibility that its implementation may widen the gap between the privileged students of private institutions and the millions of Brazilian youths who depend on public education (Branco & Zanatta, 2021).

Despite these criticisms, the BNCC emphasizes the importance of incorporating technological and digital tools into the teaching and learning processes of young Brazilians, as "young people are dynamically integrated into digital culture, not only as consumers but also increasingly as active participants" (BRASIL, MEC/CONSED/UNDIME, 2017, p. 474). Throughout the document, the need for the use of digital information and communication technologies (ICTs) in educational practices is made explicit. These technologies are seen as essential instruments for developing the new skills and competencies required in contemporary society, as stated in Competency 5 of the mathematics area:

> Use mathematical processes and tools, including available digital technologies, to model and solve everyday, social, and interdisciplinary problems, validating strategies and results (ibid. p. 267).

This emphasis extends to the teaching of Probability and Statistics:

> ...the use of technologies — such as calculators, to evaluate and compare results, and electronic spreadsheets, which help in constructing graphs and calculating measures of central tendency. Consulting pages of research institutes — such as the Brazilian Institute of Geography and Statistics (IBGE) — can offer potentially rich contexts not only for learning statistical concepts and procedures but also for using them to understand reality (ibid. p. 274).

In the final years of elementary education, and with a focus on Mathematics content, the BNCC advocates for meaningful learning that arises from "the connections that students establish between mathematical objects and their daily lives, and among different mathematical topics" (ibid., p. 298). The goal is to ensure that "students develop the ability to abstract from context, grasp relationships and meanings, and apply them to new contexts" (ibid., p. 299). However, the document does not specify either the methodological approach or practical strategies teachers should use to achieve these outcomes. To stimulate learning through open-ended and contextualized problems, teachers must be capable of applying active methodologies such as Project-Based Learning (PBL), since it would be contradictory to advocate for student-centered learning while maintaining a traditional, teacher-centered instructional model. The BNCC itself

asserts the “fundamental importance of considering the heuristic role of experimentation in learning Mathematics” (ibid., p. 265).

Within this context, Project-Based Learning (PBL) (for Education, 2008) presents characteristics that can effectively foster the development of skills and competencies through student-centered processes. In PBL, learning activities are driven by one or more guiding questions that serve as triggers for student engagement. Among the pedagogical tools commonly employed within this methodology, notable examples include brainstorming, webquests, and portfolios. Brainstorming serves to elicit and discuss ideas or hypotheses related to the proposed project and its guiding question. According to Praminingsih et al. (2023), brainstorming supports the development of critical thinking and creativity —skills essential to the 21st century. The webquest (Dodge, 1995), in turn, represents a structured online research tool guided by the teacher, promoting reflection on the material accessed. Its use enhances students’ abilities to synthesize, analyze, and evaluate information—key steps in constructing understanding of the guiding question (Zhang et al., 2022). The portfolio performs a dual function: it records and articulates the knowledge constructed throughout the project—serving as a form of collective memory—and provides the teacher with a means to assess student progress over time, replacing a single, summative evaluation at the end of the project (Boas, 2005). The use of portfolios also strengthens competencies such as textual analysis, written expression, synthesis, and knowledge organization (Gomes et al., 2010).

In ABP, assessment occurs continuously throughout the learning process and can be accessed (quantified or qualified) using various pedagogical tools, including those previously mentioned, through the implementation of rubrics. Rubrics can be organized into hierarchical levels of complexity and can be presented in analytical or holistic form. They can be used in individual or collective assessment, as Bender (2015) has noted. The fundamental element that distinguishes learning guided by PBL is the educational artifact or product. The educational product corresponds to the materialization of the learning processes, representing a synthesis of the students' investigative journey. In essence, it serves as tangible evidence of significant learning. The extant literature is unanimous in its assertion that the creation of authentic products engenders a more meaningful learning experience, as it engages students in situations that closely resemble reality and favors the mobilization of multiple skills (Almulla, 2020). Examples of such artifacts include three-dimensional models in science (Kolodner et al., 2003), websites and interactive digital resources in multidisciplinary approaches (Markan, 2011), technical reports (Thomas, 2000), and others (Ferreira, 2003; Bender, 2015).

In particular, the thematic unit of Probability and Statistics in the final stage of elementary school, as delineated by the BNCC, advocates an approach that can encompass concepts, facts, and procedures applicable to a range of everyday, scientific, and technological scenarios. Consequently, the cultivation of competencies in data collection, organization, representation, and analysis across diverse contexts is imperative at this juncture to foster critical thinking in evidence-based decision-making. For instance, a comprehensive grasp of probability principles is instrumental in deciphering the potential outcomes of games of chance. A nuanced understanding of the odds of winning or losing can

influence individual judgment, thereby shaping an optimal approach to these games. This understanding cannot be guaranteed in the case of recent online betting platforms, popularly known as Bets, since the algorithms of these platforms are proprietary and designed in a gamified way to give the user a permanent feeling of imminent victory.

In the context of Brazil, online gambling has emerged as a salient public health (Prazeres, 2024) and economic (Zorzetto & Orlandi, 2024) concern. According to the Unified Health System (SUS), there has been a 53% increase in demand for mental health services related to gambling addiction. It is estimated that the value of bets in Brazil between 2023 and 2024 was R$ 68 billion, while prizes did not reach R$ 200 million.

This paper proposes a didactic sequence for instructing the Probability and Statistics content incorporated in the BNCC for sixth grade students. The objective of this sequence is to cultivate critical thinking skills pertinent to betting. The proposal is rooted in the principles of Project-Based Methodology, encompassing activities such as brainstorming, webquest, portfolio, assessment rubrics, and artifact. This pedagogical framework can be seamlessly integrated into a STEAM approach, as will be elucidated in the subsequent exposition of this work. In addition to this introduction, which seeks to contextualize the use of digital technologies and active methodologies in teaching and learning processes, the article presents methodological foundations, a didactic proposal, a discussion of the didactic sequence, and final considerations.

METHODOLOGICAL FOUNDATIONS

BNCC CONTENTS

The proposed pedagogical approach aims to situate the instruction of probabilistic calculation, numerical representation (decimal and percentage forms), and statistical distribution of events within a broader context. To this end, as will be presented in Section 2.2—Project-Based Learning (PBL)—guiding questions were used, employing the concept of games of chance as a theme to spark students' interest. When considering the BNCC as the foundation for pedagogical planning, it becomes evident that there is a necessity to cultivate specific competencies in each content area to promote the competencies intrinsic to those skills. As Zabala and Arnau (2020) articulate, "teaching competencies represents a return to the true meaning of knowledge, since it resumes, based on its functionality, the object of study of historically accumulated knowledge" (p. 9). The present teaching proposal is intended to concentrate on the skills delineated in Table 1, which pertains to mathematics and Portuguese language content, with the respective competencies recommended by the BNCC presented in Table 2.

Table 1

Skills to be employed in the didactic proposal with Probability and Statistics concepts.

Discipline	Skills
Portuguese Language	EF69LP35
Mathematics	EF05MA22
	EF05MA23
	EF06MA07 up EF06MA10
	EF06MA30
	EF06MA31 and EF06MA33

Source: The Authors (2025).

To illustrate the relationship between skills and competencies, skill EF69LP35 determines:

> The development of scientific dissemination texts is predicated on the formulation of an outline that considers previous research, notes, and summaries of readings or records of experiments or field studies. The subsequent production, review, and editing of texts aimed at disseminating knowledge and research data and results is essential. This may include scientific dissemination articles, opinion articles, scientific reports, encyclopedia entries, collaborative digital encyclopedia entries, infographics, reports, scientific experiment reports, and multimedia field reports. It is imperative to take into account their production contexts, which may involve making information and knowledge available in a more accessible format for a specific audience or disseminating knowledge derived from bibliographic research, scientific experiments, and field studies conducted (BRAZIL, MEC/CONSED/UNDINE, 2017, p. 153).

Consequently, the aforementioned skill is procedurally related to the second competency presented in Table 2.

It is imperative to acknowledge that these competencies encompass both a foundation of mathematics and Portuguese language proficiency, underscoring the multidisciplinary essence of the proposal. Furthermore, the overarching theme of the proposal, which pertains to games of chance, should be adopted as a project aimed at raising awareness of the potential harm that this type of activity can pose to the construction of a just society. This project should emphasize the ease with which results can be influenced, thereby underscoring the importance of objective and transparent processes in ensuring fair outcomes. In this context, we can highlight some attitudinal competencies in the area of Humanities:

> Build arguments, based on knowledge of Human Sciences, to negotiate and defend ideas and opinions that respect and promote human rights and socio-environmental awareness, exercising responsibility and protagonism aimed at the common good and the construction of a just, democratic, and inclusive society. (ibid., 2017, p. 357).

Table 2

Competencies to be developed based on the skills.

Discipline	Competencies
Portuguese Language	1. Select texts and books for integral reading, according to objectives, interests, and personal projects (study, personal development, entertainment, research, work, etc.). 2. Mobilize digital culture practices, different languages, media, and digital tools to expand the ways of producing meanings (in comprehension and production processes), learn and reflect on the world, and carry out different authorial projects.
Matemathics	1. Utilize mathematical processes and tools, including available digital technologies, to model and solve everyday, social, and other areas of knowledge problems, validating strategies and results. 2. Face problem-situations in multiple contexts, including imagined situations, not directly related to the practical-utilitarian aspect, express their answers and synthesize conclusions, using different registers and languages (graphs, tables, schemes, in addition to written text in the mother tongue and other languages to describe algorithms, such as flowcharts, and data). 3. Interact with peers cooperatively, working collectively in the planning and development of research to answer questions and in the search for solutions to problems, in order to identify consensual or non-consensual aspects in the discussion of a certain issue, respecting the way of thinking of colleagues and learning from them. 4. Develop logical reasoning, the spirit of inquiry, and the capacity to produce convincing arguments, resorting to mathematical knowledge to understand and act in the world.

Source: The Authors (2025).

PROJECT BASED LEARNING (PBL)

The proposed pedagogical approach is rooted in the principles of project-based methodology (for Education, 2008). The following elements are of particular note: the utilization of a guiding question, the implementation of assessment and self-assessment rubrics, the creation of a portfolio, the execution of webquest research, the generation of ideas through brainstorming, the creation of artifacts, and, most significantly, a problem-solving approach that is centered on authentic, real-world issues or problems. The following section delineates the components that comprise the PBL activity.

Guiding Question

In ABP, the guiding question fulfills dual functions: it draws students' attention and engages them, while also serving as a focal point for the learning

objectives that should direct the approach to the problem. The fundamental inquiry guiding this proposal was formulated with three key considerations in mind: first, the question of whether casino games and analogous pastimes are rightly regarded as games of chance; secondly, the feasibility of attaining more wins than losses in a game of chance; and thirdly, the conceptual frameworks that ought to be considered during the design process of a game of chance.

In light of the aforementioned inquiries, the instructor may elect to commence the activity by introducing the subject matter through "anchor" material, such as newspaper articles, periodicals, or social media content that caution against the pitfalls of gambling addiction and the manner in which these issues are perpetuated to perpetuate the behavior without the anticipated financial rewards.

Rubrics

PBL projects should be assessed in a variety of ways, resulting in individual and collective grades. Most importantly, the assessment should occur throughout the entire process. In the context of PBL, rubrics—whether they are holistic or analytical in nature—emerge as the assessment practice that is most frequently emphasized in the extant literature (Education, 2008). In addition to functioning as an evaluation instrument for educators, their implementation can facilitate the design of task structures. For the present teaching proposal, we suggest analytical rubrics that are available online at https://pierreaoquadrado.github.io.

Teaching Strategies in PBL

The project-based methodology is characterized by the implementation of specific teaching tools and strategies that are designed to facilitate learning. Given that these are activities that employ digital technologies (blogs, wikis, webquests, games, simulators, Moodle, etc.) or that guide student action (portfolios, brainstorming, schedule planning, SQA planning [Ogle, 1986], etc.), we will treat the actions related to these activities as approaches that guide pedagogical action. In this regard, the implementation of webquests, portfolios, and brainstorming sessions fosters an environment conducive to student-centered learning.

Brainstorming is a frequently employed strategy in PBL. PBL activities prioritize teamwork in the pursuit of knowledge, guided by guiding questions. Its employment in the ideation process is facilitated by debate, hypothesis, and idea generation, and it is founded on the following principles: (i) emphasis on quantity, i.e., the greater the number of ideas, the more favorable; (ii) promotion of unconventional ideas; (iii) abstinence from negative criticism of ideas; and (iv) implementation of ideas (Bolsonello et al., 2023). The act of debating and discussing ideas and concepts during the development of a project or the resolution of a problem has been demonstrated to enhance divergent creative ability, as well as to improve students' self-esteem, self-assessment, and cooperative skills (Paulus & Kenworthy, 2019). These competencies are considered fundamental in the context of contemporary education. The efficacy

of brainstorming in the PBL methodology has been demonstrated by its ability to enhance critical and creative thinking skills (Praminingsih et al., 2023).

A webquest is an educational tool designed to guide research in virtual sources in a structured (guided) manner. The approach was developed in 1995 by Professor Bernie Dodge (Dodge, 1995) of the University of San Diego, in collaboration with Tom March. It organizes curriculum content to minimize student distraction during Internet searches. It fosters knowledge construction within a guided learning environment, leveraging online content for educational purposes and promoting student self-reflection, thereby facilitating the development of their own understanding. As Zheng et al. (2008) have noted, webquests can be utilized in a variety of ways, including as (a) spreadsheets, (b) problem-solving tools, and (c) sources of URLs. When employed as a problem-solving instrument, webquests enhance the capacity to synthesize, analyze, and evaluate information, as corroborated by the studies of Zhang et al. (2022). Therefore, it is imperative that readers understand that the utilization of this resource, as delineated in subsection "4.2 Dynamic 01," involves the implementation of webquests as a tool for problem-solving, thereby guiding students in a directed study within the context of the proposed problem.

The portfolio is intended to function as a medium for articulating knowledge during the execution of the project. Through this process, students compile a range of materials, including reflections, notes, summaries, reports, and diagrams that represent the learning process. These materials are intended to provide a clear demonstration of the learning process in construction and to enable teachers to effectively monitor student progress. The portfolio enables the educator to discern both the strengths and weaknesses exhibited throughout the project, as opposed to evaluating solely the final product (Boas, 2005). The utilization of portfolios in PBL is strongly endorsed not solely as a formative instrument, but chiefly for their aptitude to enhance critical thinking and the cultivation of competencies pertaining to textual analysis, synthesis, written expression, creativity, and autonomous knowledge seeking (Gomes et al., 2010).

In this teaching proposal, an analytical rubric is proposed as a means to assess the completeness of the development of these activities. The utilization of the "Webquest" and "Portfolio" rubrics, which are available at https://pierreaoquadrado.github.io.

Artifacts in PBL

In the process of planning a PBL activity, it is essential to deliberate on the guiding question, learning objectives, activities to be developed, educational standards to be addressed, and forms of assessment (summative and formative). The latter are distinguished by the culmination of the activity with the delivery of an artifact. The artifact is expected to serve as a physical embodiment of the knowledge acquired concerning the concepts explored within the guiding inquiry. In light of the contemporary nature of education, the artifacts produced in PBL activities extend beyond the use of Digital Information and Communication Technologies (DICT). Consequently, the production of podcasts, wikis, software, magazine articles, web pages, video creation, PowerPoint presentations, 3D prototypes, and other such artifacts, is readily observable.

In this context, the present teaching proposal takes the form of a project activity that seeks to develop in students in the final stage of elementary school, in addition to the skills and competencies recommended by the BNCC, the ability to prototype using 3D printers. Consequently, each PBL activity entails the formulation of an original design, which is to be incorporated into its progression. Students receive instruction in the utilization of the tools available on the Tinkercade online platform, thereby enabling them to construct three-dimensional designs independently and authentically. The integration of students in the process of acquiring knowledge regarding the principles of three-dimensional printing, encompassing the stages of project conception and the fabrication of prototypes, has been demonstrated to facilitate the development of interdisciplinary competencies. This integration demands the synthesis of concepts from the domain of engineering and technology with those from other academic disciplines (Martinez & Stager, 2013) in the pursuit of solutions to authentic challenges. In this sense, the didactic proposal is characterized within the framework of STEAM education (Bacich & Holanda, 2020) since it facilitates the integration of technology with mathematics within a curricular activity.

Despite the substantial growth in the use of 3D printers in education, the methods in which they are employed remain predominantly limited. In a recent study, Chen and Cheng (2021) presented an investigation into the characteristics of lessons based on 3D models developed by elementary and high school teachers. The author posits that the utilization of 3D printers as a medium for model fabrication can be categorized into the following four distinct classifications: i) the fabrication of 3D models for explanatory purposes; ii) the production of 3D models as precise replicas; iii) the fabrication of 3D models as product prototypes or artistic creations; and iv) the employment of 3D printers as an educational tool to engage students. Consequently, the utilization of 3D printers has been predominantly confined to educational settings, with minimal application in self-directed student learning. This observation underscores the intricate and multifaceted nature of the design process, which facilitates students' cognitive construction of concepts through the process of inventively creating their own prototypes.

In this proposal, educators are instructed to utilize two 3D-printed components to engage students and stimulate their curiosity. The initial piece pertains to Galton's Board, which is employed to elucidate the statistical distribution of the game The Wall, as presented by Luciano Huck on Brazilian television. The second piece, also related to the Galton Board, features some modifications that were designed to alter the statistical distribution of events. Both will be utilized as an anchor for launching the creative challenge to students (the .stl files for 3D printing are available at https://pierreaoquadrado.github.io). To illustrate this point, consider the modified Galton board. Students should be tasked with creating or recreating a game, such as one of the typical casino games, in which the probability of a game event occurring is considerably reduced or altered. In Section 5.4, we present a proposal for the design of a loaded die.

OBJECTIVE OF THE ACTIVITY

The overarching objective of this educational endeavor is to facilitate the comprehension and practical application of the foundational principles of Probability Theory. It is anticipated that upon the culmination of this activity, students will have developed the following competencies:

1. It is imperative to comprehend the notion of sample space.
2. It is imperative to comprehend the fundamental concept of probability in relation to random events.
3. The objective is to identify reduced forms of fractions.
4. The utilization of fractions and percentages in the expression of probability is paramount in this context.
5. The collection and expression of probabilistic data from random events is to be accomplished through the utilization of bar graphs and analogous graphs.
6. It is imperative to possess an intuitive understanding of the concept of probability distribution.

DIDACTIC SEQUENCE – PROPOSED ACTIVITY

The activities in the teaching sequence were developed based on the concepts of problem-based learning (PBL) and the STEAM approach. The implementation of these lessons is contingent upon the unique characteristics of each classroom, thereby enabling educators to adapt the curriculum to a specific number of lessons or select the concepts to be addressed in each activity. The subsequent section delineates the guidelines for the application of the sequence.

PROBLEM PRESENTATION

The primary objective of the activity is to ascertain the probabilities in favor of players in games of chance and lotteries. This enables them to make decisions based on scientific knowledge and thus choose the most advantageous option. The analysis is conducted through the use of a fictional scenario, which can be adapted according to the instructor's requirements. While the problem situation is fictional, it is designed to provoke learning about real-world scenarios and is employed as a means to contextualize the guiding questions (see Section 2.2.1). As Hung (2016) has noted, the presentation of the problem constitutes a fundamental element of PBL, as it is through this presentation that engagement in learning should occur (Halm, 2015). According to Hung (2016), there are four factors that have been identified as contributing to student engagement and motivation in problem-solving and study. These factors include the presence of real-life problems that remain unresolved, temporal proximity to the problem, geographical proximity to the problem, and the integration of the subject matter into everyday life. The problem presented herein aligns with the final factor

delineated by Hung, suggesting that it may prompt learning processes concerning games of chance (i.e., real-world problems).

Context: The Science Club at your school, which has recently been established, is in need of a new microscope to facilitate the study of insect characteristics. During the aforementioned meeting between club members and the school administration, the parties were informed that, regrettably, there are no financial resources available to purchase the equipment. The news provoked feelings of discontent, prompting a meeting at the Club to deliberate on a potential alternative acquisition method for the microscope. Following a deliberative process, two proposals were presented for evaluation.

Proposal 01: Raffle tickets will be sold with a prize of 5% of the total value of the raffle to the winner. The contention that the sale of each raffle ticket ensures a guaranteed prize is predicated on the premise that there is a high probability of the purchaser obtaining a winning number. Consequently, upon the completion of the sale of the ticket, the Club would retain 95% of the amount collected from the sale.

Proposal 02: It is recommended that a well-known "kitty" among club members be established and utilized for the purpose of an online roulette game. It has been posited that, despite the probability of success always being less than 50%, the potential reward is equivalent to 300% of the initial wager.

DYNAMIC 01

In the initial activity, students will be introduced to fundamental concepts of probability theory through experimental investigation of the possible outcomes of games of chance, such as casino games.

The probability of rolling a two on a six-sided die should be determined by the class. In the event that students are unable to identify this probability as 1 in 6, instructors should pose the following question: "How many different possibilities exist for the die to land with the 6 side up?" The inquiry can be reformulated by posing the following question: How many sides of the die can result in a 2 (one side)? Given that there is one hypothesis (side) among six possible options (sides), the probability of the die landing with the 2 side up is 1 in 6.

Distribute the "Dice Game Statistics" sheet (available at https://pierreaoquadrado.github.io) and explain that the class will determine the probability of each side of the die coming up through experimentation. Instruct students to roll the die 24 times in groups and record the result of each roll as a fraction with a denominator of 6 (EF05MA22, EF05MA23, EF06MA07, EF06MA08, and EF06MA09). Depending on the dynamics of the classroom, the teacher may ask for more throws to be made. However, it is important that the total number of rolls is always a multiple of six. Compare the experimental (actual) results with the theoretical (statistically expected) results. Some students or groups may notice that they did not get a specific result for each set of six throws. Guide students to research this finding, asking them to include the results of their research and the answer in the "Project Notebook (Portfolio)."

Record the total number of each face on the blackboard, aggregating the data from all groups. These results should be much closer to 1/6 for all six sides of the die than the results of a single group. At this point, the teacher can create a bar chart representing the results of all groups. Guide the students in constructing the chart to represent each group's results (EF06MA31).

This activity focuses on how results are represented, specifically how numbers are represented as fractions. In this context, the teacher can introduce the concept of percentages by guiding students in representing their results as such.

To reinforce knowledge, the teacher can establish study criteria and guide students using a webquest (see the "Webquest Activity" document available at https://pierreaoquadrado.github.io). The teacher should design the activity to encompass the concepts of probability and statistics, as well as their applications in daily life. Research records should be noted in the portfolio. Teachers can use the following objectives to support student research via webquest:

i. Define concepts related to probabilistic events, such as sample space, event, and randomness.

ii. Understand mathematical ways of expressing probability through fractions or percentages.

iii. Understand the importance of collecting statistical data and how it relates to probabilistic events.

iv. Interpret statistical data presented in bar and pie charts.

v. Apply the above concepts to a census study in the school community.

vi. Perform probability calculations for different types of games, such as roulette, cards, and slot machines.

DYNAMIC 02

The objective of this activity is to reconsider ordinary events that may go unnoticed and consider the actual mathematical probability of success or failure. Students will explore the concept of normal distribution and learn that events are not always evenly distributed, as in the case of dice. We will use an honest Galton board and a modified one, the latter of which is built to skew the distribution.

The first part of the activity should be reserved for reflecting on previous research on probability and statistics. Encourage students to share what they easily understood and what caused misunderstandings. These points can be used as guiding questions for new learning! Then, encourage students to cite examples of random events they encountered during their research that can be found in everyday life.

Next, introduce students to the honest Galton Board that accompanies this teaching proposal, describing it as a mini version of The Wall, a game that gained notoriety in Brazil through prizes awarded on Luciano Huck's TV show[1]. Based on the video, the following questions can be asked for discussion: i) Are the chances of the ball falling into each box equal? ii) Why do high prize values have very low

adjacent prize values? iii) Why is the equal prize value centered in the game? iv) If we played a large number of green and red balls (balls that subtract from the prize value), would the player win or lose? v) Is it possible to change the participants' chances of winning?

Using the Galton board, demonstrate the distribution of events by throwing a large number of balls and introducing students to the concept of the normal probability distribution, which is represented by the Gaussian curve. Highlight the central and peripheral points on the board where the minimum and maximum probabilities occur. Transpose the elements presented on the board to the Wall game.

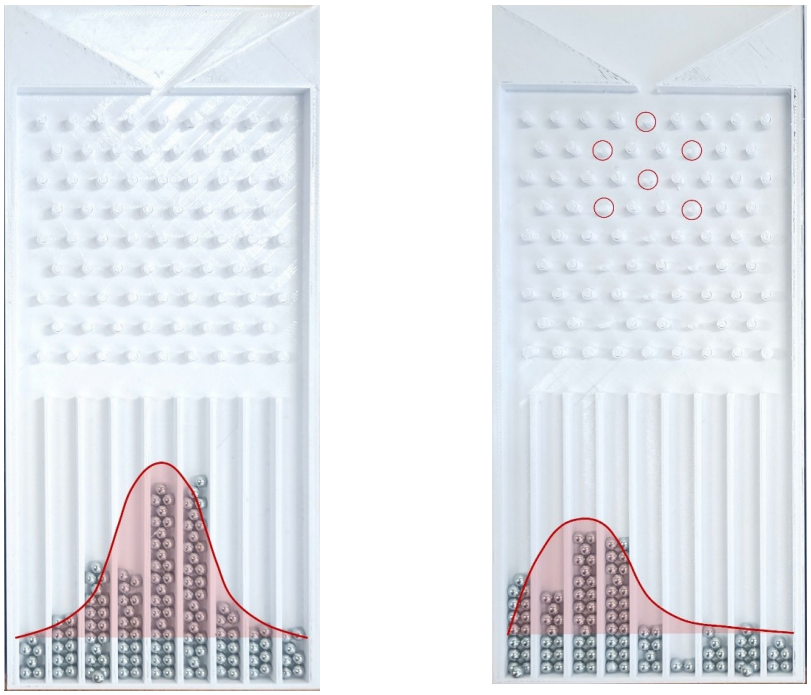
After discussing the honest Galton board, use the altered Galton board to demonstrate how easy it is to manipulate the odds of winning or losing. Present this version of the board to the students and highlight that some pins have a slightly beveled shape, as shown by the red circles in Figure 1(b). These pins are different from the perfectly cylindrical pins on the honest board. Emphasize that this nearly imperceptible modification to the pins' shape is enough to skew the distribution of results, altering their normal character and completely changing the game's outcome. Figures 1(a) and 1(b) show photos of the honest and hacked Galton boards, respectively, and illustrate the distribution of events.

Conclude the class with a new reflection on the ease with which games can be manipulated without public perception. Even in the absence of any form of manipulation, the odds in a game of chance are invariably disadvantageous for the players (EF06MA30, EF06MA31, EF06MA33, and EF06MA10). It is imperative to emphasize to students that electronic betting platforms are characterized by a conspicuous absence of transparency regarding the algorithms employed in each game of chance. This deficiency enables the potential for manipulation in a manner that is significantly more sophisticated, thereby engendering a misleading perception of fairness among players.

Figure 1

Honest and Hacked Galton Boards. In (a) the normal distribution of probabilities of the board without any modification, and in (b) the distribution of the board containing some modifications (bevels) on the pins.

(a) *(b)*



Source: The Authors (2025).

DYNAMIC 03

In this dynamic, students assume a central role when they are tasked with reproducing a game of chance in which the odds of winning have been modified, based on the following script suggestion:

i. Design a casino game that is manipulated to present statistical results different from typical casino games, such as dice, roulette, plinko boards (ball game), and slot machines.

ii. A discussion of methods for concealing the manipulations is warranted.

The objective is to guide students in groups to brainstorm how a dice game can be altered so that its faces do not have the same probability, one in six times. In a similar vein, students are to be queried on the feasibility of slightly modifying various games, such as a roulette wheel, a plinko board, a coin in a heads/tails game, or a slot machine, in order to alter the results so that they do not align with the expected outcomes of typically balanced games (EF69LP35). In this preliminary stage of conceptualization, the educator's function as a facilitator is paramount, as emphasized by Dogan and Batdi (2021). Teachers should assume a pivotal role in the design and facilitation of brainstorming sessions, overseeing

group interactions in the collaborative pursuit of solutions to intricate problems, and in the interpretation and complementation of the ideas generated (Isaksen & Gaulin, 2005).

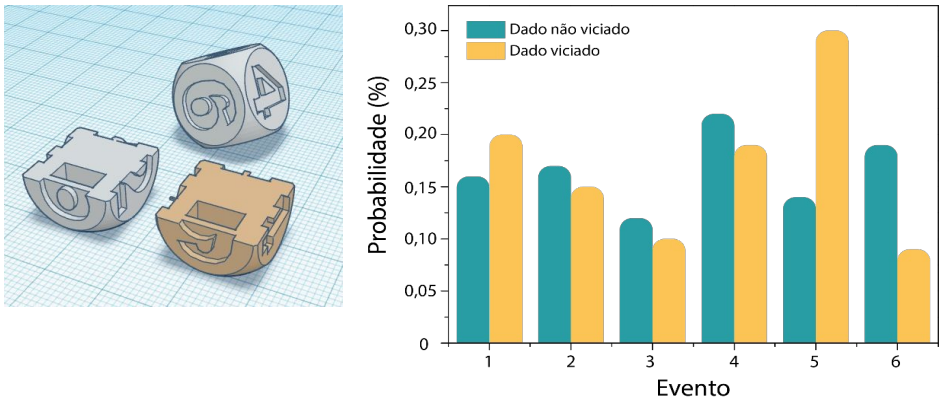
After the group discussion, students should design the prototype using the Tinkercad platform. At this point, it is assumed that the teacher has already guided students in using the platform and, therefore, students are familiar with the platform's tools. As already explained, the dynamics of this teaching sequence can be easily altered according to the reality of each classroom. Thus, the prototyping part can eventually be done outside of school.

As an example of a prototype, we made a six-sided die with one of the sides loaded, as shown in Figure 4(a) (the stl file “Loaded Die” can be found at https://pierreaoquadrado.github.io). Figure 2(b) shows the distribution of events (in 100 throws) for normal dice, where all sides have the same probability of coming up, and loaded dice, where one side has a higher probability of coming up than the others. The biased die was designed by inserting two steel balls into an internal hole adjacent to the number 6 face, as shown in Figure 2(a).

Figure 2

(a) Prototype model made in Tinkercad for 3D printing of the rigged die, and (b) the respective result of 100 throws of the dice.

(a) *(b)*



Source: The Authors (2025).

DYNAMIC 04

The subsequent two activities are contingent upon the unique characteristics of each classroom. Given the impracticality of students developing their own game prototypes, educators may, as posited by Chen and Cheng (2021), devise some prototypes themselves, such as the loaded dice presented in the preceding section and analogous ones. These prototypes can then be printed and presented to students, facilitating the execution of the ensuing activities.

The teacher's role encompasses the development of game prototypes by students, the organization of a printing schedule, and the subsequent guidance of groups in the distribution of probabilities for a designated event in the game. This

event is to be distributed considering both the altered and unaltered forms of the game. In the context of multiple events, educators can facilitate knowledge retention by encouraging students to present data in graphical form. Each group is tasked with examining—or, in other words, creating a probability distribution for—an event in the game. This examination involves two other projects from different groups, in addition to the group's own project.

The activities of this dynamic should also be recorded in the portfolio of each student/group, since the portfolio should function as a mirror of the learning process while serving as a basis for formative assessment (Ferreira, 2003). It is imperative that students possess the capacity to engage in self-assessment of their projects, meticulously identifying both the favorable and unfavorable elements that transpired during the course of their project development. Moreover, the presentation of products or projects developed in PBL to the community should be encouraged. In this capacity, educators can facilitate the exhibition of modified games at an "Unfair Fair." The salient issue concerning this endeavor is the education of the public regarding the ease with which games of chance can be modified. Moreover, it is imperative to underscore the minimal probability of winning such games, even in the absence of alterations. The objective of the activity should be to generate information, while concurrently precluding any possibility of encouraging gambling.

DYNAMIC 05

Following the completion of statistical distributions for various projects by the groups, they are to be invited to present the project they developed, along with the probability distribution results. The reasons, ideas, and motivation involved in developing the project are to be explained. Inquiries should be made regarding the primary challenges encountered during the development process. Additionally, other groups should be requested to offer their perceptions of the project during its utilization. It is recommended that inquiries be made regarding the functionality and effectiveness of the game. What measures could the group implement to enhance the modifications to the game?

Following a thorough evaluation of the project's merits and drawbacks, students are tasked with creating an illustrative title that encapsulates the modified game. Examples of suitable titles might include "Unfair Roulette" or "Complicated Dice." Students may employ software such as Canva or other relevant applications to facilitate the development of the illustration.

DISCUSSION OF THE DIDACTIC SEQUENCE

The didactic sequence presented dialogues directly with the theoretical assumptions of Project-Based Learning (PBL), as it unequivocally seeks to mobilize contextualized problems that border on the reality of today's society, triggering engaged research among students. The guiding question presented, understanding and analyzing probabilities in games of chance for decision-making, fulfills the unique function of the project highlighted by Thomas (2000),

in which it directs students' cognitive efforts, favoring the connection between theory and practice.

The implementation of brainstorming during specific phases of the sequence is intended to enhance the collaborative aspect of PBL. As Dogan and Batdi (2021) have noted, brainstorming has been demonstrated to encourage students to actively participate in proposing solutions, expanding divergent thinking, creativity, and collective engagement. The teacher, in their capacity as the mediator, organizes the progression of ideas, interprets the various contributions, and enhances the construction of shared meanings (Isaken & Gaulin, 2005). Webquests have been identified as a pedagogical resource that promotes guided research and the development of student autonomy in the process of acquiring and interpreting data. According to Dodge (1995), webquests promote critical learning through guided investigation, aiding students in the selection of critical and relevant information for the problem under study. Consequently, the implementation of webquests in this sequence serves a dual purpose, as it facilitates the exploration of probability and statistics concepts in conjunction with the development of digital literacy and research skills. These competencies are highly regarded in PBL proposals (Bell, 2010).

Given the evaluative nature of the proposal, the use of portfolios as a tool for monitoring learning and assessment is consistent with the assumptions of PBL. Portfolios facilitate the monitoring of students' progress, encompassing the documentation of advances, misunderstandings, and relevant reflections (Ferreira, 2003). Another essential element of this proposal is the fabrication of concrete artifacts. In this study, we present the prototype of the loaded die, which is expected to serve as the foundation for the development of manipulated games. As demonstrated in the extant literature, the materialization of knowledge into final products constitutes a distinctive feature of PBL (Krajcik & Blumenfeld, 2006) and represents a genuinely concrete form of the learning process. In this regard, PBL emerges as a methodology that is firmly grounded in the theoretical underpinnings of constructionism, as initially proposed by Papert (Papert & Harel, 1991). Constructionist theory establishes a correlation between the processes of learning and the execution of tasks, with the objective of materializing the knowledge that has been mobilized. In this work, we propose the socialization of results through the "Unfair Fair," which enhances the social and communicative dimension of learning (Larmer, Mergendoller & Boss, 2015).

It can thus be posited that the teaching sequence is not confined to the imparting of abstract mathematical concepts of probability, disassociated from the social being that is the student. Conversely, it fosters an investigative and participatory process, wherein students assume the roles of researchers, designers, and communicators, situating the learner at the core of the process. This pedagogical approach has been demonstrated to enhance motivation, foster interdisciplinary collaboration, and align school curriculum with real-world problems. These aspects have been identified in the extant literature as pivotal to the efficacy of Project-Based Learning (see Bell, 2010; Markham, 2011).

FINAL CONSIDERATIONS

The development of this teaching sequence was informed by a comprehensive consideration of the essential elements that define a PBL activity, with the objective of underscoring the pivotal role of learning in the student(s) and fostering their engagement with substantial problems. In contrast to conventional and technical teaching methods, this approach emphasizes a formative assessment of learning throughout the process. As Perrenoud (1999) points out, "formative assessment is defined as any continuous assessment practice that aims to contribute to improving ongoing learning, regardless of the context and the specific extent of teaching differentiation" (ibid., p. 3). Consequently, the webquest, brainstorming, and portfolio components may constitute authentic manifestations of the formative process, wherein the educator observes and enhances student learning. Summative assessments that incorporate content related to the skills mentioned in the stages of the teaching sequence can contribute to the final assessment process. It is recommended that the formative part should outweigh the summative part.

In addition to the competencies delineated in the BNCC, this pedagogical proposal endeavors to incorporate students into the utilization of contemporary technologies in the learning process, particularly the implementation of prototyping and 3D printing. Approximately five decades ago, Seymour Papert (1928-2016) coined the term "constructionism" (Papert & Harel, 1991) to denote an educational approach emphasizing the construction of potentially meaningful objects. From this perspective, the present proposal contributes to the learning processes of various mathematics contents, indirectly or unconsciously, through the adoption of prototyping of objects to be printed in three dimensions. It is widely acknowledged that the process of prototyping parts involves numerous mathematical concepts, including the rotation and translation of components, the location of geometric centers, the positioning of parts in three-dimensional spaces, and the determination of relative distances. These processes, among others, contribute to the development of mathematical thinking in students, even if they are not explicitly aware of this occurrence, as previously noted by Papert:

> In this book, I discuss ways in which the presence of the computer can contribute to mental processes, not just instrumentally, but in more essential and conceptual ways, influencing how people think, even when they are far from any physical contact with a computer (just as gears shaped my understanding of algebra, even though they were not physically present in the math class). (Papert, 1980, p. 4)

It is our hope that the proposal will contribute to the cultivation of a critical sensibility among students, equipping them with the capacity to counteract, or at the very least mitigate, issues pertaining to compulsive gambling. This objective is underscored by the observable proliferation of betting activities within the nation.

NOTES

1. As an anchor for this dynamic, teachers can use the following video for contextualization: The Wall – 27/06: Parede quebra e a bola cai para fora – Caldeirão do Huck.

REFERENCES

Aimulla, M. A. (2020). The effectiveness of the project-based learning (PBL) approach as a way to engage students in learning. *Sage Open*, *10*(3), 2158244020938702.

Bacich, L., & Holanda, L. (2020). STEAM: integrando as áreas para desenvolver competências: A aprendizagem baseada em projetos integrando conhecimentos na educação básica. *STEAM em sala de aula*, 1–12.

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future.*The clearing house*,*83*(2), 39-43.

Bender, W. N. (2015). *Aprendizagem baseada em projetos: educação diferenciada para o século XXI*. Penso editora.

Boas, B. M. D. F. V. (2005). *Portfólio, avaliação e trabalho pedagógico*. Papirus Editora.

Bolsonello, J., da Silva, M. T. B., de Barros Lara, A. M., & da Silva Macuch, R. (2023). Uso de brainstorming como ferramenta para aprendizagem. *Conhecimento & Diversidade, 15(36)*.

Branco, E. P., & Zanatta, S. C. (2021). BNCC e Reforma do Ensino Médio: implicações no ensino de Ciências e na formação do professor. *Revista Insignare Scientia, 4(3)*, 58–77. https://doi.org/10.36661/2595-4520.2021v4i3.12114

BRASIL, MEC/CONSED/UNDIME. (2017). *Base Nacional Comum Curricular: Educação é a Base*. Brasília, DF. Recuperado julho 11, 2023, de http://basenacionalcomum.mec.gov.br/abase/

Chen, J., & Cheng, L. (2021). The influence of 3D printing on the education of primary and secondary school students. *Journal of Physics: Conference Series, 1976(1)*, 012072.

de Fátima Cóssio,M. (2014). Base comum nacional: uma discussão para além do currículo. *Revista e-Curriculum,12(3)*.

Dodge, B. (1995). Webquest: uma técnica para aprendizagem na rede internet. *The Distance Educator, 1(2)*, 1–4.

Dogan, Y., & Batdi, V. (2021). Revisiting brainstorming within an educational context: A meta-thematic analysis. *Journal of Learning for Development, 8(3)*, 541-556.

dos Santos, M. L., & da Silva, M. M. (2017). Filantropia e o silencioso processo de privatização da educação básica. Em V. M. V. Peroni & P. V. Lima (Ed.), *Anais do 1o Seminário Nacional Redefinições das fronteiras entre o público e o privado: Implicações para a democratização da educação*.

Ferreira, N. S. C. (2003). *Avaliação e portfólio: uma prática em construção*. Cortez.

for Education, B. I. (2008). *Aprendizagem baseada em projetos: guia para professores de ensino fundamental e médio*. Artmed.

Gomes, A. P., Arcuri, M. B., Cristel, E. C., Ribeiro, R. M., Souza, L. M., & Siqueira-Batista, R. (2010). Avaliação no ensino médico: o papel do portfólio nos currículos baseados em metodologias ativas. *Revista Brasileira de Educação Médica*, 34, 390–396. https://doi.org/doi.org/10.1590/S0100-55022010000300008

Halm, D. S. (2015). The impact of engagement on student learning. *International Journal of Education and Social Science*, *2*(2), 22-33.

Hung, W. (2016). All PBL starts here: The problem. *Interdisciplinary Journal of problem-based learning*, *10*(2), 2.

Isaksen, S. G., & Gaulin, J. P. (2005). A reexamination of brainstorming research: Implications for research and practice. *Gifted Child Quarterly*, *49*(4), 315-329.

Krajcik, J., & Blumenfeld, P. (2006). 19. Project-Based Learning. *The Cambridge handbook of the learning sciences*, 317-333.

Kolodner, J. L., Camp, P. J., Crismond, D., Fasse, B., Gray, J., Holbrook, J. & Ryan, M. (2003). Problem-based learning meets case-based reasoning in the middle-school science classroom: Putting learning by design (tm) into practice. *The journal of the learning sciences*, *12*(4), 495-547.

Larmer, J., Mergendoller, J., & Boss, S. (2015). *Setting the standard for project based learning*. Ascd.

Limaverde, P. (2015). Base nacional comum: desconstrução de discursos hegemônicos sobre currículo mínimo. *Terceiro Incluído, 5(1)*.

Markham, T. (2011). Project based learning: A bridge just far enough. *Teacher Librarian, 39*(2), 38–42.

Martinez, S. L., & Stager, G. (2013). Invent to learn. Making, Tinkering, and Engineering in the Classroom. *Construting Modern Knowledge*.

Ogle, D. M. (1986). K-W-L: A teaching model that develops active reading of expository text. *The Reading Teacher, 39(6)*, 564–570. Recuperado junho 16, 2024, de https://www.jstor.org/stable/20199156

Papert, S. (1980). *Mindstorms: children, computers, and powerful ideas*. Basic Books.

Papert, S., & Harel, I. (1991). *Situating Constructionism*. Ablex Publishing Corporation.

Paulus, P. B., & Kenworthy, J. B. (2019). Effective brainstorming. *The Oxford handbook of group creativity and innovation*, 287–305.

Perrenoud, P. (1999). *Avaliação: da excelência à regulação das aprendizagens entre duas lógicas* (1a edição). Penso.

Praminingsih, I., Miarsyah, M., & Kurniati, T. H. (2023). PBL with the Brainstorming Method: Can It Influence Students' Critical and Creative Thinking Ability?. *Journal of Biological Education Indonesia (Jurnal Pendidikan Biologi Indonesia)*, *9*(3), 346-358.

Prazeres, L. (2024). *"Não tem que ter propaganda" de casas de aposta, diz diretora de saúde mental do governo sobre as "bets"*. Recuperado outubro 29, 2024, de https://www.bbc.com/portuguese/articles/clyzy468l99o

Rigo, M. P. M., Ghisleni, M. M., Ely, L. S., de Freitas, E. M., Bratti, E., Sehnem, E., Adami, F. S., & de Senna, J. A. G. (2016). Portfólio como instrumento de aprendizagem e avaliação. *Revista Eletrônica Debates em Educação Científica e Tecnológica, 6(02)*, 46–57.

Thomas, J. W. (2000). *A review of research on project-based learning*. San Rafael, CA: Autodesk Foundation.

Urbini, L. (2015). *Educação integral e capital financeiro: a participação do Itaú Unibanco nas políticas públicas de educação entre 2002 e 2014* [mestrado]. UFSC.

Zabala, A., & Arnau, L. (2020, maio 13). *Métodos para Ensinar Competências* (1a edição). Penso Editora.

Zhang, M., Hao, Z., Zhou, L., & Liu, X. (2022). Influence of WebQuest Teaching on Learners' Learning Performance under the Learning Technology Paradigm. *Journal of Engineering Science & Technology Review*, *15*(3).

Zheng, R., Stucky, B., McAlack, M., Menchana, M., & Stoddart, S. (2005). WebQuest learning as perceived by higher-education learners. *TechTrends: Linking Research & Practice to Improve Learning*, *49*(4).

Zorzetto, R., & Orlandi, A. P. (2024). *Proliferação das bets aumenta gastos de famílias e risco de problemas com o jogo*. Recuperado outubro 29, 2024, de https://revistapesquisa.fapesp.br/os-efeitos-nocivos-dos-jogos-on-line/

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