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The board game “Probability in Action” for students aged 6 to 10 in Brazil: an evaluation using the MEEGA+ model

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ABSTRACT

OBJECTIVE: This article aimed to evaluate the educational board game "Probability in Action" according to the player's perception of learning and experience, through the considerations of 28 students of the fifth year of elementary school (10 and 11 years old) municipal public school of Barueri, São Paulo, Brazil. METHOD: This research is framed within the quantitative approach and is considered exploratory, descriptive and statistical, using the model called MEEGA+ to evaluate its perception of quality in terms of player experience and learning perception. RESULT: Assuming that the game aims to teach probability to students from 6 to 10 years old, the evaluation results show that it is effective in learning and provides fun to students, as a learning tool. The student evaluation revealed that the board game "Probability in Action" presented more positive results in relation to the following aspects: 1) "Motivation" subcomponent: relevance and importance of the probability content, providing opportunities for feelings of progress and maintaining attention in the teaching and learning process; 2) "User Experience" subcomponent: in addition to supporting the development of players' skills, the game is enjoyable and fun to participate in, worthy of being recommended to friends; 3) "Learning" subcomponent: the pedagogical objectives of the probability teaching activities addressed were achieved, specifically with regard to short-term learning, that is, the overall effect of the game on student learning. There are indications that, the higher the score of an item or subcomponent of the board game evaluation, there is an increase, on average, in the scores of the other items or subcomponents, assuming a positive correlation or evaluation. FINAL CONSIDERATIONS: It is believed that the evaluation process adopted in this study can be replicated or adapted to different educational game models, contexts, or educational levels through specific adaptations, even if they are from different areas of knowledge, such as statistics.

KEYWORDS: Board game. Teaching probability. Primary education. MEEGA+ model.

1 INTRODUCTION

Petri, Wangenheim, and Borgatto (2018) highlight the benefits of using educational games to simulate activities and/or review concepts in a more motivating and engaging way for students. Specifically, non-digital games originate from resources such as physical board games and encourage social interaction.

For Zucarelli and Couto (2013), board games consist of pieces or tokens moved or placed on a pre-marked surface in an orderly manner, or "board," following a set of rules. Furthermore, they can be based on strategy, chance (e.g., rolling dice), or a combination of both, and typically have a goal that the player aims to achieve. Furthermore, there are many styles of board games, ranging from real-life situations to abstract games without an inherent theme, such as checkers, or a specific narrative. They may have rules or describe a universe in great detail.

Board games are characterized by socialization, and according to Santos (2023), a game is social when it encourages students to interact with each other during matches, as well as to obey the rules and limits of their opponents. The affective aspect is found in respecting a partner's turn during the match, as well as in knowing how to win and lose, understanding that this practice is inherent to the game.

For Hsiao (2007), educational games have a high capacity to entertain and amuse students while promoting learning through interactive and dynamic environments. They are capable of sparking interest and motivating students with challenges, curiosity, interaction, and imagination.

Therefore, games in education are considered promising alternatives for improving learning in any age group, as they facilitate better assimilation of content, helping students develop social skills necessary in their workplace. However, for the educational game to achieve its objective, it is of utmost importance that it be evaluated to determine whether it is truly adequate for conveying the desired knowledge, in this case, probabilistic concepts.

In this sense, this article aimed to evaluate the educational board game "Probability in Action" according to the player's perception of learning and experience, through the considerations of 28 fifth-grade elementary school students at a municipal public school in Barueri, São Paulo, Brazil.

2 THEORETICAL FRAMEWORK

A good understanding of probability can help individuals understand the risks and potential benefits of an action and ensure equity in everyday life (Bryant; Nunes, 2012). Considering the importance of probability, many countries include it as part of the school mathematics curriculum, and there was a movement to introduce probability in elementary school (Vásquez; Alsina, 2019; Oliveira Júnior *et al*., 2019b; Cazares; Ruiz, 2021; López; Gómez, 2023).

In Brazil, the National Common Curriculum (BNCC) (Brasil, 2018) indicates that uncertainty and data processing should be studied in the thematic unit Probability and Statistics, proposing the approach to concepts, facts, and procedures present in many problematic situations in everyday life, science, and technology. Regarding the study of probability concepts, the goal in the early years of primary school (ages

6 to 10) is to promote the understanding that not all phenomena are deterministic. The beginning of the work proposal with probability focuses on developing the notion of randomness, so that students understand that there are, for example, determinate events, impossible events, and probable events.

Thus, educational resources such as games, books, videos, spreadsheets, among others, play a fundamental role in the understanding and use of probabilistic concepts. These materials need to be integrated into situations that lead to reflection and systematization, in order to initiate formalization (Brasil, 2018).

Furthermore, for Alves (2015), board games are activities that involve concentration, organization, information exchange among students, prediction, and strategic analysis. For Oliveira Júnior and Datori Barbosa (2023a), the principle of play is part of every child's education, and board games, in addition to contributing to the learning of probability, provide entertainment and fun, playing a facilitating and motivating role so that students can learn in a natural and enjoyable way.

It is noteworthy that the use of board games for educational purposes, according to Oliveira Júnior and Datori Barbosa (2023b), has shown progressive development; however, it is necessary to expand on the research already conducted, such as that identified by Oliveira Júnior *et al.* (2017, 2018, 2019a) and Oliveira Júnior and Datori Barbosa (2020). The results of these studies converge with the conclusions of Grando (2000), who affirmed that games, by allowing the understanding of students' thinking, allow teachers to guide their pedagogical action, and Fonseca (2007), who maintains that games offer many possibilities for teaching practice, as a refreshing element of teaching and as a learning medium that enables the comprehensive development of children. Worldwide, in addition to entertainment, games have been used for various purposes, one of which is educational games, the purpose of which is to mediate learning, the construction of certain types of knowledge, or the development of motor or cognitive skills.

Radino (2008) highlights the importance of playful activity, including the use of games, among others, such as storytelling and games, as it is the primary expression of children's play, playing a vital role in the development of sensory, motor, socio-emotional, and cognitive aspects, in addition to representing the inclusion of children in the culture in which they are embedded.

Furthermore, for Hays (2005), the decision to use educational games is generally based on assumptions about their effectiveness, rather than on more formal and concrete evaluations. He recalls that questionnaires have been used to evaluate games shortly after they are administered to students; however, the measurement instruments are not standardized, that is, they have not undergone validation and reliability analysis and, therefore, generate dubious results.

It is important to have evidence of the benefits of games before using them in the classroom, since, according to Navarro and Van der Hoek (2007), we should have a more precise understanding of the results that the use of this type of resource would allow us to know if the costs and efforts involved in its adoption are worth it.

We further reinforce, taking Savi, Wangenheim and Borgatto (2011), that for games to have the desired educational effect, they need to be developed within

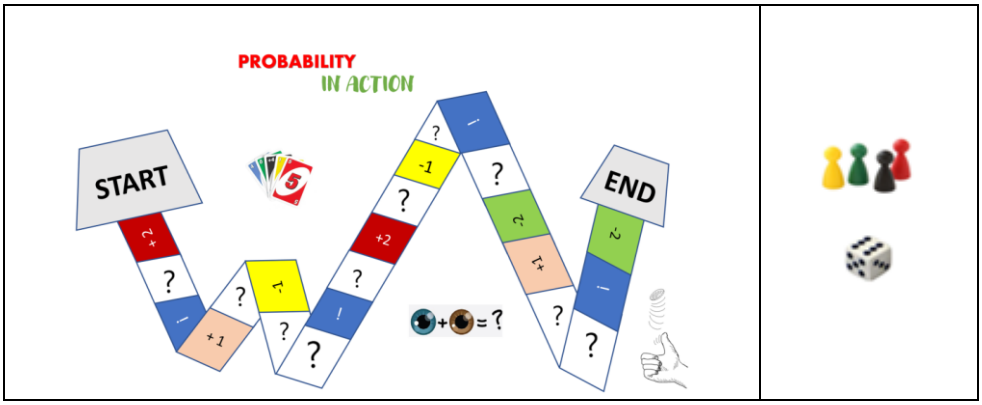
the context of the instructional unit in which they will be used, have clearly defined learning objectives in line with the learning objectives of the instructional unit, and be systematically evaluated.

3 THE EDUCATIONAL BOARD GAME "PROBABILITY IN ACTION"

The educational board game "Probability in Action" aimed to achieve learning objectives related to the notion of basic probability concepts in the early years of primary education (ages 6 to 10) in Brazil.

The game board was developed in PowerPoint to facilitate its reproduction and use in the classroom by teachers. To navigate the board, use colored markers and a common die (Figure 1).

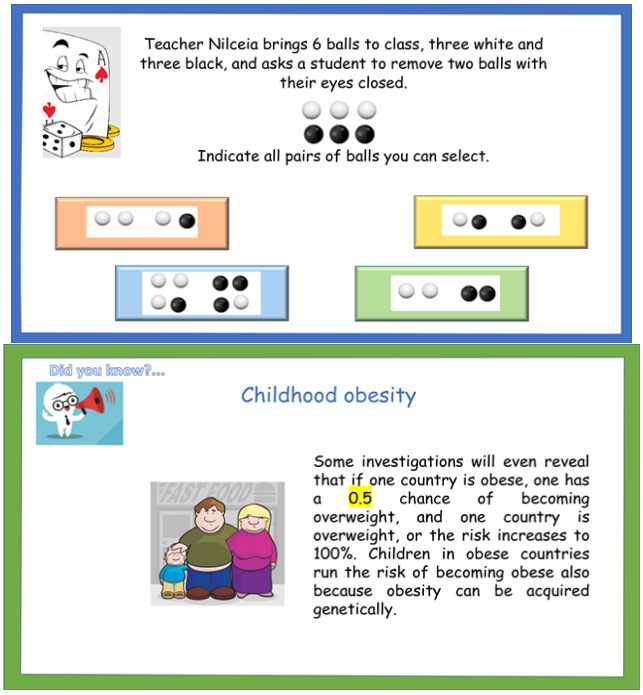
Figure 1 - Images from the board game "Probability in Action""



Source: Prepared by the authors (2024).

Regarding the game cards, there are two types (Figure 2): (1) Questions (?), which refer to the proposed tasks or questions (problem situations) that must be answered in order to move on to the board; (2) Know More (!), which provide interesting facts and/or probabilistic information through verbal language and different types of numerical representations (fractional, decimal, and percentage). A total of 89 "Questions" cards and 24 "Know More" cards were prepared.

Figure 2 - “Questions” and “Learn More” letter templates



Source: Prepared by the authors (2024).

Because players advance on the board only when they correctly answer the problem situation (question) contained on the "Question" card, the game also has an "Answer Card" (Figure 3).

Figure 3 - Representation of a "Response Card"

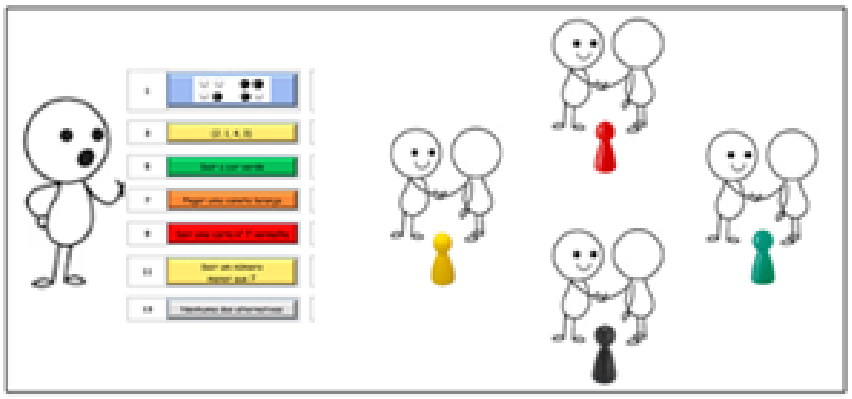
RESPONSE CARD

CARD	RESPONSE	CARD	RESPONSE
1		2	
3	(2, 1 , 4, 3)	4	
5	Select green color.	6	Select a yellow die.
7	Take an orange pen.	8	Catch a ball.
9	Draw a red card with it.	10	Paste an avocado.
11	Be a number less than 7.	12	Draw a white ball and a dark ball.

Source: Prepared by the authors (2024).

Regarding the organization of the game moments, the following will be considered: (1) a judge, in possession of the "answer card" and, therefore, responsible for indicating whether the answer of the companions is correct or not, to advance (or not) on the board the number of spaces obtained in the roll of the dice; (2) pairs of players to represent the pawns on the board, one pair per pawn, in order to encourage reflection and the exchange of ideas on the probabilistic concepts contained in the "Question" cards. The outline of its organization is shown in Figure 4.

Figure 4 - Diagram showing the organization of the game moments



Source: Prepared by the authors (2024).

To better understand the dynamics of the game and to make the students' assessment clear and understandable, its rules are presented (Figure 5), which can be applied to group, pair, or even individual work. In this research, as shown in Figure 4, the games were organized to be played in pairs of students.

Figure 5 - Rules of the educational board game

• The game starts with the roll of the dice where the group that obtains the highest number starts by taking a card from the pile of "Question" (?). By correctly answering the question, the group will be able to move forward on the board the number of spaces indicated in the value obtained when rolling the dice.
• If the group makes a mistake, it will not be able to move the piece from its place and the other group will have the right to answer the question and advance the squares, in case of success.
• If the two groups do not get the question right, the teacher can intervene in the game with questions that help the students in the search for the solution, so that together they realize the "mistakes" committed.
• Whenever the character lands on the "Question" (?) box, a card from that pile must be removed and this process is repeated.
• When the representative character of the group lands on the "Learn More" square (!), someone in the group must read it aloud, so that everyone can hear, and then move one square on the board.
• After moving one space, it will be the other group's turn to play. In case of returning to the same "Learn More" (!), the group should not draw another "Learn More" card, but rather, remain in the house and wait for the next round to continue playing.
• When the representative character of the group lands on the "Advance spaces" (+1), (+2) space, he must advance the corresponding number of spaces, in the same way, if he lands on the "Return spaces" (-1), (-2), it must return to the corresponding number of squares;
• The group that reaches the end of the board first, that is, in the "End" square, wins the game.

Source: Prepared by the authors (2024).

In preparing the tasks indicated in the "Question" cards, it is highlighted that the probabilistic notions were supported by the National Common Curriculum Base - BNCC (Brazil, 2018), bringing all the objects of knowledge and skills to be developed in the early years of primary education. The North American document Guidelines for Assessment and Instruction in Statistics Education - GAISE II (Bargagliotti *et al*., 2020) was also focused on to incorporate the skills necessary to understand the advances related to the teaching of statistics and probability in recent years.

The probabilistic contents according to the BNCC (Brazil, 2018) for the first years of primary education (6 to 10 years) are presented in Table 1 (Description of knowledge objectives and description of skills).

Table 1 - Objects of knowledge and skills of the probabilistic contents proposed in the BNCC of primary education (6 to 10 years)

Year of Study	Objects of Knowledge	Skills
1st Year	Notion of Chance.	(EF01MA20) Classify events involving chance, such as "will surely occur," "could occur," and "impossible," in everyday situations.
2nd Year	Analysis of the idea of randomness in everyday situations.	(EF02MA21) Classify outcomes of random everyday events as "unlikely," "very likely," "improbable," and "impossible."
3rd Year	Analysis of the idea of chance in everyday situations: sample space.	(EF03MA25) Identify all possible outcomes in familiar random events, estimating those that are more or less likely to occur.
4th Year	Analysis of the probabilities of random events.	(EF04MA26) Identify, among everyday random events, those that are most likely to occur, recognizing characteristics of more likely outcomes, without using fractions.
5th Year	Sample space: analysis of probabilities of random events.	(EF05MA22) Present all possible outcomes of a random experiment, estimating whether these outcomes are equally likely or not.
	Calculation of the probability of equally probable events.	(EF05MA23) Determine the probability of a result occurring in random events, when all possible results have the same chance of occurring (equally likely).

Source: Prepared by the authors (2024).

4 METHODOLOGICAL PROCEDURES

This research is based on a quantitative approach and is considered exploratory, descriptive, and statistical (Sampiere; Collado; Lucio, 2014). In this context, we present below the sample analyzed, the instrument, the variables considered, and a brief summary of the analytical procedures used to answer the proposed research questions.

The research, approved by the Ethics Committee under number 61382122.2.0000.5594, was conducted with students in two fifth-grade classes at a school in the city of Barueri, metropolitan region of São Paulo, Brazil. The research participants totaled 28 students, ranging in age from 10 to 11.

We emphasize that the students participating in this research were given access to the educational board game "Probability in Action" at the time of its implementation, bearing in mind that the students had no prior instruction in probability concepts. Students were able to learn the rules and logic, play effectively, solve probability problems, and learn more about everyday probability.

The MEEGA+ model was developed by Petri, Wangenheim, and Borgatto (2017) in Portuguese and applied in a school in the municipality of Barueri, São

Paulo, in the same language. The instrument and analyses presented in this text have been translated into Spanish.

We also highlight that the MEEGA+ model (Model for the Evaluation of Educational Games) aims to analyze educational games to assess the perception of quality in terms of the player experience and the perception of learning from the perspective of students and instructors in the context of higher education courses in the field of computer science (Petri; Wangenheim; Borgatto, 2017).

Based on this definition, the MEEGA+ model aims to assess the quality of educational games by proposing quality factors for evaluation (Moreira, 2018). MEEGA+ is a model developed for the evaluation of educational games by applying a standardized questionnaire, using the GQM (Goal/Question/Metric) approach to define outcomes involving the following variables: motivation, user experience, and learning from the student's perspective. The model provides questionnaires and spreadsheets for analyzing the collected data (Petri; Wangenheim; Borgatto, 2017).

As a methodology, the MEEGA+ evaluation assesses the experience comprised of a set of dimensions: focused attention, fun, challenge, social interaction, trust, relevance, satisfaction, and usability. The usability factor is divided into five further subdimensions: learnability, operability, aesthetics, accessibility, and protection against user error. The perceived learning factor is subdivided into two dimensions: short-term evaluation and learning objective. The short-term evaluation aims to evaluate the overall effect of the game on student learning. The learning objective is personalized, since it considers the learning objectives of each game, such as: analysis, evaluation and creation (Soares *et al*., 2018).

Thus, from the evaluation objective, the measures related to the data to be collected during the study are derived to achieve the evaluation objective. Thus, the theoretical model for evaluating educational games is composed of three subcomponents (motivation - ARCS, user experience - UX, and learning) and 11 dimensions. This model assumes a causal relationship between the constructs and that the quality of the educational game will be determined by the student's reaction to the game's motivating effect, the experience of playing, and the perceived learning gains.

The motivation subcomponent is broken down based on the ARCS model (Keller, 2009), which presents four categories to represent motivation in instructional projects: 1) Attention - gaining and maintaining attention; 2) Relevance - the importance of the content; 3) Confidence - providing students with feelings of progress; 4) Satisfaction - the importance and application of what has been learned.

The user experience (UX) subcomponent considers the individual's interaction with the entire product, considering the thoughts, feelings, pleasure, and other perceptions that result from the interaction (Tullis; Albert, 2008). UX in games is often measured by a set of dimensions, but there is no consensus on what these are. Analyzing four UX models for games (Takatalo *et al*., 2010) with the aim of identifying common dimensions, a proposal was reached with the most repeated dimensions among the models:

1. Immersion: Deep involvement, i.e., decreased awareness of surroundings, altered sense of time, and a sense of emotional involvement with the game;

2. Challenge: It should be sufficiently challenging and compatible with the player's skill level;
3. Competition: Supporting the development of players' skills;
4. Fun: Playing is enjoyable and fun, and worth recommending to friends;
5. Social Interaction: Feeling connected to others, empathy, cooperation, and competition.

The learning subcomponent is measured based on two dimensions: short-term learning (achieving the educational objectives of a course or activity) and long-term learning (verifying whether the game contributes to the student's development), based on the Sindre and Moody (2003) assessment model.

Additionally, we present the scale's subcomponents and their respective dimensions in Table 2, seeking to assess the board game "Probability in Action" by fifth-grade primary school students.

Table 2 - Subcomponents and their respective dimensions with respect to the structure of the educational games evaluation model

Subcomponents of the Attitude Scale	Dimensions	Items
Motivation – ARCS	Attention	1 – 2 – 3
	Relevance	4 – 5 – 6
	Trust	7 – 8
	Satisfaction	9 – 10
User Experience - UX	Immersion	11 – 12 – 13
	Social Interaction	14 – 15 – 16
	Challenge	17 – 18
	Fun	19 – 20 – 21 – 23
	Competence	22 – 24
Learning	Short-Term Learning	25 – 26
	Long-Term Learning	27

Source: Prepared by the authors (2024).

Prior to applying the scale, a code was established for the correct tabulation of the information, considering that all are expressed in a positive sense, it being necessary that all be focused on the same direction for there to be homogeneity in the comparison scale. To generate the frequencies of the students' responses, the mean value and the standard deviation, each student established a number of points per item answered, expressed using a Likert-type scale, that is: I totally agree (5 points); partially agree (4 points); indifferent (3 points); partially disagree (2 points); Totally disagree (1 point). It should be noted that the higher the score obtained in each item or in the sum of the items corresponds to a more positive evaluation in relation to their motivation to play, positive experience of the student when playing and perception of learning in relation to probabilistic concepts through the game.

We will also determine the internal consistency index for the entire scale and each of its subcomponents using Cronbach's alpha (α), which is the most widely used method when measurements are taken at a single point in time (Sijtsma,

2009). For Pasquali (2013), internal consistency analysis (Cronbach's alpha) refers to calculating the correlation between each item in the scale (sum of all students' scores for a given item) and the other items or the total of the same scale (total score of all items in the scale for each student).

Generally, guidelines are adopted for interpreting Cronbach's alpha values, with George and Mallery (2019) suggesting that alpha > 0.90 = excellent; alpha > 0.80 = good; alpha > 0.70 = acceptable; alpha > 0.60 = questionable; alpha > 0.50 = poor; alpha < 0.50 = unacceptable. Likewise, according to Hair *et al*. (2018), at least 0.70 would be an acceptable reliability value.

In the educational game evaluation process, the Pearson correlation coefficient was also used to sum the scores for each item on the game evaluation scale associated with the total score of the scale. In addition, the statistical significance of the correlations will be determined by comparing the p-value with a significance level of 0.05 or 0.01. A significance level of 0.05 indicates that the risk of concluding that there is a difference between the score for a given scale item and the total score is 5%.

According to Magalhães and Lima (2023), the correlation coefficient is the quotient between the covariance and the product of the standard deviations of x and y. Dividing by the product of the standard deviations serves to standardize the measurement and enable its use for comparisons with other variables. It is not difficult to verify that $\rho x,y$ is a dimensionless number bounded by 1, that is, $|\rho x,y| \leq 1$. The interpretation of its expression follows the same steps as for the covariance, with values of $\rho x,y$ close to ±1 indicating a strong correlation.

The free software PSPP version 1.6.2 was used to prepare the technical report, and the technical sheet and database were generated using Excel.

5 RESULTS AND DISCUSSIONS

Based on a descriptive analysis, Table 3 presents the students' evaluations of the board game "Probability in Action" regarding the "Motivation" subcomponent and its different aspects (attention, relevance, confidence, and satisfaction). It presents the absolute frequencies and percentages of students' responses to each of the components of the game evaluation scale, as well as the calculation of the mean and standard deviation, which allow indicating a more or less positive rating of these items.

Table 3 - Distribution of the scale items to evaluate the motivation subcomponent

n	Subdimension	Propositions (Items)	Statistics(*)	Totally Disagree	Partially Disagree	Indifferent	Partially Agree	Totally agree
1	Attention	The game design is engaging (interface or objects, such as cards or boards).	4.14 (0.834)	0 (0.0%)	0 (0.0%)	8 (27.6%)	9 (31.0%)	12 (41.4%)
2	Attention	There was something interesting at the beginning of the game that caught my attention.	3.83 (1.037)	1 (3.4%)	2 (6.9%)	6 (20.7%)	12 (41.4%)	8 (27.6%)
3	Attention	The variation (in form, content, or activities) helped keep me interested in the game.	4.10 (0.976)	0 (0.0%)	2 (6.9%)	6 (20.7%)	8 (27.6%)	13 (44.8%)
4	Relevance	The game content is relevant to my interests.	3.83 (1.197)	1 (3.4%)	3 (10.3%)	8 (27.6%)	5 (17.2%)	12 (41.4%)
5	Relevance	The way this game works fits my way of learning.	3.79 (1.082)	1 (3.4%)	3 (10.3%)	5 (17.2%)	12 (41.5%)	8 (27.6%)
6	Relevance	The game content is connected to other knowledge I already had.	4.28 (0.841)	0 (0.0%)	0 (0.0%)	7 (24.1%)	7 (24.1%)	15 (51.7%)
7	Trust	It was easy to understand the game and began using it as study material.	4.55 (0.686)	0 (0.0%)	0 (0.0%)	3 (10.5%)	7 (24.1%)	19 (65.5%)
8	Trust	As I progressed through the stages of the game, I felt confident that I was learning.	3.79 (1.236)	1 (3.4%)	4 (13.8%)	7 (24.1%)	5 (17.2%)	12 (41.4%)
9	Satisfaction	I am happy because I know I will have	3.62 (0.979)	0 (0.0%)	3 (10.3%)	12 (41.4%)	7 (24.1%)	7 (24.1%)

		opportunities to put into practice the things I have learned in the game.						
10	Satisfaction	It is thanks to my personal effort that I am able to advance in the game.	3.55 (1.270)	3 (10.3%)	2 (6.9%)	8 (27.6%)	8 (27.6%)	8 (27.6%)

(*) Mean (standard deviation)

Source: Prepared by the authors (2024).

Even considering descriptive aspects, Table 4 presents basic statistics (absolute and relative frequencies, mean, and standard deviation) on the responses to the items on the board game evaluation scale "Probability in Action," according to the subcomponent of the scale called user experience (students). The following aspects were considered: immersion; social interaction; challenge; fun; and competition.

Table 4 - Distribution of scale items to evaluate the user experience subcomponent

n	Subdimension	Propositions (Items)	Statistics (*)	Totally Disagree	Partially Disagree	Indifferent	Partially Agree	Totally agree
11	Immersion	I temporarily forgot my daily worries and became fully focused on the game.	4.03 (1.295)	2 (6.9%)	3 (10.3%)	2 (6.9%)	7 (24.1%)	15 (51.7%)
12	Immersion	I didn't notice the passage of time while playing until I saw that the game was over.	4.00 (1.134)	2 (6.9%)	1 (3.4%)	3 (10.3%)	12 (41.4%)	11 (37.9%)
13	Immersion	I felt more like I was in the game environment than in the real world, oblivious to my surroundings.	3.48 (1.326)	3 (10.3%)	4 (13.8%)	6 (20.7%)	8 (27.6%)	8 (27.6%)
14	Social	I was able to interact with other people during the game.	4.14 (1.246)	2 (6.9%)	2 (6.9%)	2 (6.9%)	7 (24.1%)	16 (55.2%)
15	Interaction	I had fun with other people.	4.31 (0.891)	0 (0.0%)	1 (3.4%)	5 (17.2%)	7 (24.1%)	16 (55.2%)
16	Social	The game promotes moments of cooperation and/or competition among the participants.	3.90 (0.860)	0 (0.0%)	1 (3.4%)	9 (31.0%)	11 (37.4%)	8 (27.6%)

17	Interaction	This game is challenging enough for me; the tasks are neither too easy nor too difficult.	3.31 (1.491)	5 (17.2%)	3 (10.3%)	9 (31.0%)	2 (6.8%)	10 (34.5%)
18	Social	The game evolves at an appropriate pace and doesn't become monotonous: it offers new obstacles, situations, or variations of activities.	3.38 (1.147)	2 (6.9%)	4 (13.8%)	9 (31.0%)	9 (31.0%)	5 (17.2%)
19	Interaction	I had fun playing the game.	4.10 (1.176)	1 (3.4%)	3 (10.3%)	3 (10.3%)	7 (24.1%)	15 (51.7%)
20	Challenge	When I was interrupted, I was disappointed that the game was over (I would have liked to play more).	3.86 (1.246)	0 (0.0%)	3 (10.3%)	6 (20.7%)	9 (31.0%)	11 (37.4%)
21	Challenge	I would recommend this game to my colleagues.	4.41 (0.733)	0 (0.0%)	0 (0.0%)	4 (13.8%)	9 (31.0%)	16 (55.2%)
22	Fun	I would like to use this game again.	4.21 (1.048)	1 (3.4%)	1 (3.4%)	4 (13.8%)	8 (27.6%)	15 (51.7%)
23	Fun	I was able to achieve the game's objectives through my skills.	3.90 (0.900)	0 (0.0%)	1 (3.4%)	10 (34.5%)	9 (31.0%)	9 (31.0%)
24	Fun	I had positive feelings of efficiency as the game unfolded.	4.17 (1.002)	1 (3.4%)	1 (3.4%)	3 (10.3%)	11 (37.4%)	13 (44.8%)

(*) Mean (standard deviation)

Source: Prepared by the authors (2024).

Table 5 presents some basic statistics (absolute and relative frequencies, mean and standard deviation) on the responses to the items of the scale to evaluate the board game "Probability in Action" according to the learning subcomponent (short and long term).

Table 5 - Distribution of the scale items to evaluate the learning subcomponent

n	Subdimension	Propositions (Items)	Statistics (*)	Totally Disagree	Partially Disagree	Indifferent	Partially Agree	Totally agree
25	Short-term learning	The game contributed to my probability learning.	4.24 (0.704)	0 (0.0%)	0 (0.0%)	5 (17.2%)	12 (41.4%)	12 (41.4%)

26	Short-term learning	The game was effective for my probability learning, compared to other math activities.	3.97 (1.085)	1 (3.4%)	2 (6.9%)	5 (17.2%)	7 (36.8%)	11 (37.4%)
27	Long-term learning	The experience with the game will contribute to my performance in my Basic Education training.	4.00 (1.000)	0 (0.0%)	1 (3.4%)	11 (37.4%)	4 (13.8%)	13 (44.8%)

(*) Mean (standard deviation)

Source: Prepared by the authors (2024).

5.1 Analysis of results by items

An analysis was conducted of the results for each of the 27 items on the "Probability in Action" board game evaluation scale, based on the perception of learning and playing experience of 28 10- and 11-year-old Brazilian elementary school students, 14 female and 14 male.

The results are shown in Tables 1, 2, and 3, which show the number of cases tabulated for each item on the scale, as well as the means and deviations obtained. Means and deviations were calculated based on the scores obtained for each response or item on the scale.

Regarding the scoring on the scale, each student assigned a number of points per item answered as follows: strongly agree = 5 points; partially agree = 4 points; indifferent = 3 points; partially disagree = 2 points; and strongly disagree = 1 point. Furthermore, it is considered that the higher the average score assigned to each item by the student group, the more positive the evaluation of the game is. Furthermore, the average score for the evaluation was obtained by assigning values from 1 to 5 to the levels of agreement on the Likert scale, with a mean of 3 indicating equal agreement and disagreement for the total number of participants and statements.

5.2 Top rated items

It can be observed that, for 13 items on the scale, the student group's task averages had an average score greater than or equal to 4.0. These scores are considered to have the highest scores, with 6 (out of 10) for the Motivation subcomponent, 6 (out of 14) for User Experience, and 1 (out of 3) for Learning. Based on the overall results by item, the highest-rated items for each of the subcomponents are:

1. Motivation Subcomponent:

1.1) Item 6 - Relevance (The game content is connected to other knowledge I already had) with a score of 4.14;

1.2) Item 7 - Confidence (It was easy to understand the game and start using it as study material) with a score of 4.11;

1.3) Item 3 - Attention (Variation—in form, content, or activities—helped keep me engaged with the game) with a score of 4.11.

It is indicated that the relevance and importance of the probabilistic content is perceived, providing students with feelings of progress. Furthermore, it is worth noting that the game provided moments of focus.

2) User experience subcomponent:

2.1.) Item 19 – Fun (I had fun playing the game) with a score of 4.54;

2.2.) Item 22 – Competence (I would like to use the game again) with a score of 4.50.

This subcomponent indicates that students found the "Probability in Action" board game fun to play, and that they want to play it again.

3) Learning Subcomponent:

3.1) Item 25 - Short-term learning (The game contributed to my learning in Probability) with a score of 4.04.

In this case, it is indicated that the students consider that the educational objectives of the activities related to the teaching of probability addressed in the board game "Probability in Action" were achieved.

5.2 Worst rated items

It is assumed that a mean of 3 indicates equal agreement and disagreement across all participants and statements, and therefore, a score below 3 indicates a negative evaluation. Thus, in this case, no scores below 3 were observed, constituting no negative aspect; rather, all items were rated positively. In any case, it is worth highlighting the lowest-rated items, although we emphasize that they were rated positively, namely:

1) Motivation Subcomponent, the least positive results were:

1.1. Item 2 (There was something interesting at the beginning of the game that caught my attention) with a score of 3.68;

1.2. Item 4 (The game content is relevant to my interests) with a score of 3.68.

2) User Experience Subcomponent, the least positive results were:

2.1. Item 24 (It's through my personal effort that I'm able to advance in the game) with a score of 3.54;

2.2. Item 13 (I was able to achieve the game's objectives through my skills) with a score of 3.57;

2.3. Item 23 (I felt more immersed in the game environment than in the real world, forgetting my surroundings) with a score of 3.64.

3) Learning Subcomponent (short-term), the least positive result was:

3.1. Item 26 (The game was effective for my learning in Probability, compared to other Mathematics activities) with a score of 3.71.

In the case of the six highlighted items, it is indicated that the game caught the students' attention, but it may not have been an interest if it was aimed at teaching probability. It is also highlighted that the students' individual effort while playing the game may have been compromised in some way by errors and/or correct

answers to the questions posed, in addition to not having caused a complete disconnect from the classroom environment. Furthermore, compared to other areas of mathematics, some students may struggle with probability concepts.

5.3 Homogeneity of response

Another question to consider comes from Estrada (2002), when he suggests studying response dispersion, since a small dispersion indicates greater agreement regarding a given topic under study. In our study, there is homogeneity in the students' responses, as a small degree of data dispersion is found. This means that the responses are similar across the entire student sample, as the standard deviations are relatively low relative to the means.

Based on DeVellis (2023), it is highlighted that items with means close to the extremes of the response interval generally have low variance, and because they vary within a short interval, they may have low correlation with the other items in the response interval. However, in this study, even with item means approaching the upper part of the scale, the variance was not affected. Furthermore, the variance in the response to one item on the scale indicates that the item is capturing a significant level of diversity among the surveyed population (the 28 fifth-grade students at the elementary school).

Below are the four items with the greatest degree of dispersion, ranging from 1.369 to 1.513, all from the User Experience subcomponent, from greatest to least dispersion: 1) Item 13 (standard deviation = 1.513) – “Immersion” dimension (I felt more immersed in the game environment than in the real world, forgetting my surroundings); 2) Item 17 (standard deviation = 1.416) – “Challenge” dimension (This game is adequately challenging for me; the tasks are neither too easy nor too difficult); 3) Item 11 (standard deviation = 1.397) – “Immersion” dimension (I momentarily forgot my daily worries, fully focused on the game); 4) Item 12 (standard deviation = 1.369) – “Immersion” dimension (I did not notice the passage of time while playing, when I saw that the game was over).

Thus, there is a different position regarding the item referring to the challenge of playing, which may indicate that the board game "Probability in Action" presents different perceptions or difficulties for students regarding the challenge related to the probabilistic tasks proposed in the game. The other three items also indicate that there are different positions regarding students' full engagement with the game, with a change in the perception of the passage of time, in addition to the feeling of emotional involvement.

Considering George and Mallery (2019), in this study, the degree of reliability of the scale responses was 0.91, confirming the excellent internal consistency of the instrument. The values obtained in each of the subcomponents demonstrate that the reliability of the evaluation model is considered good for the motivation subcomponents (α Motivation = 0.80) and user experience (α User Experience = 0.84), in addition to being acceptable for the motivation subcomponent (α Learning = 0.72). Therefore, in this study, the reliability coefficient confirms the internal consistency of the instrument.

Furthermore, it is observed that the three subcomponents of the scale (motivation, user experience, and learning) are positively correlated with each

other and with the total score of the scale (the correlation is significant at the 0.01 level).

It is also noted that this study indicates that the higher the score related to an item or subcomponent of the educational board game evaluation, the higher the score of other items or subcomponents, on average, assuming a positive correlation or evaluation.

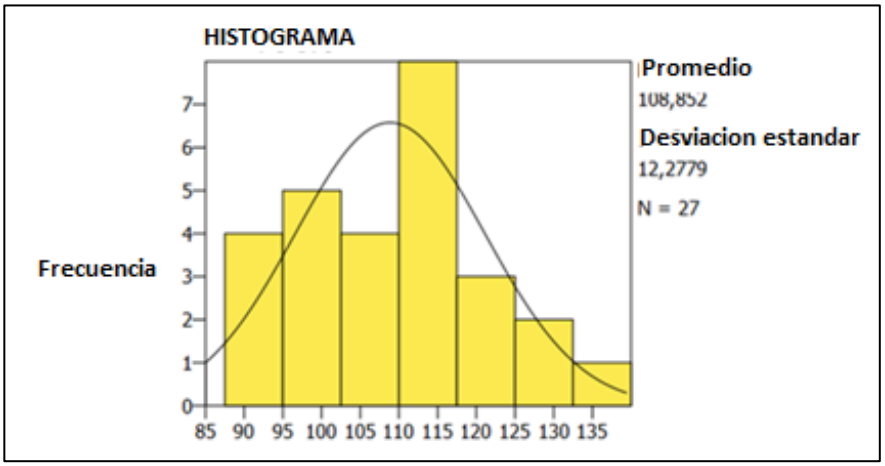
5.4 Analysis of overall results

Once the results were analyzed by item, the attitude scale was analyzed using each student's total score, that is, considering the sum of the scores assigned to each item on the scale, which ranges from 27 to 135 points.

Based on the total scores, it should be noted that if all respondents had a position of indifference (score 3 on the questionnaire), the score would be 81, indicating that the students' assessment of the educational board game "Probability in Action" is positive.

Furthermore, the total scores for each student are largely concentrated around the mode, which is 114, the median, which is 108, and the mean, 108.825, as shown in the histogram (Figure 6), which corresponds to an approximately normal shape of the frequency distribution of the total score.

Figure 6 - Histogram referring to the frequency distribution of the total score of the evaluation of the board game “Probability in Action”



Source: Prepared by the authors (2024).

The mean score obtained from the scores is 108.852, with the lowest score being 88 and the highest 135. The standard deviation, equal to 12.779 in this study, is an indicator that shows the difference in the average of each value in a given set (Takahashi, 2010). It starts at 0 (which would indicate no variation in the responses for each sample), and the higher its value, the further away the responses will be from the mean. In this way, we can use the standard deviation as an indicator of the convergence or divergence of the given responses.

Furthermore, as long as the histogram does not show inconsistencies with the normal distribution, it is recommended to evaluate the symmetry and kurtosis estimators, which represent aspects related to the shape of the histogram: shifted

left/right (symmetry) or peaked/flattened (kurtosis); both measures approach zero when the data are normal. Because these estimators are affected by sample size and extreme values, it is prudent to calculate the ratio of their values to the standard error of their estimates. In general, the value of the coefficient divided by its standard error should be between -1.96 and +1.96 in normal distribution (Kim, 2013).

The mean score obtained was 106.9, with the lowest score being 72 and the highest 135. Furthermore, the standardized coefficient of skewness (0.70) and kurtosis (0.67) fell within the limits of [-1.96;1.96], which fell within the normal range. Furthermore, the Kolmogorov-Smirnov (K-S) test indicated normality in the data.

In terms of external validity, limitations may arise from the sample size and the educational cycle (28 students aged 10 and 11 from a Brazilian elementary school). This study is an initial one for this educational cycle, requiring further research to allow for generalization of the results. As a process to mitigate this problem, we can start from the process of development and validation of the research instrument used (Meega+ model), in which data were collected from 48 case studies that evaluated 18 different educational games, involving a population of 843 students from 6 different higher education institutions (Petri; Wangenheim; Borgatto, 2017).

6 FINAL CONSIDERATIONS

Through the results observed from the analysis of student responses to the evaluation of the board game "Probability in Action," using a Likert scale, it can be characterized as an option to support the teaching and learning process of probabilistic concepts for 10- and 11-year-old students, providing them with a fun and motivating environment.

The evaluation also revealed that the board game "Probability in Action" presented more positive results in the setting in which it was evaluated. In the student responses to the "Motivation" subcomponent, the relevance and importance of the probabilistic content was perceived (score 4.14 out of a total of 5.00), providing opportunities for feelings of progress (score 4.11) and maintaining attention in the teaching and learning process (score 4.11).

This student perception coincides with Keller (2009), who indicated that the educational proposal must be consistent with its objectives and connect the game's content with other existing knowledge. It was still easy to understand the game and began using it as a learning tool. Furthermore, the game, through its format, content, and activities, helped students stay engaged.

For the "User Experience" subcomponent, students considered that, in addition to supporting the development of players' skills, participating in the "Probability in Action" game was enjoyable and fun, and they would recommend it to their friends (score of 4.54). Furthermore, students indicated that they had fun playing it and would like to play it again (score of 4.50).

For Takatalo *et al.* (2010), engagement with other people is an element of fun in games and is related to the feeling of sharing a specific environment and having an active role. Games can create opportunities for players to compete, cooperate,

and connect, providing feelings of fun, pleasure, relaxation, distraction, and satisfaction (Poels; Kort; Ijsselsteijn, 2007).

In the case of the "Learning" subcomponent, students considered that the educational objectives of the probability-related activities addressed in the board game "Probability in Action" were achieved, specifically with regard to short-term learning (score of 4.04), that is, the overall effect of the game on student learning.

Regarding the learning of probabilistic concepts assessed through the research instrument, it is indicated that students felt motivated, possibly because it was a proposal different from their routine, reinforcing that the use of board games in the teaching and learning process presents the possibility of learning through play. It is also considered that playing develops students' cognitive abilities, allowing them to acquire probabilistic knowledge, in addition to stimulating communication and expression skills in the areas of interpersonal relationships and teamwork.

For Sindre and Moody (2003), the effectiveness of a short-term learning activity is determined by the achievement of its objectives (in terms of knowledge, skills, and attitudes). This short-term learning influences long-term learning, potentially generating in the individual a perception of the usefulness of what is being studied (probabilistic concepts), going beyond the scope of the discipline and considering its use in everyday life.

Thus, based on the research results, it is considered that board games can be used for teaching and learning, while being inclusive at the same time. This implies considering their use in comparison to traditional methodologies in the search to generate motivating moments for the teaching and learning process, in addition to being a tool capable of leading students to overcome challenges related to their own learning.

In this sense, it is considered that the evaluation process adopted in this work can be replicated or adapted to different educational games, contexts, or educational levels, through specific adaptations, even if these are from different areas of knowledge, such as statistics.

EL JUEGO DE MESA “PROBABILIDAD EN ACCIÓN” PARA ALUMNOS DE 6 A 10 AÑOS EN BRASIL: UNA EVALUACIÓN SEGÚN EL MODELO MEEGA+

RESUMEN

OBJETIVO: Este artículo tuvo como objetivo evaluar el juego de mesa educativo "Probabilidad en Acción" según la percepción del jugador sobre el aprendizaje y la experiencia, a través de las consideraciones de 28 estudiantes del quinto año de la escuela primaria (10 y 11 años) escuela pública municipal de Barueri, São Paulo, Brasil. MÉTODO: Esta investigación se enmarca en el enfoque cuantitativo y se considera exploratoria, descriptiva y estadística, utilizando el modelo denominado MEEGA+ para evaluar su percepción de calidad en cuanto a la experiencia del jugador y la percepción del aprendizaje. RESULTADO: Asumiendo que el juego tiene como objetivo enseñar probabilidad a estudiantes de 6 a 10 años, los resultados de la evaluación muestran que es efectivo en el aprendizaje y brinda diversión a los estudiantes, como herramienta de aprendizaje. La evaluación realizada por los estudiantes reveló que el juego de mesa “Probabilidad en Acción” presentó resultados más positivos en relación a los siguientes aspectos: 1) Subcomponente “Motivación”: relevancia e importancia del contenido probabilístico, brindando oportunidades para sentimientos de progreso y mantenimiento de la atención en el proceso de enseñanza y aprendizaje; 2) Subcomponente “Experiencia de usuario”: además de apoyar el desarrollo de las habilidades de los jugadores, es agradable y divertido participar en el juego, digno de ser recomendado a amigos; 3) Subcomponente “Aprendizaje”: se lograron los objetivos pedagógicos de las actividades relacionadas con la enseñanza de las probabilidades abordadas, específicamente en lo relacionado con el aprendizaje a corto plazo, es decir, el efecto general del juego en el aprendizaje de los estudiantes. Hay indicios de que, cuanto mayor es la puntuación de un ítem o subcomponente de la evaluación del juego de mesa, hay un aumento, en promedio, en la puntuación de los demás ítems o subcomponentes, asumiendo una correlación o evaluación positiva. CONSIDERACIONES FINALES: Se considera que el proceso de evaluación adoptado en este trabajo puede ser replicado o adaptado a diferentes modelos de juegos educativos, contextos o niveles educativos, mediante adaptaciones específicas, aunque sean de distintas áreas del conocimiento, como la estadística.

PALAVRAS CLAVE: Juego de mesa. Enseñanza de la probabilidad. Enseñanza primaria. Modelo MEEGA+.

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