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Combinatory thinking: an approach from the password game

Pensamento combinatório: um enfoque a partir do jogo da senha

Pensamiento combinatorio: un enfoque desde el juego de contraseña

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Abstract

The purpose of this article is to present the paths outlined for the development of combinatorial reasoning and the fundamental principle of counting through problem situations arising from the game. The conception of this work arose from the contact with games at the Mathematics Teaching Laboratory (LEM) and from discussions about new teaching methodologies in the Supervised Internship IV discipline of the Full Mathematics Degree course at the State University of Maringá. In this way, in partnership with LEM, this activity proposal was developed, whose target audience was students from the 8th and 9th years of Elementary School. The Password Game was used as a methodological resource, in order to work the multiplicative principle in a playful way and different from the traditional one. The

realization of this activity with the students made us realize that it is possible, through the use of games, to trigger very rich mathematical discussions, as well as to promote learning situations in the classroom.

Keywords: Mathematical education; Multiplicative principle; Combinatorial reasoning; Playful resource.

Resumo

O objetivo deste artigo é apresentar os caminhos traçados para o desenvolvimento do raciocínio combinatório e o princípio fundamental da contagem por meio de situações-problemas suscitadas a partir do jogo. A concepção desse trabalho surgiu a partir do contato com jogos no Laboratório de Ensino de Matemática (LEM) e de discussões a respeito de novas metodologias de ensino na disciplina de Estágio Supervisionado IV do curso de Licenciatura Plena em Matemática da Universidade Estadual de Maringá. Dessa maneira, em parceria com o LEM, desenvolveu-se essa proposta de atividade que teve como público alvo alunos de 8º e 9º anos do Ensino Fundamental. Utilizou-se como recurso metodológico o *Jogo da Senha,* com vistas a trabalhar o princípio multiplicativo de uma maneira lúdica e diferente do tradicional. A realização dessa atividade com os discentes nos fez perceber que é possível, a partir do uso de jogos, desencadear riquíssimas discussões matemáticas, bem como promover situações de aprendizagem em sala de aula.

Palavras-chave: Educação matemática; Princípio multiplicativo; Raciocínio combinatório; Recurso lúdico.

Resumen

El objetivo de este artículo es presentar los caminos trazados para el desarrollo del razonamiento combinatorio y el principio fundamental de contar a través de situaciones problemáticas derivadas del juego. La concepción de este trabajo surgió del contacto con los juegos en el Laboratorio de Enseñanza de las Matemáticas (LEM) y de las discusiones sobre nuevas metodologías de enseñanza en la asignatura de Pasantía Supervisada IV de la Licenciatura en Matemáticas de la Universidad Estatal de Maringá. De esta manera, en alianza con LEM, se desarrolló esta propuesta de actividad, cuyo público objetivo fueron los estudiantes de 8º y 9º de primaria. El Juego de Contraseñas se utilizó como recurso metodológico, con el fin de trabajar el principio multiplicativo de una manera lúdica y diferente a la tradicional. La realización de esta actividad con los alumnos nos hizo darnos cuenta de que es posible, mediante el uso de juegos, desencadenar discusiones matemáticas

muy ricas, así como promover situaciones de aprendizaje en el aula.

Palabras clave: Educación matemática; Principio multiplicativo; Razonamiento combinatório; Recurso lúdico.

1. Introduction

According to the National Curriculum Parameters (Brasil, 1998), games represent an important methodological resource to be used by the teacher in the classroom, being a different form of activity, encouraging the student to think about and create strategies to solve problems. Also according to that document, games:

> They provide the simulation of problem situations that demand immediate and lively solutions, which stimulates the planning of actions; make it possible to build a positive attitude towards mistakes, since situations happen quickly and can be corrected naturally, during the action, without leaving negative marks (Brasil, 1998).

Thus, it can be said that the game determined by its rules "establishes a path that goes from the imagination to the abstraction of a mathematical concept, establishing a reflexive action that makes it possible to solve problems" (Mattos, 2009).

In the case of Mathematics classes, the use of games proposes a significant change in the teaching and learning process, since working with games arouses interest, reasoning and decision-making, as pointed out by Oliveira (2019) in his dissertation, highlighting the importance of care so that the focus is on learning and not just playfulness.

For Borin (1998), one of the reasons for the introduction of games in Mathematics classes is the possibility of reducing blockages presented by students, since they feel more comfortable to learn, as they are free of pressures and evaluations imposed by the teacher, which strengthens learning and stimulates the search for new knowledge.

The classification and characteristics of the games are addressed by several authors. In this work we refer to the classification denoted by Grando (1995), who points out that games can be classified into: games of chance, puzzle games, strategy games, concept-fixing games, computer games and games pedagogical.

- Games of chance: are those in which the player depends only on luck to win, not being able to interfere or change his solution;
- Puzzle games: are those in which the player, most of the time, plays alone and its solution is unknown to the student;

● Strategy games: are those that depend purely and exclusively on playing to win. The finding of the best strategy will therefore depend on the observation and analysis of the players;

● Concept-fixing games: they are the most common and most used in the classroom, after the presentation of a concept in order to replace the exercise lists and reinforce the learned contents;

● Computer games: they are of most interest to children, being designed and executed in the educational environment;

● Pedagogical games: those that can be used during the learning process.

Analyzing each of these games, pedagogical games were chosen. Such choice is due to the fact that these games provide the construction of new concepts on the part of the students, as well as assist in the fixation and expansion of concepts already known in an attractive way, thus, it becomes a possibility to replace the tireless lists of exercises proposals, with a view to memorizing the contents.

2. Literature Review

In order to obtain a broader look at the research on the subject, we conducted a survey at the Brazilian Digital Library of Theses and Dissertations (BDTD). Our search was carried out on July 24, 2020, and the keywords searched were “combinatorial”, “games”, which resulted in 34 jobs.

Based on Cervo, Bervian and Silva (2007), who define informative reading as an essential stage of collecting information on the topic to be studied, and highlight the importance of keeping in mind the objective of the research in order not to deviate from the focus. These authors define the following steps for informative reading: pre-reading, selective reading, critical or reflective reading, interpretive reading, and text comments.

Thus, we performed the pre-reading and the selective reading simultaneously, by reading the abstracts of the 34 works. In this first stage, we selected six papers, all of them dissertations. Based on this selection, we carried out the critical reading, the interpretative and the comments simultaneously, and we chose to briefly discuss four of these surveys, as they have characteristics similar to those present in the proposal we presented.

Ambozi (2017) presents a didactic sequence elaborated and executed by him containing games that involve combinatorics. Among the activities and games present in the sequence prepared by the author, there is the password game. Ambrosi (2017) points out that

the game was developed in 1970 by the Israeli Mordechai Meirovitz. From a questionnaire applied after the game, the author concludes that the concepts were understood.

Laureano (2017) puts it as an objective "[...] to identify the perception that the student has about the content of Combinatory Analysis and Probability through a card game as an activity to review, deepen or motivate the study of these contents". Through the analysis of questionnaires applied after the execution of the game, the author concludes that the use of this facilitates the understanding of the content, "[...] which would not be entirely possible only with the theoretical exposition and lists of exercises".

Based on Vergnaud's Conceptual Field Theory, Chilela (2013) used Didactic Engineering to "[...] understand how the Combinatorial teaching and learning process occurs, in the particular case of the problem of counting clusters of objects, considered difficult by teachers and students", and concludes that the teaching of combinatorics must start from concrete problems, verifying that in general teaching starts in the formulas and uses problems that suit them, which may be the origin of learning disability.

In the most recent work of this selection, Oliveira (2019) investigated "[...] the contributions of the poker game to facilitate the learning of the content of combinatorics and probability in high school". The author points out that it is necessary to be careful on the part of the teacher so that the focus of learning is not lost amid playfulness, but that when used properly, the game enhances learning and increases the involvement of the class even in the expository classes.

From these readings, the relevance of the use of games as an enhancer of teaching is highlighted, and the importance of care by the teacher so that the game is not seen as a moment of leisure, of "pause" in the Mathematics class, but as another way to learn and develop concepts.

3. Methodology

3.1 The game in the mathematics teaching process

In view of the trajectory of the educational approach to mathematics over the years, there is a need to rethink teaching practices. One of the methodological approaches suggested by the National Mathematical Curriculum Parameters (Brasil, 1998) is the inclusion of games in the teaching of Mathematics. This document points out that games "are an interesting way of proposing problems, as they allow them to be presented in an attractive way and favor

creativity in the elaboration of problem solving strategies and search for solutions" (Brasil, 1998). In view of the trajectory of the educational approach to mathematics over the years, there is a need to rethink teaching practices. One of the methodological approaches suggested by the National Mathematical Curriculum Parameters (Brasil, 1998) is the inclusion of games in the teaching of Mathematics. This document points out that games "are an interesting way of proposing problems, as they allow them to be presented in an attractive way and favor creativity in the elaboration of problem solving strategies and search for solutions" (Brasil, 1998).

For Grando (1995):

> [...] the game represents a simulated problem situation and determined by rules, in which the individual seeks, at all times, developing strategies and restructuring them, to win the game, that is, to solve the problem. This dynamism characteristic of the game is what makes it possible to identify it in the context of problem solving (Grando, 1995).

Still, according to the author:

> [..] both, game and problem solving, are impregnated with content in action and, psychologically, involve thinking, structuring cognitively from the conflict generated by the problem situation. The action in the game, as well as in the problem, involves a single goal which is to win the game or solve the problem and, in both cases, the student feels challenged and motivated to fulfill that goal (Grando, 1995).

Regarding the pedagogical character of games in Mathematics classes, Grando (2000), proposes what he calls seven moments: familiarization with the game material, recognition of the rules, playing to guarantee rules, verbal pedagogical intervention, game registration, intervention writing and playing competently.

- Familiarization with the game material: at this moment the student will have contact with the game material, will make the experimentation through simulation of possible moves and will be able to establish analogies with previously known games;
- Recognition of the rules: at this stage, it is important that students become familiar with the proposed rules, through model matches, by the teacher's presentation, and / or by reading them;
- Play to guarantee the rules: spontaneous moment when the plays will serve for the appropriation and internalization of the rules by the students and for the understanding of mathematical concepts;

● Verbal pedagogical intervention: these are the interventions performed by the teacher, in order to make the students analyze their plays, and have tools to solve the situations - problems triggered by the game;

● Game registration: systematization and formalization stage, using a specific mathematical language that will start from the registration of points, procedures and calculations used by students during the stages of the game;

● Written intervention: it deals with problematizing game situations proposed by the teacher, in order to give students the opportunity to carefully analyze their moves and, later, when returning to the game situation, do it with competence;

● Playing with competence: it is the return to the real situation of the game, using the conclusions and reflections acquired in the previous stages (Grando, 2000).

Thus, it can be said that the use of the game in the teaching of Mathematics has a relevant role, once the student comes into contact with the game. According to Alsina[1]:

> Teaching and learning mathematics can and should be a successful experience in the sense of something that brings happiness to students. Interestingly, happiness is almost never mentioned within the objectives to be achieved in the teaching-learning process, it is evident that we can only speak of a teaching job well done when we all reach a satisfactory degree of happiness (Alsina, *apud* Corbalán , 1994).

According to Kamii and Joseph (1997), games in the teaching of Mathematics "can be used to stimulate and develop the child's ability to think independently, contributing to his / her process of building logical-mathematical knowledge" (Kamii and Joseph, 1997). Still in this sense, Parra et al. (1996) points out that:

> [...] games play an important role. On the one hand, they allow the students to begin to have more independent work in the classroom: they learn to respect the rules, to exercise different roles and reciprocal controls, to discuss, to reach agreements. On the other hand, they provide the teacher with greater opportunities for observation, the possibility of varying the proposals according to the students' work levels and even working more intensely with those who need it most (Parra et al. 1996).

Thus, using games in math classes has been an important stimulating resource for students, especially those who have blocks or difficulties with the discipline, since they provide group work, exchange of ideas, interaction with the teacher and other colleagues. Not

[1] Alsina, À. Desenvolvimento de competências matemáticas com recursos lúdico-manipulativos. Porto: Porto Editora, 2004.

forgetting the possible discussions, which allow students to develop mathematical thinking in a pleasant and stimulating way (ter Vrugte et al. 2015).

However, the use of games in the classroom requires the teacher to play a different role. According to Freire (2002) "to teach is not to transfer knowledge, but to create the possibilities for your own production or construction". Right through the games, the teacher can provide this construction and thus provoke and stimulate in students the interest and the search for new mathematical knowledge, combining the attractiveness of the game with the concept that is being studied or that will later be addressed in the classroom.

Therefore, when opting for the game, it is important that the teacher be clear that his / her role will be an intermediary, motivator and stimulator, leading students to choose their own hypotheses, to conjecture and create strategies (Katmada, Mavridis & Tsiatsos, 2014). The search for solutions opens space for new ways of teaching and new ways of learning that distance themselves from traditional methods of presenting concepts that are still present in our school environments.

Before the application of the game, it is necessary that the teacher intentionally chooses the material to be used, which is clear about the objectives proposed by the game, its rules, as well as the possible interventions and questions that may be raised by him from the game situation (Novak & Tassell, 2015). Thus assisting in the construction and consolidation of mathematical knowledge.

For Borin (1998), the activity of playing, if well oriented, plays an important role in the development of reasoning skills (organization, attention and concentration), in decentralization (seeing something from a different point of view from yours and reaching a conclusion), in language development, creativity and deductive reasoning, in addition to reducing blockages of students who fear mathematics and feel unable to learn it.

With this in mind, this work was developed with the aim of focusing on the multiplicative principle in a fun and different way. The main objective was to develop combinatorial reasoning and the concept of counting through problem situations arising from the password game.

3.2 The development of the activity

In this qualitative research, the interpretation of the opinions given by the students about the phenomenon under study was sought, in which with these descriptive opinions we identified the favoring of learning involving the content of multiplicative principle and the

development of combinatorial reasoning. Pereira et al. (2018) that in these studies data collection often occurs through interviews with open questions, therefore, through the comments described by the students, the discussion of the results presented in the results and discussion section was used.

The password game also known as "Mastermaid", is a board game, played in pairs. It consists of having a player try to guess the code established by his opponent. Each player is provided with a card with eight rows and four columns represented in Figure 1, as well as six different symbols. Both players must choose, without the opponent seeing, four of the six symbols provided to compose their "password". Then, players will be given a maximum of eight opportunities to try to find out what password their opponent has set. The winning player will be the one who first finds out "the password".

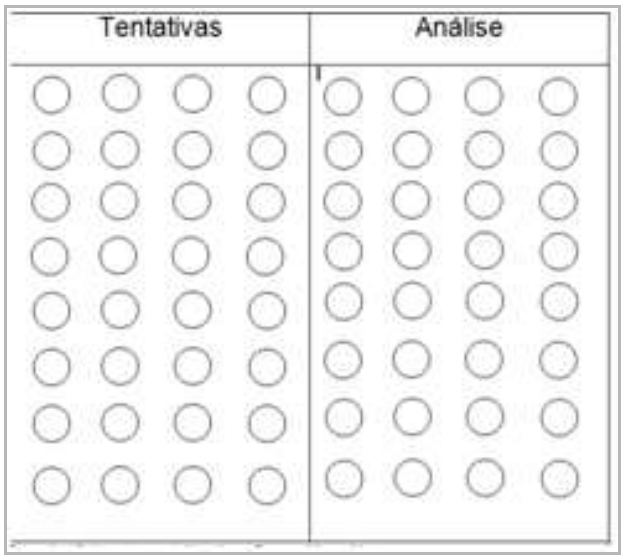
During the plays, students were encouraged to observe what was going on, such as which symbols could be relocated in a different position, as well as which could be disregarded. While the students appropriated the rules of the game, the number of columns and symbols was increased, in order to make them build and generalize some concepts involving combinatorial reasoning and the multiplicative principle. According to Grando (1995), this game can be classified as pedagogical, as it encompasses games of chance, strategy and concept setting.

The application occurred in a school period and had the participation of students from the 8th and 9th years of Elementary School. The purpose of the activity was not to find out which students would be winners, but to promote a meaningful teaching-learning relationship based on the use of the game in order to lead students to interact with their peers, formulating hypotheses, attempts and solutions for the problem in question. The game in question can also be applied in high school, in order to build, improve and deepen concepts related to combinatorial analysis.

Before conducting the application, simulations were carried out with students of the undergraduate course in mathematics at the State University of Maringá, to which we were linked, in order to familiarize themselves with the game, better knowing its rules, discussing which mathematical concepts could be addressed from there, taking into account the level of education for which the activity would be proposed in order to ensure that the use of the game promotes the learning of such concepts, represented in Figure 2.

Materials used:

Figure 1. Game Card.



Source: Authors.

Number of players: Two

Objective: Find out what your opponent's password is.

Game rules:

1. It is decided by some criterion who will start the game;

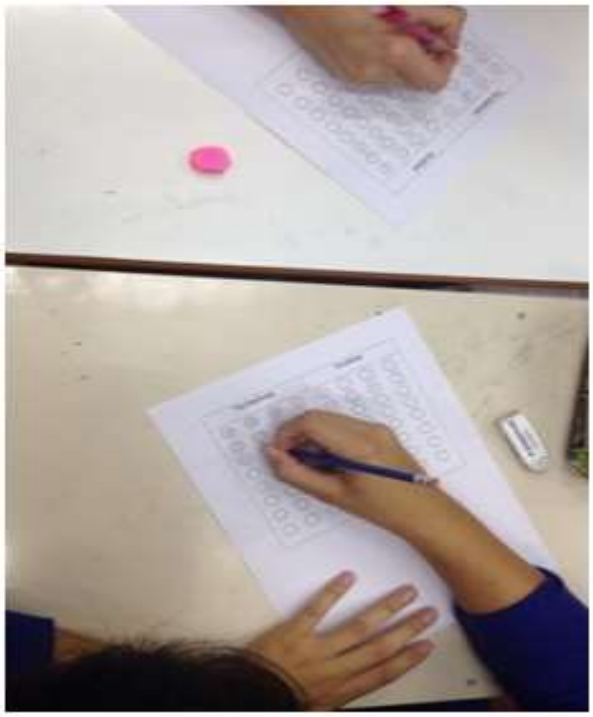
2. Both players (without the opponent seeing) choose four of the six symbols available to compose their “password”, as well as the order in which these symbols will be displayed on their cards;

3. Player (A) must fill in the circumference contained in the tentative wing, and the other player (B), who will guess the passwords, must also use his circumference contained in the tentative wing to launch his guesses in order to guess the order of the symbols that make up your colleague's password.

4. After making a guess, player (B) gives his card to player (A) and vice versa. Both players will use the circumferences contained in the analysis wing to verify that the password formed by the opponent resembles the password initially created.

5. If the symbol is in the right place, player (A) or (B) must leave it fixed. If the symbol is in the wrong position, both players must cancel the position it is in, but they will make a square or other representation (previously agreed between the players), in order to indicate that the symbol is present in the password, but not in that position and finally, if the symbol is not contained in the password, it is crossed out.

Figure 2. Students performing the activity.



Source: Authors.

4. Results and Discussion

In order to guarantee the anonymity of the participants and the suitability of the discussions presented here, fictitious names are used in subsequent discussions. The first relevant aspect to be noted was the observation made by one of the students here called a student (1):

Student (1): *"If I have already placed a symbol in a certain position, I cannot place it again in another position, because the password is made up of different symbols, so it becomes easier and easier to guess the password, already that the possibilities are getting smaller."*

It is clear from the interlocution that the student in question realizes that there is a finite number of possibilities for finding the password and that with each round, the guesses become more restricted, if we pay attention to the order of each symbol in the sequence. This fact is relevant for the discovery of the password and for the discussion and subsequent analysis of other situations with a view to generalizing a mathematical concept.

After that first moment, the students were led to reflect and think a little more about the game, observing their plays and those of their opponent. The intention was to allow

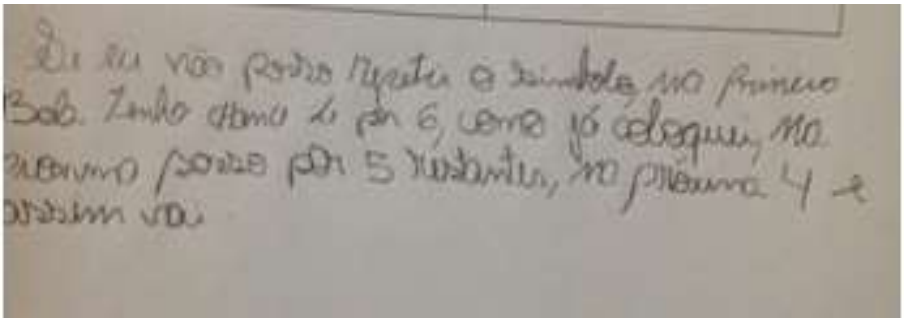
greater discussions about the game. The exchange of pairs was also proposed, in order to lead students to establish new conjectures about the game without touching the definition of the multiplicative principle. During the new plays, one of the students raised the following problem:

Student (2): *What is the minimum number of moves required to win the game? And the maximum?*

The students were looking for a strategy that would make them winners with a fixed amount of moves. For them, there would then be a minimum number of moves in which the winners could be defined. However, the definition of the number of moves will depend on the analysis of the player who will be able to guess the password as soon as the game starts or not, even being able to extrapolate the eight attempts available on his card. This is due to the mathematical concept involved here - that of simple permutation.

When preparing his password, the challenger has 6 possibilities to choose the first symbol, 5 possibilities (since there can be no repetition of symbols) for the second, for the third 4 and finally, 3 possibilities for the last symbol. Therefore, by the multiplicative counting principle, the challenger has $6 \cdot 5 \cdot 4 \cdot 3 = 360$ possibilities to compose his password. Thus, to guess the combination of your opponent, the player must observe what actually happens with the moves, that is, if any of the symbols are part of the sequence and are in the correct position; if it is part of the sequence, but it is not in the correct position; or if that symbol is not part of the sequence. The minimum number of moves will then depend on such facts, and is therefore not a fixed number. But can students, from the analysis of their plays, identify this fact? After some discussions in the groups, one of the pairs came to the conclusion, represented in Figure 3:

Figure 3. Reasoning of one of the pairs present in the application.



Source: Authors.

Bearing in mind that the objective was to build together with the students the mathematical concept referring to the multiplicative principle: “if a decision d1 can be made in n ways and then another decision d2 can be made in m ways, the total number of ways to make decisions d1 and d2 will be the product of n per m (n.m) ”. It was possible to take advantage of the conclusion presented by this pair of students to make a new discussion. We then proposed that the students explain to the other colleagues on the board the conclusion they had reached and what this conclusion implied.

During the presentation and exhibition of the students on the board one of the students stated that he had already studied something similar, and raised another question “can we get the number 360 - corresponding to the number of possibilities making different products such as: 3.4.6.5 or 4.6.5.3, because both lead us to the same result - 360 ”. The student mentions the commutative property of multiplication. At that moment, there was intervention in the application and the class was asked whether in the presented situation - “the game” changing the order of the elements in the product would make a difference or not.

After the question raised, we tried to make the representation of our object with the students - “the password game” questioning the students if it would be possible to consider the products presented taking into account the possibilities of symbols that could be displayed in each of the positions to form the initial password that would then be displayed in the game. From the questions, the students described that the order of the symbols to compose the initial password was based on the number of elements that we would have available to place in the first, second, third and fourth positions, with the product to be considered equal to 6.5.4.3 = 360.

Then, the questioning was redone now thinking not about assembling the password, but about discovering it. For this, we raise the following example: if the player, when trying to guess the opponent's password, hit the symbols that were in the second and third position, how many possibilities would there be to obtain the other elements? Could we here describe the same mathematical representation used to form the initial password or would the product be changed? And if we had found the last three elements of that password, would we still have 6 elements available to compose the first symbol? What would happen?

The students were able to realize that in this situation, the final products would be changed and that the description of these products will depend on the number of symbols that the opponent player had encountered a priori. In the case of the first place, the player when guessing the second and third symbols of the sequence would have 12 possibilities to find the other terms, since now only 4 symbols could occupy the 1st position and 3 symbols the last.

In that case, the final product would be 4.6.5.3. In the second example, we would have only 3 possibilities to find the first term of the sequence, which would result in the product 3.6.5.4.

At that point, two questions were raised, the first regarding the assembly of the password and the fixation of a certain product. For this situation, the example considered with a smaller number of elements. A password was taken with only two elements that should be assembled in four colors and the students should describe all possible possibilities. In this case, the students observed that the sequence of two elements could be described in 12 different ways if the colors were considered: Blue (A); Green (V); Purple (R) and Orange (L), which are: (A, V); (A, R); (A, L); (V, A); (V, R); (V, L); (R, A); (R, V); (R, L); (L, A); (L, V) and (L, R). So it was asked if we changed the order in which these elements appear (sequence order) would we change the possibilities? That is, to think that for the first element of the sequence there are 4 possibilities and for the second 3, or to think that for the second term of the sequence we have 4 possibilities and that for the first there would be only 3, the total number of passwords would change or both would we have the 12 possibilities described above?

From the intervention, students were led to understand that in the previous case, regardless of the position chosen to set the 6, 5, 4 or 3 possibilities, the total number of passwords obtained will always be the same 360. However, to facilitate the visualization of what occurs, we used the description of a sequence that follows the form of the written record - from left to right, so we always think a priori about the product 6.5.4.3. However, as the symbols do not repeat the order in which we set the largest quantity (6 possibilities), it already leads us to think that for the next chosen terms we will have 5, 4 and 3 possibilities. Thus, when changing the representation, in this case it does not lead us to find different passwords.

The second issue discussed here was whether or not to limit the fixed number of moves to identify a winner. In this case, after some notes previously described, the students were able to understand that, to determine the winner, there is no fixed number of moves, since the possibilities will be different depending on the number of signs found, a fact that depends on the observation ability of the player regarding their moves as well as the luck factor that will influence the faster finding of the password.

At the end of the discussions, we explained that the mathematical concept behind this activity was that of simple arrangement that involves the multiplicative principle in which: “the first place can be filled in n different ways, the second in n - 1 ways, the third of n - 2 ways and so on until the p-th place, which can be filled in n - (p + 1) different ways, which by the multiplicative principle can be described as: A (n, p) = n. (n - 1). (n - 2). (n - 3). ... .(n - (p

- 1)) ". It was also emphasized that such concepts will be deepened in later years and that the concepts presented are part of a branch of mathematics which is called Combinatorial Analysis.

5. Final Considerations

Understanding Mathematics is learning to verbalize thoughts and reasoning, listening to opinions and ideas in order to argue, criticize, negotiate, establish conjectures, parameters of agreement. Finally, it is to develop strategies that help in solving problems with which students can reflect on the real meaning of this science and its presence in our daily lives.

However, for this to happen, the teacher must prioritize in his daily practice strategies that allow group work, discussions, the formulation of arguments and counter arguments by the students, since the group discussions mediated by the teacher, have the potential to generate rich interactions.

When working with his peers, the student verifies the existence of hypotheses different from his own, which leads him to conflict and argument. The student feels the need to evaluate and justify his opinions and ends up organizing his own ideas, clarifying his own thinking as well as expanding his own understanding.

Thus, the game in the teaching-learning process of mathematics presents itself as a resource that generates challenging situations for the student, which help in the teaching-learning process, enabling the understanding of the existing mathematical structures, placing the student in situations in which he will have to think from the rules of the game, establishing hypotheses and conjectures with a view to solving them.

Despite this, the simple introduction of games in the teaching of mathematics does not guarantee the learning of the discipline. In this process, the teacher plays a primary role that goes far beyond the choice of materials to be used, going through the objectives and intentionality when choosing and proposing such a resource in the classroom, as well as creating an atmosphere of mutual respect, establishing the necessary conditions for its proper execution. Your role will then be that of a facilitator, mediator between language (present in problem situations and group discussions), students and mathematics.

It was noted that, during the application, many observations and questions may arise from the students and that we need to be prepared to mediate such questions in order to build concepts in a collective and intermediated way, avoiding the simple presentation of the mathematical elements present in the situations raised for the game. It is necessary to be open

to the possibility of unforeseen situations and questions, because when using these resources we will never be certain and convinced of what questions and analyzes will be triggered at the moment of the activity.

Therefore, it is emphasized that new research is developed addressing concepts of statistics in the classrooms, either through manipulable materials, workshops, gymkhana, among other enhancers different from traditional teaching, this fact being justified by the potential observed when developing the critical knowledge of the students educated about the information that can be collected on a daily basis.

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