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CHAPTER 2

SOME GAMES FOR TEACHING GEOMETRY IN THE EARLY YEARS OF ELEMENTARY SCHOOL

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ABSTRACT

This research aims to contribute to the teaching practice of educators who teach the mathematics curriculum component in the early years of elementary school. Characterized as bibliographic and exploratory research with a qualitative approach, it seeks to identify activities that incorporate playfulness in the teaching of geometry for the early years. The suggested activities involve games covering plane geometry and/or spatial geometry. As theoretical foundations, we draw on Huizinga (2004); Smole and Diniz (2007); Malaquias (2013); and Massa and Ribas (2016), which help us understand the importance of using games for teaching mathematics and thereby select them for geometry instruction. We conclude that it is necessary to consider integrating games into mathematics lessons, as we believe it is possible to propose and deliver geometry instruction grounded in playfulness, which contributes to the teaching–learning process of mathematics in the early years.

Keywords: Teaching; Mathematics; Resources; Games.

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INTRODUCTION

During elementary school, it is essential that students have classroom experiences that capture their attention for Mathematics lessons. A teacher who adopts, for example, a game-based methodology encourages active student participation. Dividing the class into groups and solving problems through rule-based games that yield a winner is fundamental for fostering an appreciation of Mathematics.

Designing these ludic activities is challenging for the mathematics teacher.

> Teaching Mathematics as a school subject has proven challenging for educators, given that many students consider it difficult to learn—perhaps because, when taught by traditional methodology with only content presentation and calculation exercises, it feels overly abstract, especially for elementary students who are still developing formal operations, according to Piaget (Massa & Ribas, 2016, p. 2).

The teacher's main challenge is to keep students motivated—a concern across all disciplines, not just the exact sciences. Making learning more meaningful and combating resistance to Mathematics are essential actions for the desired teaching–learning process. Ultimately, the goal is that students not only learn, but also comprehend the material covered in class.

> The use of games in the classroom can be an effective methodological resource to motivate the teaching–learning of Mathematics. Consequently, mathematical games as a teaching tool can promote more engaging instruction and dynamic learning, making lessons more playful and challenging, thereby developing logical reasoning (Massa & Ribas, 2016, p. 2).

Just as games benefit student learning, they also play a fundamental role in the teaching process. The teacher–student relationship becomes more practical, relaxed, and less burdened, allowing both to fulfill their roles more effectively and achieve their objectives.

In this context, the primary objective of this research is to identify activities that incorporate playfulness into geometry instruction for the early years, making lessons more engaging and meaningful for students. After identification, we present how each activity contributes to the development of mathematical content in the early years. We then propose four games.

The main role of these games is to enable students to reflect on the problems discussed in class, seeking solutions through practical, playful engagement that addresses their challenges in an immersive way.

METHODOLOGICAL PATHWAYS

The methodological approach of this research was qualitative, since, in agreement with Bogdan and Biklen (1994, p. 47), "the direct source of data is the natural environment, with the researcher as the primary instrument." We also sought to understand the study object, expanding comprehension rather than explaining the phenomena (Rampazzo, 2005).

The research is also exploratory, linking the themes of playfulness and mathematics teaching in the early years of elementary school. According to Marconi and Lakatos (2003, p. 6), exploratory studies "are empirical investigations aimed at formulating questions or problems for: developing hypotheses, increasing the researcher's familiarity with an environment, fact, or phenomenon, or clarifying concepts." We agree with Prodanov (2013), who emphasizes that exploratory research gathers information to increase familiarity with the subject.

As a technical procedure for data collection, we used bibliographic research, which, according to Gil (2002), is conducted using existing material, primarily books and scientific articles, to foster greater familiarity with the problem and stimulate comprehension.

The research followed these stages:

1. Literature review on the research theme, including articles, dissertations, books, and curricular documents such as the National Curricular Parameters (PCN) and the Common National Base Curriculum (BNCC);
2. Selection of texts on playfulness in mathematics teaching, focusing on geometry;
3. Research and selection of activities based on playful geometry instruction to develop plane and spatial geometry concepts and knowledge for early elementary students.

Search engines used included Google and Google Scholar, as well as physical and digital libraries.

RESULTS AND DISCUSSION

CHALLENGES OF TEACHING MATHEMATICS AND GEOMETRY IN THE EARLY YEARS

Mathematics is an ancient science, estimated to have originated in Ancient Egypt, although prehistoric humans already used concepts of counting and measuring. Thus, mathematics emerged from humans' relationship with nature and the need to quantify and measure objects. Geometry, part of mathematical knowledge, has also been present in human life since antiquity.

In school geometry, there is often a disconnect between students and the mathematical objects taught, leading to monotonous and seemingly purposeless lessons. It is necessary to contextualize mathematics, as many perceive it as highly abstract and call for more "concrete" approaches linked to everyday life.

One reason geometry is seen as abstract lies in how the subject is taught, often following the order of presentation found in mathematical texts rather than tracing how a concept developed and the questions it answers.

> Although mathematical objects may seem especially abstract, they vividly illustrate the link between abstraction and concrete reality. Counting objects, for instance, naturally demonstrates that the abstract number 5 corresponds to any collection of five items—bananas, people, stones, regular polyhedra, and so on. In fact, knowledge requires abstraction (Machado, 2014, p. 50).

According to Groenwald and Timm (2002, p. 21), “teaching mathematics is developing logical reasoning, stimulating independent thought, creativity, and problem-solving skills.” Playful practices support learning by encouraging greater interest in mathematical content. Play allows students to assimilate geometry concepts in a fun context with peers.

But who teaches mathematics in the early years of elementary education? A significant portion of teachers working in this cycle holds only pedagogical training: they have a degree in Pedagogy, with no additional licensure. Thus, when they are required to teach various subjects, a fundamental question arises: how to teach specific content? Or even more directly, how to teach mathematics?

Although their initial training in higher education prepares them to be polyvalent, many of these teachers believe that what they learned in college/university does not sufficiently prepare them to teach specific content areas in the early years of elementary school.

Since mathematics is a science that requires observation and understanding, learning geometry must be achieved through collective effort. Teachers who teach mathematics/geometry in the early years must develop educational resources based on the competencies and objectives that should be attained in this educational cycle (BRASIL, 2018). In this sense, the teaching of geometry needs to be contextualized to meet the social needs of each era and the educational needs of students.

Therefore, for the teaching of mathematics/geometry to focus on meaningful learning, teachers must understand that each individual learns and evolves in different ways. For this reason, teachers must be prepared, continually seeking to innovate their methods and developing more engaging mathematical activities without neglecting the mandatory curriculum content for the early years.

LEARNING MATHEMATICS THROUGH PLAYFULNESS: IS IT POSSIBLE?

What does playfulness mean? The word "ludic" comes from the Latin ludus, which, according to Huizinga, “encompasses children's games, recreation, competitions, liturgical and theatrical representations, and games of chance” (Huizinga, 2004, p. 41). For Malaquias (2013), the impulse to play is a natural characteristic of children.

> [...] playfulness naturally induces motivation and fun. It represents human freedom of expression, renewal, and creation. Playful activities allow children to creatively rework feelings and knowledge, building new possibilities for interpreting and representing reality according to their needs, desires, and passions. (BRASIL, 2012, p. 6).

Regardless of chronological age, playfulness is present throughout an individual's life. However, it should not be restricted solely to moments of leisure but should also contribute to moments of creative development, social interaction, and linguistic, cognitive, motor, and affective domain (Iavorski, 2008).

According to Luckesi (2015, p. 6), playfulness is an internal and personal experience. We recognize that playfulness is a fundamental component of human development, widely incorporated into educational practices. In the educational context, play fosters interest in other activities, enabling the use of reasoning to solve problem situations and expanding students' mathematical knowledge, while also stimulating imagination.

Playful activities are powerful tools for teaching mathematics, as they stimulate creativity, encourage students to face challenges, and promote socialization. In mathematics, playfulness can include games, concrete materials, songs, and rhymes to teach mathematical concepts.

However, it is not enough to simply play, sing, or engage in games without intentionality or educational objectives. For example, when we talk about games, we agree with Kishimoto et al. (2017) apud Fromberg (1987, p. 36), that a game should include the following characteristics: (a) symbolism: representing reality and attitudes; (b) significance: enabling the relation or expression of experiences; (c) activity: the child does things; (d) voluntary or intrinsically motivated: incorporating motives and interests; (e) rule-governed: subject to implicit or explicit rules, and (f) episodic: with goals developed spontaneously.

We emphasize here that we understand games as a pedagogical resource that provides students with a favorable environment for learning mathematics (Smole; Diniz; Milani, 2007). Furthermore, as highlighted by the BNCC, they are voluntary activities conducted within time and space constraints, enjoyable for students, and whose rules can be altered or modified before the activity begins (BRASIL, 2018).

When we choose to use games as a playful teaching strategy for mathematics lessons, teachers must keep in mind the need to facilitate learning. Thus, students in the early years should find joy in learning. We then understand that:

> [...] for Mathematics and its exercises, often the cause of fear and insecurity, nothing is more appropriate than the use of games to work on mathematical concepts and enable students to genuinely grasp them. Games are the means to make mathematics enjoyable and the discovery of solutions pleasurable, as they truly are, although students have not yet had the opportunity to perceive mathematics in this way due to its intimidating character. The discovery and search for solutions provide children with the pleasure of learning. The challenges contained in playful situations can help not only to build mathematical knowledge but also to make students feel challenged to solve problems and puzzles. (Nunes; Saraceni, 2013, p. 28).

The game should help students in the early years think mathematically. Even though there is an element of fun, the ultimate goal remains learning.

SUGGESTIONS FOR MATHEMATICAL ACTIVITIES FOR THE EARLY YEARS

Following the initial reflections presented in this research, we selected four mathematical games focusing on plane and spatial geometry. Our aim is to offer activity suggestions for teachers working in the early years of elementary education.

Activity 1: Hex Game*

This game helps in identifying and recording similarities and differences among the geometric shapes used in the game. In other words, it aids in shape recognition and also contributes to naming figures such as hexagons, trapezoids, triangles, squares, rhombuses, and parallelograms; counting vertices and sides; composing and decomposing figures; and visual discrimination and memory.

One advantage of using this game with students is that it fosters spatial awareness and skills essential for geometric thinking, particularly visual, verbal, drawing, and logical abilities (Smole; Diniz; Cândido, 2007). For this game, we highlight:

Components: Game board and 36 colored geometric pieces.

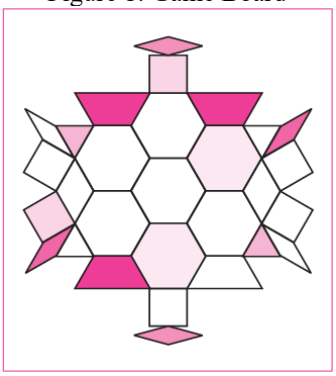
Objective: To be the last player to place one of the available pieces on the board. It is not necessary for the board to be completely covered with pieces.s.

Game rules:

- The class should be organized into pairs.
- The pieces should be spread around the board, accessible to all players. Next, decide who will start.
- The chosen player will select one, two, or three pieces of different colors to place on the board. Once they start placing the pieces, no exchanges are allowed.
- On the board, pieces must be placed without covering the lines that delineate the geometric shapes. The entire space does not need to be covered, leaving room for other pieces.
- Once pieces are placed, they cannot be removed or repositioned.
- The winner is the player who manages to place the final piece(s) in the available spaces or if the opponent cannot fit all the pieces they selected.

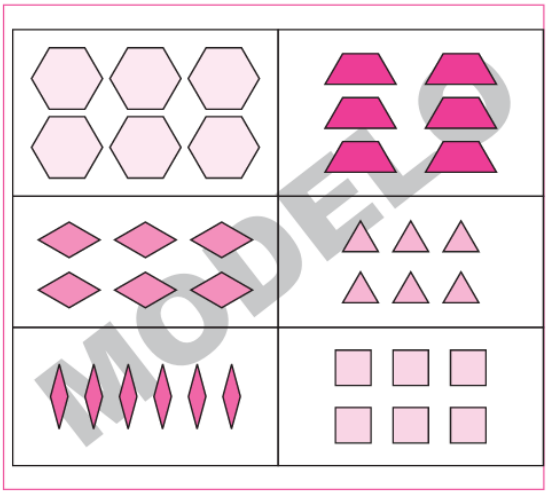
Throughout the game, teachers can pose questions to help students choose their pieces and better understand the game at each round. Sample questions include: How many ways can we cover the trapezoid, the rhombus, or the hexagon?

Figure 1: Game Board



Source: Smole; Diniz; Cândido, 2007.

Figure 2: Game Pieces



Source: Smole; Diniz; Cândido, 2007.

At the end of the game, students can be asked to create a drawing to document their gameplay experience. Drawing a classroom experience is a way to record significant moments, giving the teacher insight into which aspect of the game each student focused on (Smole; Diniz; Cândido, 2007).

This game helps students develop visual, verbal, drawing, and logical skills. Visual skills involve the ability to interpret diagrams and schematics, identify shapes, and visualize their properties. Verbal skills involve expressing perceptions, elaborating and debating arguments, justifications, or definitions, describing geometric figures, and using specific geometry terminology.

Drawing skills refer to the ability to communicate ideas through drawings and diagrams, including tasks like constructing figures using a ruler. Logical skills involve analyzing and evaluating arguments and definitions, identifying valid or invalid arguments, presenting counterexamples, and understanding and creating demonstrations.

Activity 2: Property Card Game

This game helps students identify plane figures and their properties, record similarities and differences between them, develop geometry-related vocabulary, and identify and count vertices/sides in some plane figures (Smole; Diniz; Cândido, 2007).

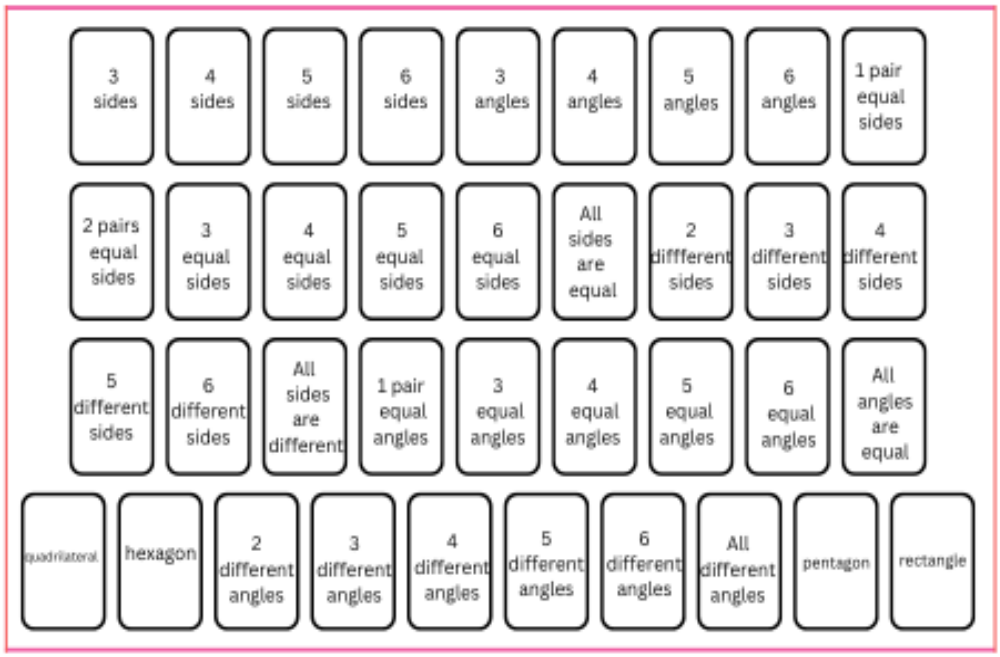
Components: 14 cards, each with a plane geometric figure, and 37 cards, each with a geometric property.

Objective: Score the highest number of points by the end of the game.

Game rules:

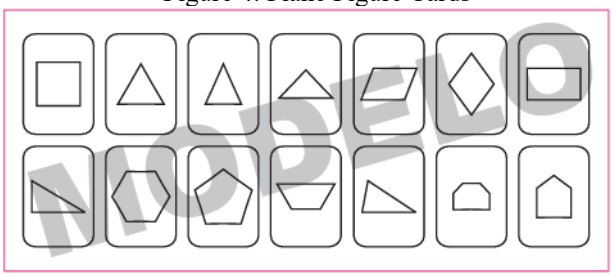
- The class is organized into groups of four players.
- A dealer places the deck with plane figure cards face down in the center of the table and deals five property cards to each player.
- The dealer then turns over the top card of the deck and places it face up for all players to see. Anyone with a property card related to the figure turns over their card and earns points if correct. Multiple players can score in a single round.
- Property cards are then collected by the dealer, shuffled, and five new cards are dealt to each player. The next figure card is revealed.
- The game ends when all figure cards are used.
- The winner is the player with the most points

Figure 3: Property Cards



Source: Smole; Diniz; Cândido, 2007.

Figure 4: Plane Figure Cards



Source: Smole; Diniz; Cândido, 2007.

After the game, teachers may ask students:

- What are all the geometric properties of the triangle that appear on the cards?
- What are the names of the plane figures shown on the cards?
- What properties are shared by squares and rectangles?
- Find a property that applies to three different figures.
- Create a riddle and exchange it with a classmate.

The "Property Card Game" offers significant educational benefits. While playing, students develop their ability to identify plane geometric figures and their properties, such as the number of sides, vertices, and symmetries, fostering a deeper understanding of geometric concepts. Additionally, the game helps build technical geometry vocabulary, familiarizing students with the correct terms to describe shapes and their features.

Group interaction should be encouraged, fostering a collaborative environment where students work together to apply knowledge in a practical and fun way. The game's dynamics, involving quick thinking and property comparison, stimulate critical thinking and the ability to make connections between different geometric concepts, making learning more meaningful and engaging.

Activity 3: Solid Figures Scavenger Hunt

The "Solid Figures Scavenger Hunt" game aims to help students recognize and differentiate the main geometric solids in a practical and fun way. By bringing everyday objects that represent geometric shapes such as spheres, cylinders, and cones, students can visually and physically explore the characteristics of these solids.

Objective of the game: To identify and differentiate geometric solids using objects brought by students.

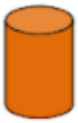
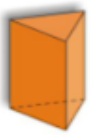
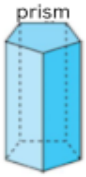
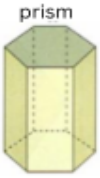
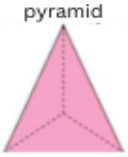
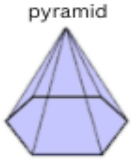
Components: Objects, packaging, containers, etc., shaped like identifiable geometric solids.

Game rules:

- The game should be conducted in groups of 4 or 5 students.

- Each student group must bring to school objects, packaging, containers, etc., that resemble geometric solids with the intention of differentiating these shapes.
- Points are awarded according to a specific table where each type of geometric solid has a designated score.
- For the point count, up to three examples of each geometric solid will be considered..

Figure 5: Points Table

Geometric Solid	sphere 	cylinder 	cone 	cube 
Points	3	3	5	5
Geometric Solid	parallelepiped 	retangular-based prism 	pentagonal-based prism 	hexagonal-based prism 
Points	3	7	10	10
Geometric Solid	trinagular based pyramid 	square based pyramid 	pentagonal based pyramid 	hexagonal based pyramid 
	10	8	10	10

Source: Gomes; Franco, 2013.

In addition to promoting learning about geometry, the game encourages teamwork, careful observation, and creativity while fostering the development of classification and shape identification skills in the surrounding environment. The activity also promotes healthy competition, motivating students to engage more deeply with the task and to explore the content in an active and collaborative manner.

Activity 4: Geometric Bingo

"Geometric Bingo" is an educational game designed to reinforce learning about geometric solids and their planar representations. The game enables students to differentiate and establish relationships between spatial figures and their two-dimensional representations in an interactive and enjoyable way.

Objective of the game: To assist students in recognizing and differentiating geometric solids and their nets, promoting understanding of the relationships between spatial figures and their planar representations.

Components: Bingo cards with drawings of geometric solids, markers (such as beans, corn kernels, bottle caps, etc.), information cards with descriptions of geometric solids, and a container to hold the cards.

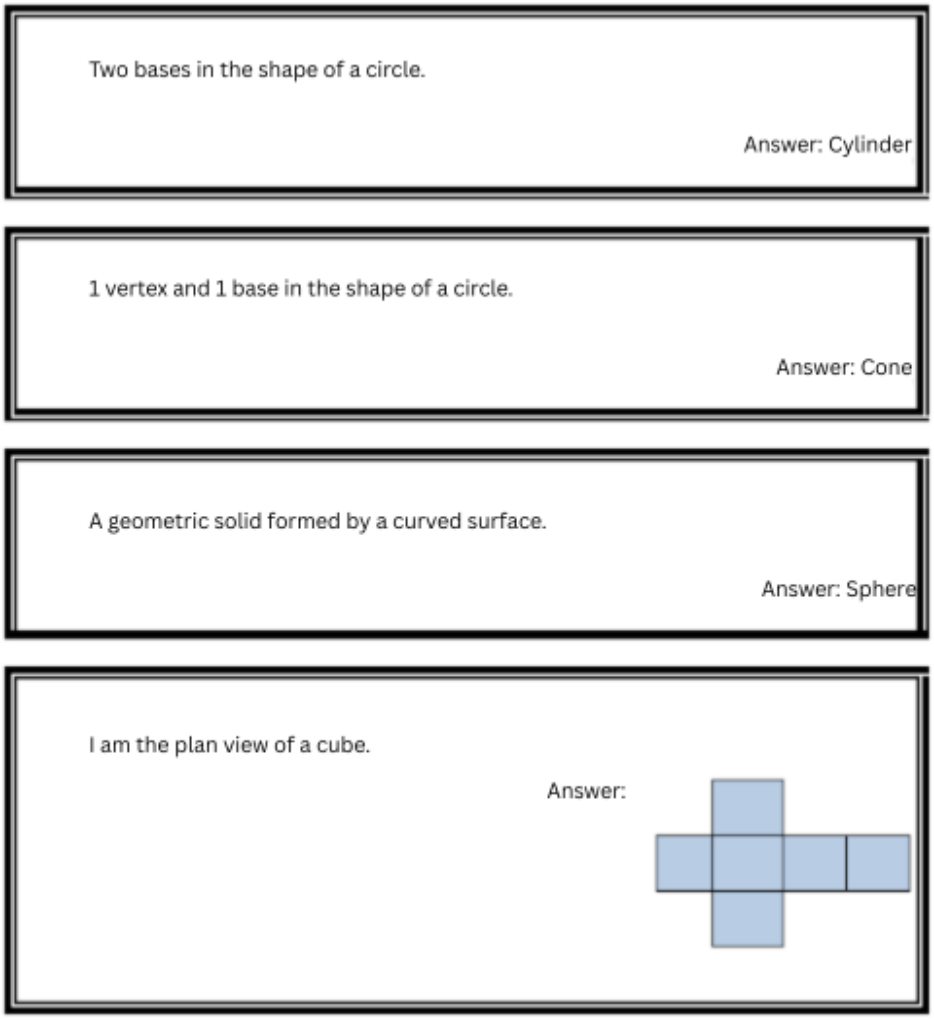
Game rules:

- Each student will receive a bingo card featuring different geometric solids and their corresponding nets, allowing them to identify and establish connections between spatial figures and their planar representations.
- The teacher will draw a card containing a description of a geometric solid and read it aloud.
- Students who have the corresponding solid or its net on their bingo card will mark it.
- The winner will be the first student to complete their bingo card. Once this happens, the student should loudly say "bingo" to announce their victory.

Figure 5: Examples of question cards

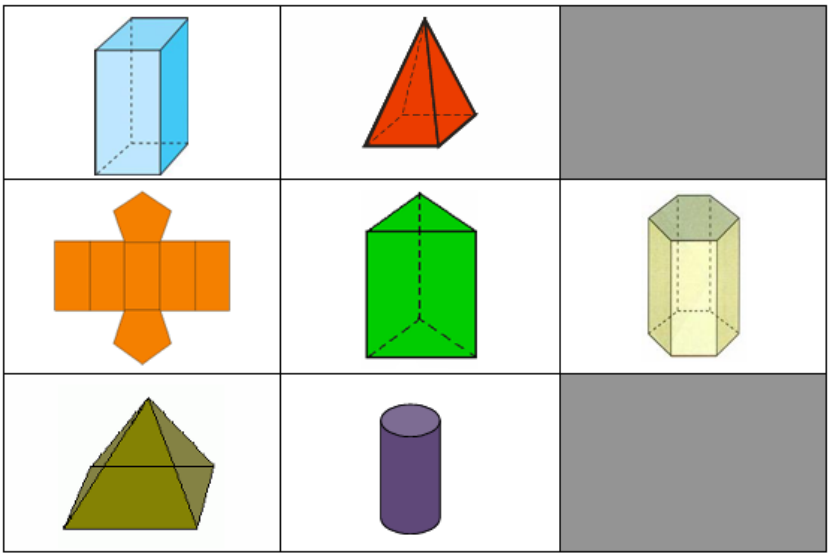
Source: Gomes; Franco, 2013.

Figura 6: Examples of question cards



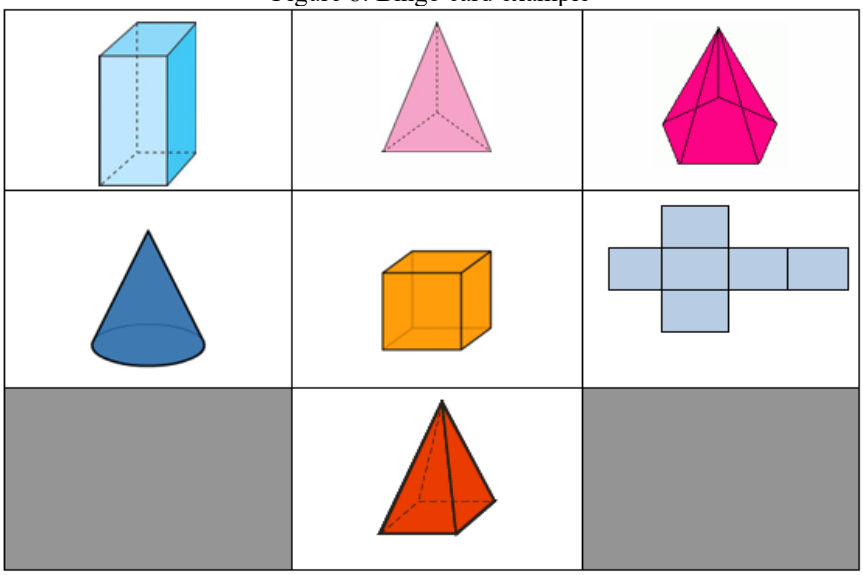
Source: Gomes; Franco, 2013.

Figure 7: Bingo card example



Source: Gomes; Franco, 2013.

Figure 8: Bingo card example



Source: Gomes; Franco, 2013.

The game contributes to student learning by allowing them to identify and relate geometric solids to their nets in a practical and enjoyable way. Moreover, it promotes memorization, logical reasoning, and attention to detail while encouraging interaction among peers and active participation in the learning process, making geometry more engaging and accessible.

FINAL CONSIDERATIONS

The development of visual, verbal, drawing, logical, and technical vocabulary skills in geometry are just some of the contributions observed in each of the games presented. These characteristics initially reinforce the importance of incorporating games into Mathematics classes.

Through these tools, students are exposed to practical and concrete ways of applying abstract concepts, facilitating the assimilation of content. Furthermore, the use of games enables experiential learning, meaning that learning occurs through experiences and actions that consolidate knowledge in a more solid and lasting way. Thus, geometry—often seen as a difficult-to-understand area—becomes more accessible and interesting for students.

There are also other advantages that students may develop during the application of these games. By engaging students through questioning and inquiry, the games encourage them to think and reflect on the problems to be solved, stimulating the development of quick reasoning as they make connections between the explored possibilities. This fosters critical thinking, as students are challenged to evaluate different solutions to the same problem, reflect on their choices, and adjust their strategies as necessary. Additionally, this process helps develop problem-solving skills, which are essential not only in academic contexts but also in everyday situations.

Moreover, the dynamics of implementing a game offer students healthy group interaction, promoting, even within competition, a collaborative environment in the classroom. Rather than viewing competition as a barrier, games enable it to become a catalyst for cooperation, where students, working together, share knowledge, strategies, and solutions.

This collaborative environment not only facilitates collective learning but also contributes to building social skills such as communication and teamwork. It also enhances memorization and active student participation, making the teaching of geometry more captivating and effective. By engaging actively, students tend to retain information better and apply concepts more confidently across different contexts.

Therefore, by integrating games into Mathematics teaching—especially in geometry—a more dynamic and interactive environment is created, promoting learning in a more engaging and meaningful way. This not only improves academic performance but also prepares students to face future challenges more creatively and collaboratively, developing skills that go beyond simple mastery of technical content. The use of games thus stands out as a powerful strategy that can transform Mathematics teaching into a more enriching and enjoyable experience for everyone involved.

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