Exploring Traditional Games in Timbazia Village

Florida Owa, Yohanis Ndapa Deda, Stanislaus Amsikan

Department of Mathematics Education, University of Timor, East Nusa Tenggara, Indonesia
E-mail: yndapadeda@unimor.ac.id

Abstract

East Nusa Tenggara is home to several villages with traditional games that are intrinsically linked to mathematical learning contexts. However, these traditional games are often underutilized by educators in these areas as starting points for teaching mathematics. This study aims to identify the mathematical concepts embedded in these traditional games and to explore the cultural values and benefits associated with them in Timbazia village. A qualitative research methodology with an ethnographic approach was employed in this study. Data was collected through observation, interviews, and documentation from the same sources. The data analysis followed Spradley's framework, encompassing domain analysis, taxonomy, componential analysis, and cultural themes. The findings reveal that the traditional game known as "Boy's game" encompasses various mathematical concepts, including basic geometry (such as circles, rectangles, squares, triangles, and trapeziums), the concept of a sphere as represented by the Katu ball, symmetry, probability, combinations, and arithmetic operations including addition, multiplication, and subtraction. Additionally, the game incorporates mathematical logic and elements of the Pythagorean Theorem. Beyond its mathematical dimensions, Boy's Game embodies several cultural values, including solidarity, togetherness, discipline, effective communication, acceptance of both success and failure, respect for cultural heritage, and patriotism. The benefits derived from playing Boy's Game include enhanced understanding of mathematical concepts, development of motor skills, promotion of collaborative learning, improvement in social skills, acquisition of cultural values, advancement of strategic thinking abilities, and enhanced concentration and focus.

Keywords: Ethnomathematics, Qualitative Method, Spradley's Design, Traditional Boy Game

Introduction

Indonesia is renowned for its myriad islands, each rich in cultural heritage. The nation's cultural diversity represents a significant asset that can be leveraged to address contemporary challenges, such as the erosion of local culture in the face of technological advancements. Among the manifestations of local cultural diversity are traditional games (Fitri et al., 2020). These games serve as reflections of a country's cultural background, beliefs, and passions, encapsulating the living conditions at the time of their inception (Palumbo et al., 2019). Although traditional games are widely appreciated by communities, there has been a noticeable decline in public interest over time (Aisyah, 2017).

Children are increasingly moving away from traditional games, perceiving them as outdated and less engaging, despite the numerous benefits they offer (Wahyuni et al., 2019). Technological advancements have shifted the popularity from traditional games to modern alternatives (Dyani, 2020). Timbazia village, located in the Nangapanda District of Ende Regency, East Nusa Tenggara Province, is a notable area with a rich diversity of traditional games. In Timbazia Village, traditional games include Boy game, kaku awu (congklak), marbles, jidhi jedhe, ana maria (catfish per game), among others. Notably,

the Boy game remains popular among children today.

The Boy game has been a longstanding tradition in the Timbazia Village community. Typically played in groups, the game involves two teams: one team is the playing team, and the other is the opposing team (Haryawati et al., 2017). Furthermore, Rodziyah et al. (2019) explain that the Boy game usually comprises five to ten players per team and is conducted in a relatively large field. Notably, in Timbazia Village, the Boy game is played with unique variations compared to other regions.

This traditional game incorporates mathematical concepts, whether consciously or unconsciously, which warrants exploration to identify these mathematical elements. To conduct a thorough investigation, an exploration within the field of ethnomathematics is necessary. Ethnomathematics is an educational approach that integrates mathematical learning with cultural contexts, utilizing cultural products as sources of mathematical knowledge (Eglash et al., 2006). D'Ambrosio and Rosa (2017) define ethnomathematics as the practice of mathematics by various cultural groups, including urban and rural communities, labor groups, specific age groups, indigenous peoples, and others. This approach connects mathematical concepts with the cultural values present within a community.

Traditional games are a significant cultural activity that not only embody cultural values but also contain elements that are relevant to learning, including mathematics education (Salsabilah et al., 2022). These games can serve as effective tools in ethnomathematics learning methodologies (Zuhri et al., 2023). On the other hand, Zayyadi et al. (2018) indicated that traditional games can be integrated into ethnomathematics learning methods as a means of fostering social interaction among students while connecting them to local cultural contexts. One such traditional game with inherent value is the Boy game.

Several studies have demonstrated that the traditional Boy game can serve as an effective learning medium. Research conducted by Safitri (2022) on ethnomathematics within the Boy-boyan game concluded that the game encompasses various ethnomathematical aspects, including concepts related to plane geometry, spatial structures, probability and counting, and speed. Additionally, Aisyah (2020) explored the impact of traditional Boy-boyan games on early childhood social development. The study revealed a positive influence of these games on the social development of early childhood in Group B at TK Muslimat NU 79 Miftahul Huda Jemundo Taman Sidoarjo.

These findings underscore the multifaceted benefits of traditional Boy games. Consequently, this research aims to investigate the mathematical concepts embedded in the Boy game, as well as to explore the cultural values and additional benefits it offers.

Methods

This research employed a qualitative methodology with an ethnographic approach (Reeves et al.,

2008). The study was conducted in February in Timbazia Village, Nangapanda District, Ende Regency, East Nusa Tenggara Province. The research participants included five informants: a community shop representative (aged 48 and 22 years), an elementary school mathematics teacher (aged 55 years), and two children who engage in playing the traditional Boy game (aged 8 and 11 years), totaling five subjects.

The initial stage of the study involved selecting informants, specifically children who participate in playing the traditional Boy game, as data sources. The data collection methods employed included observation, interviews, and documentation (Amsikan & Deda, 2023). Observations were conducted directly with the children engaged in playing the Boy game, while interviews were carried out to gather information regarding the game's form, gameplay, and perceived benefits from the informants. The instruments utilized in the study comprised the researcher, observation guidelines, interview guidelines, and a cell phone for recording purposes. Data analysis was performed according to Spradley's framework, which includes domain analysis, taxonomy analysis, componential analysis, and cultural theme analysis (Febrian et al., 2023).

Results and Discussion

On February 16, 2024, the researcher obtained a research permit from the Village Head of Timbazia Village, which served as formal authorization to conduct research in the village. Following the meeting with the Village Head, a recommendation was made to focus on Mboapoma Hamlet. Subsequently, on January 17, 2024, the researcher approached the interviewees and children to request their consent and schedule interviews. The selected informants were individuals familiar with the Boy game, particularly those who had prior experience playing it.

Research activities commenced on February 17-18, 2024. The researcher first conducted observations of the children engaged in playing the Boy game, and simultaneously conducted interviews with the players. The observations focused on several aspects: the tools and materials used, the layout and structure of the Boy game arena, the rules of the game, the strategies employed by the players, and the number of participants.

Description of the Traditional Boy Game

The traditional Boy game is characterized by its unique set of rules and gameplay mechanics. The game is described as follows:

a. The game begins with players creating *katu* balls from wads of paper, which are secured with rubber bands. The playing area, known as the Boy game arena, is then drawn using limestone and wood to ensure precision. The arena consists of 13 boxes: 12 boxes are outlined, each measuring 3x4, and one main box is designated for storing 12 stones. After drawing the arena, the players

collect 12 stones and divide themselves into two groups. Each group must consist of at least 2 and no more than 6 players.

b. Representatives from each group engage in a game of rock-paper-scissors to determine which group will play and which will guard. The winner becomes the playing group, while the loser becomes the guarding group.

c. The playing group throws the ball towards the pile of stones from a predetermined distance. Each member of the playing group is allowed three attempts to hit the pile of stones. If a thrown ball hits the pile, the playing group retrieves the ball, and the guarding group must retrieve it. If none of the attempts hit the pile, the playing group is declared to have failed, and the roles are reversed, with the guarding group becoming the playing group.

d. Upon successfully hitting the pile of stones, the playing group runs to arrange the 12 stones from the main box into the 12 empty boxes on the arena, ensuring each box is filled with one stone. While doing so, the playing group must avoid being hit by balls thrown by the guarding group. If a player is hit by a ball, they are considered to have failed.

e. If a stone is placed such that it crosses the boundary line of a box or falls outside the designated lines, it is considered a "La" (meaning the attempt is unsuccessful), and the game immediately transitions to the next round of players.

f. Player rotation occurs under the following conditions: (1) All members of the playing group fail to hit the pile of stones with any of their three attempts; (2) All members of the playing group are hit by balls before successfully arranging all 12 stones; (3) A "La" occurs, where stones are incorrectly placed on box boundary lines or outside the designated box areas.

g. A group is declared to have won ("Boy") if it successfully arranges all 12 stones into the designated box spaces without any stones crossing the boundaries and if at least one member of the playing group remains unhit by the ball. The winning group continues to play. During the game, the guarding group employs strategies to aim their balls effectively to hit the opponents and obstruct them from arranging the stones.

Furthermore, the results of the observations in this study encompass various aspects of the traditional Boy game, including the playground setup, tools and materials used, and the activities involved in playing the game. These observations are detailed as follows:

a. Observation of the Boy's Game Arena

    Figure 1 shows the result of observations of the Boy game arena. The game arena is depicted on the field using white stones with boxes with a total of 13 boxes where 12 boxes are 3x4 and one

box as the main box for storing 12 stones. The line as a determinant of distance in throwing the ball.

Figure 1. Observation of the Boy's Game Arena

b. Observation of the tools and materials used

Figure 2 explains the result of observations of the tools and materials used in traditional Boy games. The tools and materials used are paper, rubber, Watu (stone) and katu ball made of a lump of paper and tied using rubber.

Figure 2. Paper, Rubber, Ball Katu, and Watu (Stone)

c. Observation of the Rules in the game Boy

Figure 3 shows the result of observations of the rules found in Boy's game.

Figure 3. Suit: Rock Paper Scissors and the player shows that there is la

The rules found include representatives of the group do paper rock scissors to determine which group will play and one of the rules in Boy's game is la. In the picture one of the members of the watch group shows that la occurred. La is a stone that is arranged by the playing group on the boundary line between boxes or even out of the existing box. If la occurs, Boy will fail.

d. Observations on play activities

Figure 4 shows the result of observations on playing activities whereas shown in the picture are the activity of throwing the ball towards the pile of stones from a mutually agreed distance and in the other picture is a strategy carried out by the guard group in covering the ball to block the opponent from arranging the stones and happening Boy.

Figure 4. Ball throwing activity and player strategy to cover the ball

e. Observations Number of players

Figure 5 shows the number of members in the traditional boy game, which is divided into two groups

Figure 5. Number of players

Based on the results of the research through observation and interviews, several mathematical concepts present in the traditional Boy game in Timbazia Village were identified. The Boy game

incorporates various elements of mathematics, cultural values, and numerous benefits. Key findings related to the ethnomathematical aspects of the game include:

a. Basic Geometry Concepts: The game encompasses fundamental geometric shapes taught in elementary school mathematics, such as circles, rectangles, squares, triangles, and trapeziums.

b. Concept of the Ball: The katu ball used in the game represents the mathematical concept of a sphere.

c. Concept of Symmetry: The design of the Boy game arena demonstrates the application of symmetry.

d. Concept of Chance: Elements of probability are evident in the game's mechanics and outcomes.

e. Concept of Combination: The game involves combinatorial strategies in organizing and arranging stones.

f. Concept of Line: The game arena's layout includes the use of lines to define boundaries and spaces.

g. Concept of Calculation: Mathematical operations such as addition, multiplication, subtraction, and division are inherent in various aspects of the game.

h. Concept of Mathematical Logic: The rules of the game reflect logical reasoning and problem-solving strategies.

i. Concept of the Pythagorean Theorem: The theorem is applied in the strategies used by players to pass the ball effectively.

The following section will provide a detailed explanation of these research findings.

Domain Analysis

The initial stage of data analysis involves domain analysis. From the study results, the researchers identified several ethnomathematical domains within the traditional Boy game. These domains include:

a. Design Activities: The process of creating and setting up the game, including the design of the game arena and the arrangement of tools and materials.

b. Tools and Materials: The objects used in the game, such as katu balls and stones, and the methods of their preparation.

c. Game Arena: The physical layout and markings of the playing field, including the design and dimensions of the boxes and boundaries.

d. Playing Activity: The procedures and strategies involved in playing the game, including the rules and interactions between players.

These findings represent the key ethnomathematical aspects observed in the traditional Boy game.

Taxonomy Analysis

The second stage of data analysis involves taxonomy analysis. Based on the research findings, the taxonomy analysis of the traditional Boy game encompasses two main categories related to design-making and playing activities:

a. Spatial Shapes in Tools, Materials, and Game Arena

The tools and materials used in the game, as well as the design of the game arena, exhibit various spatial shapes. This includes the geometric configurations of the game arena and the forms of the tools, such as the katu balls and stones.
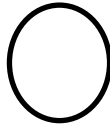
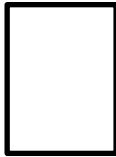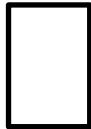b. Rules and Techniques in Playing Activities

The playing activity involves specific rules and techniques that govern the execution of the game. This includes the procedural aspects of the game, the strategies employed by players, and the techniques used to achieve the game's objectives.

These categories provide a structured understanding of the ethnomathematical elements inherent in the traditional Boy game.
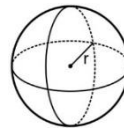
Component Analysis

The third stage of data analysis is compensation analysis. This stage involves a deeper examination of the traditional Boy game to identify and elaborate on the ethnomathematical aspects within mathematical concepts. To achieve this, the researcher analyzes the specific components related to the materials, game arena, rules, and playing techniques. These components are detailed in Table 1.
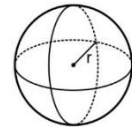
Table 1. Compensation Analysis

Number	Object	Shape	Photograph	Description shape	Conceptualization
1	Tools and materials used	Rubber			Circle
		Paper			Rectangle

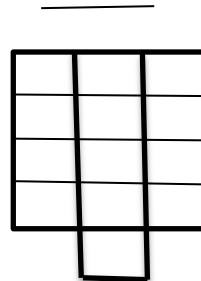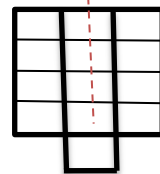|				
	Katu ball			Ball
	Watu (stone)			Trapezoidal shape Triangular shape
2	Boy's playground	Boy's playground		Square In a boy's game arena built by utilizing symmetrical geometric shapes. Line concept
3	Play activities	Paper rock scissors		The rock-paper-scissors activity carried out by group representatives to determine the first player contains the concept of chance.

The activity of throwing a ball towards a pile of stones
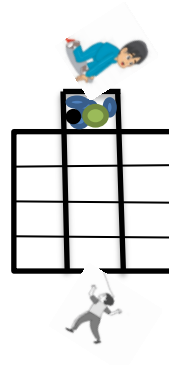
There are several findings of ethnomathematics concepts when players throw the ball

- The concept of calculation is found in the opportunity for each member to throw the ball 3 times

- combinatorial concept by using combinatorial symbols to calculate the number of possible outcomes in this game.

Player activity in arranging the stones into the boxes

In this stone arrangement activity, there are findings of mathematical concepts, namely

- the rules of the game when the player arranges the stones into the box and the stones arranged hit the boundary line or even get out of the existing box it will be said la (failed boy) found the concept of mathematical logic
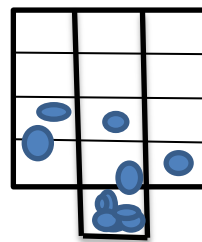
- there is the concept of simple division when players take 12 stones in the main box and fill them

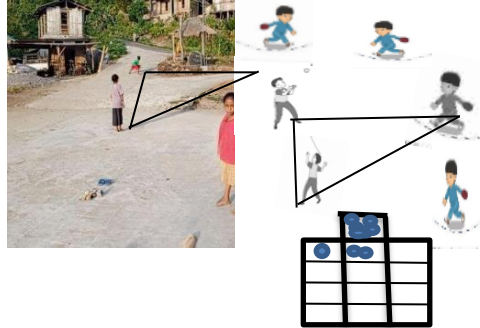|			
			into 12 existing box spaces.
3	Players' strategies for ball handling	right triangle formation in pass ball boy		- When the guard group throws the ball towards the opponent and he is hit by the throw, the player will be declared dead, so there is a concept of reduction. - As for the right triangle pharmaceutical strategy made by the guard group to pass the ball, in keeping the opponent from arranging stones and happening Boy

The results of the study indicate that the traditional Boy game in Timbazia Village exhibits differences from the findings of Safitri (2022) on ethnomathematics in traditional Boy-boyan games. These differences are evident in various aspects of the game, including the design of the game arena, the rules of the game, and the tools and materials used.

In this study, in addition to exploring the ethnomathematical aspects of the traditional Boy game, the researchers also investigated the social values and benefits associated with the game. Furthermore, there are a number of mathematical concepts contained in the traditional boy game, as follows:

a. Concept of Plane Shapes

Several relationships between ethnomathematics forms and elementary school geometry concepts have been identified. These concepts include circles, rectangles, squares, triangles, and trapezoids, each demonstrated through various aspects of the game. The circle is exemplified in the rubber used by players to tie the katu ball. In geometry, a circle is defined as the set of all points in a plane that are equidistant from a fixed point called the center (Juano & Jediut, 2019). This fundamental concept is visually and practically represented in the circular shape of the rubber. The rectangular shape appears in the paper used to craft katu balls. A rectangle is characterized as a parallelogram with four right angles and opposite sides of equal length (Juano & Jediut, 2019). Thus, a rectangle is a quadrilateral where each angle is a right angle, and opposite sides are

congruent. The square is represented in the layout of the Boy game arena. A square is a special type of rectangle where all four sides are of equal length and all angles are right angles (Juano & Jediut, 2019). Key properties of a square include equal length sides, equal right angles, and diagonals that are of equal length, dividing the square into two congruent right triangles. The triangle and trapezoid concepts, though less explicitly described in the game, can be inferred from the spatial arrangements and design elements within the playing arena and materials used. Each of these geometric shapes contributes to the understanding of spatial relationships and mathematical principles within the context of the traditional Boy game. Overall, the traditional Boy game provides a practical application of these geometric concepts, enriching the learning experience through cultural and recreational activities.

In addition to the circle, rectangle, and square, the traditional Boy game in Timbazia Village also incorporates the geometric concepts of triangles and trapezoids through the shapes of the stones used in the game. The triangle shape is represented by some of the 12 stones used in the Boy game. A triangle is a flat, two-dimensional geometric shape bounded by three line segments, forming three angles (Juano & Jediut, 2019). In the context of the Boy game, these triangular stones serve as tangible examples of this geometric form, demonstrating the fundamental properties of having three sides and three angles.

Similarly, the trapezoid shape is found among the stones used in the Boy game. A trapezoid is defined as a quadrilateral with at least one pair of parallel sides (Juano & Jediut, 2019). In a trapezoid, the parallel sides are known as "parallel sides" or "equal parallel sides," while the remaining two sides are referred to as "non-parallel sides." This shape is represented by certain stones in the game, illustrating the concept of a geometric figure with two sides that are not parallel to each other. These geometric shapes—triangle and trapezoid—further enhance the educational value of the Boy game by integrating additional mathematical concepts into its traditional play. This connection to geometry not only enriches the game but also provides a practical application of these concepts in a cultural and recreational setting.

b. The concept of space

In the traditional Boy game observed in Timbazia Village, the katu ball, which is meticulously crafted from paper and secured with rubber, exemplifies the geometric concept of a sphere. A sphere is a three-dimensional shape where all points on its surface are equidistant from a central point, resulting in a perfectly symmetrical form. This geometric figure is distinguished by its uniformity and symmetry; every part of the sphere's surface maintains the same distance from the center, ensuring an even distribution of shape. Unlike other three-dimensional objects, a sphere has no edges or corners, which sets it apart in its physical characteristics. Furthermore, the sphere is defined by its

radius, the distance from the center to any point on the surface, and its diameter, which is twice the length of the radius and represents the longest distance between two points on the sphere's surface, passing through the center. The katu ball's spherical shape demonstrates the practical application of these geometric principles within the context of the traditional game, merging cultural practices with fundamental mathematical concepts.

c. Line Concept

In the traditional Boy game, the concept of a line is represented by the markings made by players to establish the distance for throwing the ball. In mathematics, a line is defined as a one-dimensional figure that extends infinitely in both directions without any width or thickness. It can be visualized as an endless series of points arranged in a straight, continuous path, maintaining parallel alignment. This geometric concept of a line is crucial in the game for measuring and regulating the distance from which players throw the ball, illustrating the practical application of mathematical principles in everyday activities.

d. Symmetrical concept

In the traditional Boy game, the concept of symmetry is prominently featured in the design of the game arena. The arena is constructed using symmetrical geometric shapes, which become evident when an axis of symmetry is introduced. When this axis is drawn, it divides the arena into two equal halves, with each half mirroring the other. This axis of symmetry is a line that splits a shape into two congruent parts, ensuring that each side is a mirror image of the other. This symmetrical design not only highlights an important mathematical concept but also enhances the visual appeal and balance of the game arena.

e. Concept of Probability

In the traditional Boy game, the concept of chance is exemplified through the game of scissors, rock, paper. Each player in this game has three potential choices: scissors, rock, or paper, leading to three possible outcomes per round. The concept of chance is crucial in this game, as the outcome of each round is determined by the random choice of each player. Each choice has an equal probability of 1/3. However, the chance of winning a round varies based on the opponent's choice. For instance, if Tedi chooses rock, there are two favorable outcomes (if Jesika chooses scissors or if Jesika also chooses rock) and one unfavorable outcome (if Jesika chooses paper). Thus, Tedi's probability of winning in that round is 2/3. Probability, in this context, measures the likelihood of a particular event occurring and is calculated as the ratio of the number of favorable outcomes to the total number of possible outcomes. This aspect of the game illustrates how mathematical concepts like probability and chance are integrated into everyday activities, providing a practical application of these concepts.

f. Combination Concept

In the traditional Boy game, the concept of combination is evident in the activity of throwing the ball toward the pile of stones, where players have three attempts to achieve a specific result. This scenario introduces the combination concept, as players face two possible outcomes for each throw: successful (hitting the pile of stones) or unsuccessful (missing the pile of stones). To determine how many different ways the outcomes can occur in these three throws, we apply the combination principle.

For each throw, there are two possible outcomes, leading to various combinations of results over the three throwing opportunities. Using the combination formula, we can explore the different ways players can achieve various numbers of successful throws. Specifically, with n = 3 (the number of throwing opportunities) and r = 0, 1, 2, or 3 (the number of successful throws), we calculate how many distinct ways these outcomes can be arranged.

For instance, if a player successfully hits the pile of stones in 2 out of the 3 throws, this outcome can occur in several combinations. We use combinations to account for all possible scenarios of successful and unsuccessful throws, highlighting how this mathematical concept helps in understanding and analyzing the different possible results of the throwing activity. We count the number of different ways:

• Total number of throws (n) = 3

• We will use any combination of 3 throws, with 0, 1, 2, or 3 successful throws.

$$C\ (3, 0) = \binom{3}{0} = \frac{3!}{0!(3-0)!} = \frac{3!}{3!} = 1$$

$$C\ (3, 1) = \binom{3}{1} = \frac{3!}{1!(3-1)!} = \frac{3!}{2!} = 3$$

$$C\ (3, 2) = \binom{3}{2} = \frac{3!}{2!(3-2)!} = \frac{3!}{1!} = 3$$

$$C\ (3, 3) = \binom{3}{3} = \frac{3!}{3!(3-3)!} = \frac{3!}{3!} = 1$$

The total number of different ways is:

1+3+3+1=8

So, there are 8 different ways in which group members can have different outcomes in 3 tosses, regardless of whether they hit or miss the pile of stones.

g. The concept of basic arithmetic

Based on the results of research on the traditional Boy game in Timbazia Village, several fundamental concepts of elementary mathematics were identified: addition, subtraction, multiplication, and division.

- Addition

  The concept of addition is applied during the game when calculating the total number of opportunities each player in a group has to throw the ball. For instance, if each player has three opportunities and there are four players, the total number of opportunities is calculated as 3 + 3 + 3 + 3 = 12. Addition, being a fundamental mathematical operation, involves combining two or more numbers to find their total.

- Multiplication

  The concept of multiplication is also utilized in the game. For example, to find the total number of opportunities for a group of four players, each with three throws, we calculate 4 x 3 = 12. Multiplication is essentially repeated addition and helps simplify the calculation of total opportunities in a more efficient way.

- Subtraction

  Subtraction is evident in the game when a player is hit by a thrown ball and is declared out. For instance, if there are four players and one gets hit, the number of remaining players is 4 - 1 = 3. If subsequent players are also hit, the calculation continues as 3 - 1 = 2, and so on. Subtraction involves taking away one quantity from another to find the difference.

- Division

  Division is observed when the playing group takes 12 stones from the main box and distributes them evenly into the 12 spaces drawn on the ground. This process illustrates the division concept as 12 ÷ 12 = 1, where each space gets one stone. Division, which can also be seen as repeated subtraction, simplifies distributing a total quantity into equal parts.

In summary, the traditional Boy game in Timbazia Village effectively incorporates fundamental mathematical concepts, demonstrating practical applications of addition, multiplication, subtraction, and division within the game's context. These elements not only enrich the cultural value of the game but also provide an engaging way to reinforce mathematical learning for children.

h. The concept of mathematical logic

In the research results, the concept of mathematical logic in the traditional Boy game is evident in the rules governing the arrangement of stones. Specifically, if the arranged stones touch the boundary line of the box or go outside the designated box, it is declared "la" (failed Boy), and the player's turn ends. This can be understood through the lens of propositional logic, which helps us formally define the rules of the game.

- Propositional Logic in Boy Game Rules

  Propositional logic deals with propositions that can be true or false. Here are the propositions we can define based on the game rules:

  P: Stones are arranged not touching the edge line.

  Q: There is a "la" (Boy failed).

  R: Alternate players (change of turn).

  Using these propositions, the logical implications can be formulated as follows:

  $\neg P \rightarrow Q$: If the stones touch the edge line ($\neg P$), then "la" (failed Boy) occurs (Q).

  $Q \rightarrow R$: If there is a "la" (failed Boy) (Q), then there will be a change of players (R).

- Logical Implication Chain

  Combining these implications, we get a logical sequence that represents the flow of the game rules:

  $\neg P \rightarrow Q \rightarrow R$: If the stones touch the edge line ($\neg P$), then "la" (Q) occurs, leading to a change of players (R).

- Explanation

  $\neg P \rightarrow Q$: This indicates that if the condition of not touching the edge line is not met ($\neg P$), then the consequence is a "la" (Q), meaning the player has failed.

  $Q \rightarrow R$: This indicates that if a "la" (Q) occurs, the turn will pass to another player (R).

- Propositional Logic Representation

  Rule 1: If the stones touch the edge line ($\neg P$), then "la" (Q) occurs.

  Rule 2: If "la" (Q) occurs, then the player's turn ends, and the turn passes to the next player (R).

This formal representation of the game rules using propositional logic provides a clear and precise understanding of the conditions under which players either continue their turn or pass it on to the next player. This logical framework ensures that the rules are consistently applied, making the game fair and educational.

i. Pythagorean Theorem Concept

Based on the study results, the guard group employs specific formation strategies to secure the ball and prevent the opponent from arranging stones and achieving their goals, such as "Boy." A notable strategy is the right triangle formation pattern, which utilizes the Pythagorean Theorem. This formation helps in both planning player placements for maximum defensive effectiveness and optimizing their movements to support counterattacks. By calculating the hypotenuse distance, players receive guidance on maintaining optimal proximity to each other, ensuring team cohesion, and maximizing opportunities to block opponents. These defensive and attacking strategies are crucial in thwarting the opponent's attempts to assemble "stones" and accomplish their objectives.

Figure 6 shows the player positioning in the activity of the players handling the ball
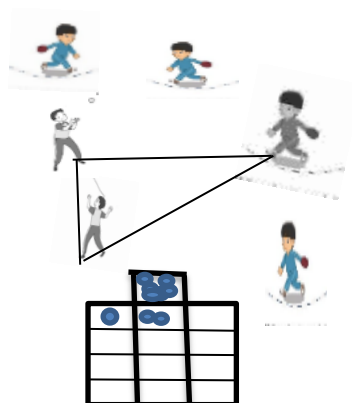

Figure 6. The right triangle formation strategy used by players in covering the ball

The players' right triangle formation consists of four sections, as follows

- Player A is the starting point of one leg of the triangle, ready to cover the ball

- Player B is positioned on the other side of the triangle, ready to receive the ball from Player A about 12 meters vertically from Player A, creating one side of the right triangle.

- Player C is 9 meters horizontally from Player A, with Player A as the right-angle point of the triangle. Player C is ready to receive the ball from Player B

- Calculating Hypotenuse:

  With Players B and C forming the legs of a right triangle, the distance between Players B and C will be key to closing down the opponent and taking possession of the ball.

  Using the Pythagorean Theorem ($a^2 + b^2 = c^2$) if player B is 12 meters from A, and player C is 9 meters from A, then:

  $$9^2 + 12^2 = c^2$$
  $$81 + 144 = c^2$$
  $$225 = c^2$$
  $$\sqrt{225} = 15$$
  $$c = 15$$

  This means that the direct distance between Players B and C is about 15 meters

Cultural Values and Benefits of Traditional Boy Games in Timbazia Village

Based on the research data, researchers identified numerous cultural values and benefits associated with traditional games in Timbazia Village. These traditional games, which have been passed down through generations, continue to be preserved in the village, particularly in Mboapoma Hamlet, the location of the study. The traditional Boy game, in particular, is rich in cultural values and benefits. When engaging in traditional games, the cultural values and benefits that emerge include:

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a. Cultural Value

Traditional games such as the Boy game impart several cultural values to players, especially elementary school students, and provide educational benefits. These cultural values include:

- Solidarity and Togetherness

This value is reflected in the teamwork required to achieve a common goal. When players work together to throw balls and stack stones, they demonstrate solidarity and togetherness in striving for victory.

- Discipline and Obedience to Rules

This value is illustrated through the acknowledgment of a group representative, who is chosen to perform tasks like the rock-paper-scissors suit. Players must respect the decisions made by this representative, showing adherence to the rules and respect for authority.

- Effective Communication

This value is evident in the strategic planning interactions between team members. Clear and effective communication is essential for players to work well together and achieve their goals.

- Acceptance of Failure and Victory

This value is seen in players' attitudes towards both defeat and victory. They learn to accept losses gracefully and appreciate victories, understanding both as integral parts of the game process.

- Social Skills

This value is reflected in the interactions between team members and opponents. Players develop social skills such as empathy, which helps them understand the roles and feelings of both teammates and opponents.

- Respect for Cultural Heritage

This value emerges through the preservation of local cultural heritage in the game. By playing the Boy game, participants appreciate and uphold the cultural traditions passed down through generations.

- Patriotism

Love for one's country is a positive attitude that encourages making contributions towards national development. Patriotism encompasses loyalty, attention, and high appreciation for the nation's language, culture, and environment. In the Boy game, players use local natural resources as primary materials, demonstrating respect for their homeland's environment and resources.

These cultural values foster personal development and enrich the educational experience, helping students build a strong sense of community, respect, and cultural identity.

b. Benefits that players get

There are several general benefits that players, especially elementary school students, as well as the field of education, can obtain from traditional games such as the Boy game. These benefits include:

- Understanding Mathematical Elements

  Interviews with players and explorations conducted by researchers revealed that mathematical concepts are present in the Boy game. Children can recognize and understand various mathematical elements through play.

- Motor Skill Development

  Activities such as throwing balls, running, and arranging stones in the Boy game aid in the development of both gross and fine motor skills in elementary school students.

- Collaborative Learning

  The game necessitates teamwork to achieve common goals, fostering collaborative learning. Students learn to communicate, cooperate, and value individual contributions within a group setting.

- Enhanced Social Skills

  Interaction with team members and opponents helps players develop social skills such as empathy, cooperation, and communication, contributing to the formation of positive personality traits and healthy social interactions.

- Learning Cultural Values

  The Boy game introduces students to cultural values and local traditions, helping them appreciate and understand their cultural heritage. This is essential for building a cultural identity and a sense of pride in their homeland.

- Development of Strategic Thinking Skills

  Players must plan strategies for throwing the ball and arranging stones effectively, which promotes the development of strategic thinking, problem-solving, and decision-making skills that are valuable in everyday life.

- Improved Concentration and Focus

  The game requires high levels of concentration and focus, enhancing players' ability to stay attentive and focused on tasks.

These benefits illustrate the multifaceted advantages of traditional games in promoting educational and personal development among elementary school students.

Conclusion

The traditional Boy game, a cherished pastime in Timbazia Village, transcends mere entertainment to offer a rich blend of mathematical and cultural elements. Passed down through generations, this game integrates foundational mathematical concepts with engaging play. It encompasses basic geometry, including shapes such as circles, rectangles, squares, triangles, and trapeziums, which are fundamental to elementary mathematics. The concept of the ball, embodied by the katu ball used in the game, introduces players to spatial and practical applications of geometry. Additionally, the game arena's design illustrates symmetry, while its layout incorporates lines and boundaries that are integral to the game's structure.

Mathematical concepts such as chance are reflected in the game of scissors, paper, rock, which determines the playing and guarding teams. The game also demonstrates the concept of combination, as players experience various outcomes from three attempts to throw the ball. Essential arithmetic operations, including addition, multiplication, subtraction, and division, are embedded in the gameplay, further linking the game to mathematical learning. The application of mathematical logic in the rules and strategies of the game provides an opportunity for players to engage with logic and reasoning. Notably, the concept of the Pythagorean Theorem is utilized in strategic ball-passing, showcasing the practical application of geometry in game tactics.

Beyond its mathematical aspects, the Boy game plays a significant role in instilling cultural values and providing developmental benefits. It promotes values such as solidarity and togetherness, discipline and adherence to rules, and effective communication among players. The game fosters an acceptance of both failure and victory, encourages respect for cultural heritage, and nurtures a sense of patriotism. The benefits of playing the Boy game are extensive, including an enhanced understanding of mathematical elements, development of motor skills, collaborative learning, improved social skills, and strategic thinking. Additionally, it aids in increasing concentration and focus, making it a valuable tool for both educational and personal growth. Through its multifaceted nature, the Boy game serves as an effective medium for teaching mathematics and cultural values, seamlessly blending learning with play and cultural preservation.

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