

Slingshot: Between Traditional Games and Learning Mathematics

Ach. Naura Z.I. Zulviansyach¹, Faisal K. Risaldi², Sugi Hartini³, Rachmaniah M. Hariastuti⁴

^{1,2,3,4}Universitas PGRI Banyuwangi, Indonesia

Article Info

Keywords:

Traditional game
Slingshot
Ethnomathematics

ABSTRACT

Traditional games are part of the culture that contains various concepts of knowledge, one of which is the slingshot game. Among the knowledge concept contained in traditional games is mathematics. This study aims to explore slingshot games and identify mathematical concepts in them. The research was conducted qualitatively with five informants from the slingshot game community in Banyuwangi (CODOT), Indonesia. Data was collected using participatory observation, in-depth interviews, and cultural documentation. The data analysis was carried out qualitatively and triangulated based on data sources. The research results show that there are concepts of measurement, two-dimensional shapes, three-dimensional shapes, lines, parabolas, angles, and whole-number arithmetic operations. The results of this research can be developed in learning by integrating slingshot games as a representative medium.

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Corresponding Author:

Rachmaniah M. Hariastuti
Faculty of Math and Science, Universitas PGRI Banyuwangi, Indonesia
Email: rachmaniah@unibabwi.ac.id

1. INTRODUCTION

Indonesia has various cultures, one of which is traditional games. Traditional games are games that contain cultural values [1]. Traditional games have various forms and variations and tend to utilize tools or objects in the environment without buying them, requiring high imagination and creativity [2]. One of them that utilizes objects in the surrounding environment is a slingshot.

The Indonesian traditional children's games encyclopedia states that the slingshot is also known as *slepetan* in Betawi [3]. This game begins with looking for a strong, two-pronged wooden branch-like letter "Y," which is cut 5 to 7 cm long. Then the base of the wood is cut along 8 cm, serving as a handle. Then cut the rubber with a length of about 40 cm and a diameter of 0.5 to 1 cm. One end of the rubber is tied around the wood, while the

other is tied to the leather (you can use old shoe leather). The game uses bullets made of round wet soil or other round objects the size of marbles. The Online Indonesian Language Dictionary, it is stated that a slingshot is a children's toy whose handle is made of forked branches, both ends are tied with rubber straps, and the other two ends of the rubber strap are tied to leather 3 to 4 cm wide which helps throw small stones [4].



Figure 1. Slingshot made of tree branches (researcher documentation)

Traditional games are symbols of knowledge passed down between generations and have various functions or messages [5]. Traditional games can instill national values such as honesty, discipline, hard work, sportsmanship, love of the motherland, democracy, friendship/communication, independence, patience, creativity, and cooperation [6]. Both understandings show that traditional games contain the knowledge and positive values to be taught and instilled in various circles. Besides that, it can also be seen that traditional games contain a variety of knowledge, one of which is mathematics.

The mathematical concepts embedded in culture are known as ethnomathematics. Ethnomathematics is a mathematical concept in a culture that a group of people carries out as part of everyday life [7]–[9]. D'Ambrosio explained that ethnomathematics is mathematics practiced in cultural groups, such as urban or rural communities, working groups, professional groups, children of a certain age, indigenous peoples, and so on, which can be identified through their various activities [10]. This understanding shows that traditional games, as part of the culture, also contain ethnomathematics.

In previous studies, ethnomathematics identification has been carried out in several traditional games, like the research conducted by Risdiyanti and Prahmana in Yogyakarta to explore the games of *kubuk*, *kubuk manuk*, *dhukter*, *macanan*, and *jeg-jegan* which contain the concepts of numbers, number operations, two-dimensional shapes, congruence, comparison, and relations [11]. The game of marbles contains the concepts of balls, circles, counting, and arithmetic operations [12]. The *dengklaq* game in Mataram contains the concepts of two-dimensional geometry, relationships between angles, cube nets, reflection, logic, and probability [13]. Furthermore, the *selodor bhanteng* game in Madura contains the concepts of two-dimensional shapes, arithmetic operations, and numbers [14].

Exploration of traditional games has also been carried out in Banyuwangi. Research by Jannah et al. explores the firing game [15]; research by Susena et al. which explores the game of *gobak sodor* [16]; research by Supahmi et al. which explores the *seltok* game [17]; and research by Hariastuti et al. which explores the game *patheng dudu* [18]. However, ethnomathematics identification has only been carried out in the *seltok* game, which contains the concepts of two and three-dimensional geometric shapes, sets, relations, measurement, velocity, combinations, and probability [17], and the *patheng dudu* game, which contains the concepts of the polyhedron, polygons, counting, comparisons, measurements, angles, relationships between lines, statistics, sets, distances, time, and functions [18]. Among the explorations carried out in the research above, no one has identified ethnomathematics in slingshot games. For this reason, this study aims to explore slingshot games in Banyuwangi, then identify their ethnomathematics. The results of this research can later be implemented in learning mathematics as part of the media used to make abstract concepts more tangible.

2. METHOD

This research is qualitative with an exploration and identification framework. Exploratory research was conducted from 8 to 12 October 2022. The research informants were five members of the CODOT community who were active in community activities. Data was collected using participatory observation techniques, in-depth interviews, and cultural documentation. Data validation was carried out in the form of source triangulation. Furthermore, the resulting data is used for the ethnomathematics identification process in slingshot games. The data analysis was carried out qualitatively with the stages of data reduction, data presentation, and conclusion.

3. RESULTS AND DISCUSSION

The results were obtained in the form of videos, photos, and interview recordings that were transcribed. Data is validated through source triangulation. After being reduced, the data is presented in a description of the slingshot exploration results.

3.1. Slingshot Game Exploration

Slingshot is one of the traditional games in Indonesia (and in several other countries). In the past, the slingshot was used as a hunting tool. Nevertheless, the slingshot is used more for education and agility contests. Slingshot is now included in the category of traditional sports and has been registered as part of KORMI (*Komite Olahraga Rekreasi Masyarakat Indonesia*), an institution in Indonesia that oversees various recreational sports principles. The slingshot game has also been contested in agility contests to shoot at predetermined targets.

The term slingshot comes from the Greek word *catapult*, which means to throw down. In several other areas in Indonesia, the slingshot is called by various names, such as *plintheng*, *blandring*, etc. In Banyuwangi, the slingshot is more often called *tepel*.

CODOT (*Dolanan Tepel Banyuwangi Community*) is the first slingshot community in Banyuwangi, established in February 2022. This community has around 30 permanent members. Community member training was carried out in the Karangrejo Banyuwangi.

The informants in this study were Mr. Felix (head of the community), Mr. Eko (founder of the community), Mr. Toni, Mr. Edi, and Mr. Jadid (member of the community).

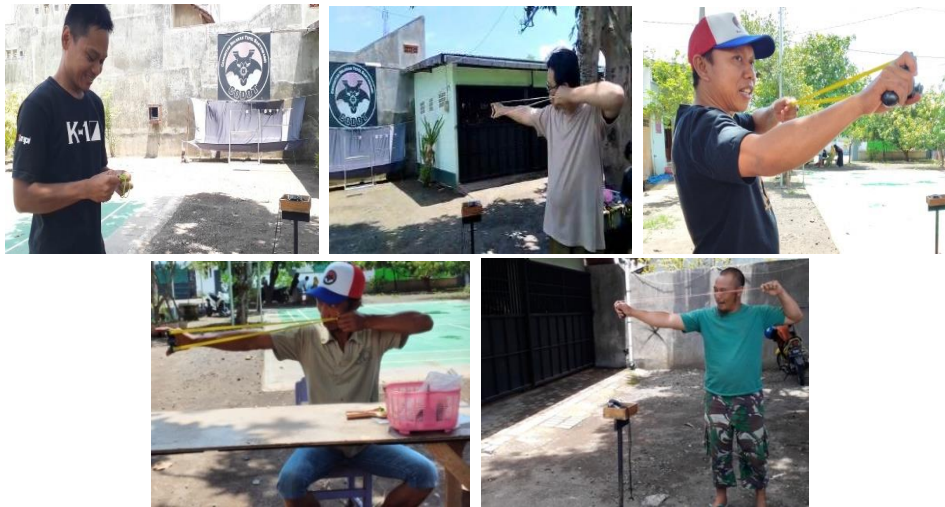


Figure 2. Research Informants (Researcher Documentation)

The slingshot has names on its parts, such as frame, tip, gap, and rubber. These parts are shown in Figure 3. The frame is the whole shape of the slingshot. The tip is left and right to tie the rubber on the frame. The gap is the arch between the two tips. The handle is part of the player's frame to hold the slingshot.

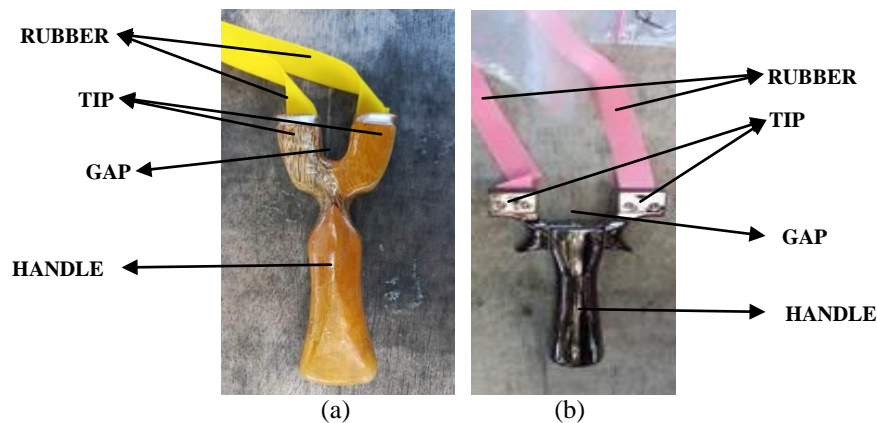


Figure 3. Slingshot Parts (Researcher Documentation)

Rubber is the essential part of the slingshot, which functions to launch bullets. There are two types of rubber used, namely flat rubber, as shown in Figure 4 (b), (c), and (e), or tumbler rubber, as shown in Figure 4 (a). Flat rubber consists of two types: thin flat rubber and thick flat rubber.



Figure 4. Various slingshot models (Researcher Documentation)

In addition, some bullets are ejected/fired. Bullets generally use stones or other objects in the form of small spheres. Nevertheless, in slingshot competitions, the bullets used are *gotri*. *Gotri* is part of the bicycle equipment made of iron in the form of small balls, as shown in Figure 5.

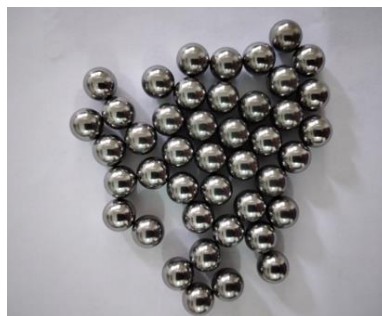


Figure 5. *Gotri* (Researcher Documentation)

The aiming target used in training and matches is called a spinner. Figure 6 shows a spinner which is generally made in the knockdown form. The spinner has a diameter of 8 cm, 7 cm, 6 cm, 5 cm, and 4 cm, respectively. The points obtained are 1, 2, 3, 4, and 5, respectively. In general, in a match, the shooting time limit is used, which is 1 minute for five shots. The standard shooting distance is 10 m for adults and 7 m for children.



Figure 6. *Spinner* (Researcher Documentation)

Several fighting systems exist in slingshot matches, such as a single spinner, target muddling, and cans. The single spinner system uses a spinner with a diameter of 4 or 5 cm by shooting 5 or 10 times in a row (according to set rules). The muddling target system uses all sizes of spinners. At the same time, the can system uses the rule of 10 shots with an assessment of 1 point for each successful shot on target.

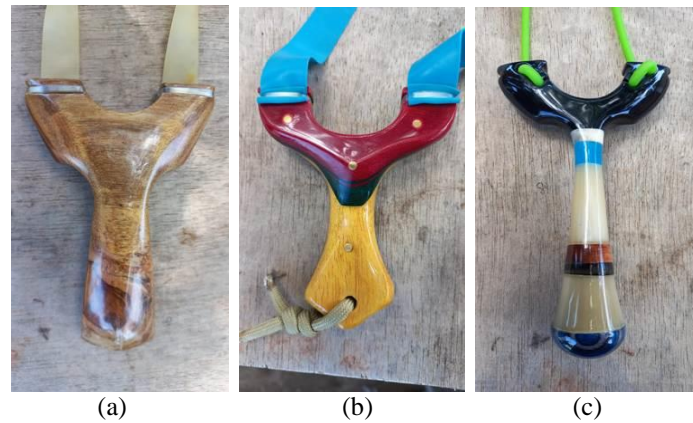


Figure 7. Slingshot of various materials (Researcher Documentation)

Most community members have learned to make their slingshot game tools. The slingshot was initially made of wood. As development progresses, slingshots can also be created from various materials. Figure 7 (a) shows a slingshot made of single wood or a combination of several types of wood glued together and then cut into the desired shape. Various types of wood can be used, such as *durian* wood, teak, guava, pine, jackfruit, and others. Figure 7 (b) shows a slingshot made of wood covered with cloth. The fabric used to make the slingshot is micarta fabric. This cloth is used because it is flexible and more substantial than wood. Micarta cloth is used by stacking several fabrics, gluing them together, and then pressing them. After that, it is cut according to the shape of the slingshot to be made. Figure 7 (c) is a slingshot with various materials; successively from below are laminate wood, oq horn, setigi wood, and ox leg bones. Production time generally varies from one to three days.

Each slingshot has a tip and a place to attach the rubber to the slingshot (frame). There are two types of tips: round tips, as shown in Figure 8 (a), and square tips, as shown in Figure 8 (b). A slingshot with a round tip (circular surface) can eject bullets faster than a square tip (rectangular surface). This happens because the pressure of the rubber is tighter on a round surface.



Figure 8. Types of the tip on the slingshot (Researcher Documentation)

The slingshot has two types of handles, namely, hammer and finger. The slingshot is said to be of the hammer type if it is held in a gripped manner, as shown in Figure 9 (a). Meanwhile, the finger-type slingshot is a slingshot that is held with the focus on two fingers, namely the thumb, and forefinger, as shown in Figure 9 (b).



Figure 9. Slingshot holding type (Researcher Documentation)

The slingshot has several types of shapes, namely Over the Top (OTT), Through the Fork (TTF), and Pickle Fork Shooter (PFS). The OTT type is a slingshot with a width of 8 cm, a grip length of between 11 and 14 cm, a gap length of 4 cm, and a tip length following the width of the rubber of about 2 cm. The slingshot with the OTT model is shown in Figure 3 (b), Figure 6 (a) (b), and Figure 7 (b) (c). The OTT-type slingshot has a rubber attachment pattern above the tip, so the bullet is ejected upwards. The gap on the OTT slingshot must be curved because otherwise, the shooting will hit the slingshot. The OTT-type slingshot has the characteristic anchor point on the player's cheek, as shown in Figure 10.



Figure 10. Aiming with an OTT-type slingshot (Researcher Documentation)

The PFS-type slingshot has a width of 5.2 cm. The tip length generally follows the width of the rubber of about 2 cm, and the length of the gap is about 1.2 cm. The PFS type is shown in Figure 3 (a). The PFS gap is smaller (in fact, there is almost no gap) compared to the OTT type. This causes the bullet to go straight (rather than through the gap). So that the smaller the gap, the target point (anchor point) must be higher. Shooting using a PFS-type slingshot is done by pulling the rubber, twisting it, then the rubber part of the bullet in the thumb position is pushed forward (tuik).



Figure 11. Aiming with a PFS-type slingshot (Researcher Documentation)

This method is done so that the bullet does not hit the frame and returns to the shooter. The shooter's position is also slightly tilted, so the bullets are also twisted. The aiming point is located at the player's eye, as shown in Figure 11.

The TTF-type slingshot is similar to the OTT-type slingshot but uses a thicker type of rubber and is attached to the side of the tip. The TTF-type slingshot is shown in Figure 4 (d). The aiming point for shooting with a TTF-type slingshot is located in the middle of the rubber, as shown in Figure 12 (a). Meanwhile, how to aim using a TTF-type slingshot is shown in Figure 12 (b).

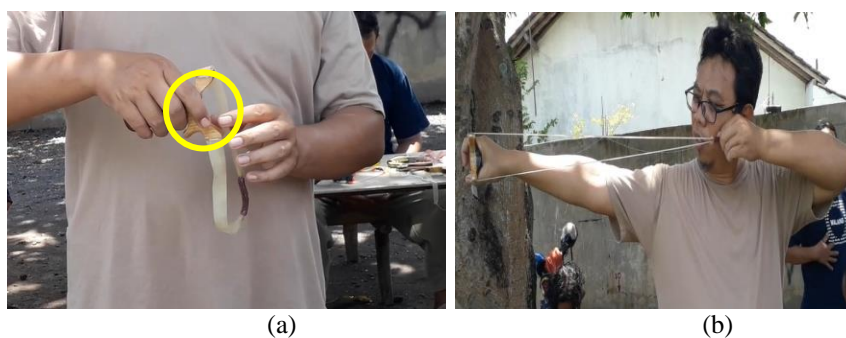


Figure 12. Aim points and methods of aiming with a TTF-type slingshot (Researcher Documentation)

There are several styles of shooting bullets in slingshot games, namely aim, overdraw, semi-butterfly, and butterfly styles. Figure 13 (a) shows aiming style shooting carried out by positioning the rubber containing the bullet right at the cheekbone. Figure 13 (b) shows an overdraw shot executed by pulling the rubber-loaded bullet to a position behind the player's ear. Figure 13 (c) shows a semi-butterfly-style shot carried out by pulling the rubber up to about 70 cm. Meanwhile, the butterfly style is shown in Figure 13

(d), which is done by pulling the rubber up to 1 or 1.5 m. To do both styles, a lightweight rubber is used to make the withdrawal longer. So the bullets ejected further and harder.

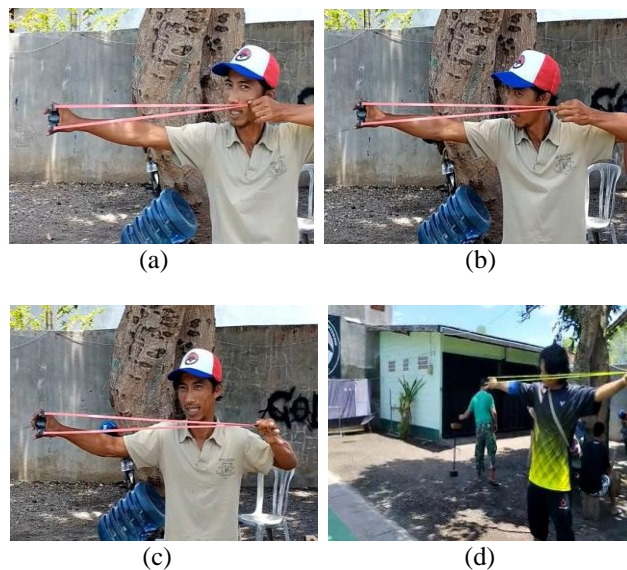


Figure 13. Bullet shooting style (Researcher Documentation)

The slingshot game can also be played without frames. Players can use flat rubber rings, as shown in Figure 14 (a), or stacked rubber, as shown in Figure 14 (b).

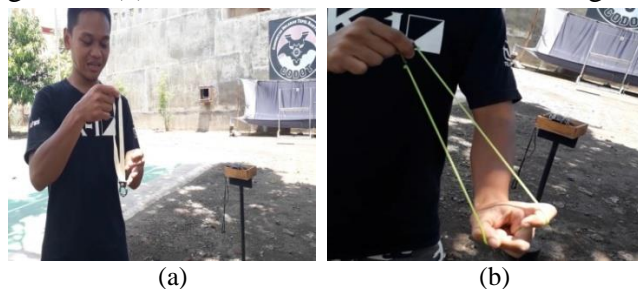


Figure 14. Unframed slingshot game (Researcher Documentation)

3.2. Ethnomathematics of the slingshot game

The results of the slingshot game exploration then become material for identifying the mathematical concepts contained in the game. The basis for identification is basic competence in learning mathematics in primary and secondary education, contained in The Minister of Education and Culture Number 37 of 2018 [19] and learning outcomes in the *merdeka* curriculum [20].

According to the size specified for each type of slingshot, there is a concept of measurement in manufacturing slingshots. Measurements are made so that the tip position, gap, and grip length are appropriate and comfortable. Measurements are made to obtain OTT and PFS slingshot types, as shown in Figure 3. Measurement is a process of comparing the measured quantity with other quantities used as units [21]. The measurement concept is also contained in using rubber in the slingshot, pulling the rubber in each shooting style, and determining the distance between the player and the target.

In the slingshot, geometric concepts exist, with two and three dimensions. Figure 8 shows the existence of a circular tip surface (Figure 8 (a)) and a rectangular tip surface (Figure 8 (b)). The tip surface is said to be a circle because it fulfills the requirements of a two-dimensional shape, a collection of points equidistant from a certain point [22]. The tip surface is said to be rectangular because it fulfills the requirements of a quadrilateral which has two pairs of opposite sides of the same length and four right angles [23]. As for the slingshot handle, it tends to show irregular prism or frustum (truncated pyramidal shapes), as shown in Figure 4 and Figure 7. A prism is multiple planes bounded by two parallel planes and several other planes that intersect according to parallel lines [24], while a frustum is part of a pyramid bounded by a base plane and a base parallel plane that intersects the pyramid [24].

The concept of a circle can also be identified from the shape of the target, as shown in Figure 6. The shape of the *gotri*, which resembles a ball, is part of the three-dimensional concept. This concept follows the understanding of a sphere as a three-dimensional shape bounded by a curved plane obtained from a semicircular shape rotated by 360° based on its diameter [25].

Bullets (*gotri*) generally move straight or follow a curve like a parabola. So that in bullet movement, there is the concept of a linear equation curve (line) or a quadratic equation curve (parabola). A line is an object that is not defined in mathematics [26]. However, a line can be made from a set of points that form a straight curve embodiment of a linear equation. The parabola is a set of points that form a curve embodiment of a quadratic equation. Parabola is the locus of points equidistant from a certain point (focus) and a particular line (directrix).

In the aiming process, the slingshot rubber is pulled, showing an acute angle between the rubbers, as shown in Figure 15. The area that forms an acute angle is marked with a yellow curved line. The concept of an acute angle indicates that there are areas in the form of a wedge whose angles are between 0° and 90° [26]. The pull of the rubber when the slingshot is used to aim at the target shows the concept of two intersecting lines. The concept of intersecting lines follows the condition that it has one common point [26], which is the position of the rubber held by the player.



Figure 15. The concept of acute angles on stretching slingshot rubber (Researcher Documentation)

The slingshot game also contains the concept of multiplication and addition of whole numbers. This can be seen in determining the total points earned by players. Figure

16 shows a slingshot target with a predetermined diameter. For example, if a player can knock over targets with a diameter of 8 cm, 7 cm, and 5 cm in the muddling system, the points obtained will be $1 + 2 + 4 = 7$. Meanwhile, if a player can drop a target with a diameter of 4 cm 7 times in a single spinner game, the points obtained are $5 \times 7 = 35$.



Figure 16. Slingshot aim target (Researcher Documentation)

Slingshot competitions also contain the concept of probability. Players can determine the probability of shooting the target if given a certain number of bullets. The probability of an event is a comparison between the many possibilities that arise from an event and the many possibilities that arise in the sample space [27].

The identified mathematical concepts show that slingshot as a traditional game can be integrated into learning mathematics as a media/visual aid. For example, adding whole numbers corresponds to the target of essential competencies in grade I elementary schools, and multiplying whole numbers corresponds to the essential competencies in class II elementary schools [19][20]. This is supported by previous research showing that traditional games can be used by children of various ages in learning arithmetic operations [28], so traditional games can be integrated as fun learning media in elementary schools through teacher development [29].

At a higher level, a slingshot can also represent the concept of probability or parabola as a graph of a quadratic function in middle school learning [19][20]. This condition indicates that traditional games can also be used as a medium for learning mathematics in secondary schools. Previous research on snakes and ladders games in high school trigonometry learning supports that traditional games are effective in increasing student interest and motivation [30].

4. CONCLUSION

Based on the exploration that has been done, it can be seen that the slingshot game is a traditional game that has developed into a traditional sport. Slingshot games have also been contested in various regions in Indonesia and abroad. The identification results show that the slingshot game contains mathematical concepts, such as measurement, two-dimensional shapes, three-dimensional shapes, lines, parabolas, angles, and whole-number arithmetic operations. These mathematical concepts can be integrated into learning mathematics in primary and secondary education. The integration can be in the form of learning media, making learning more exciting and meaningful.

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Submission date: 27-Oct-2023 11:52AM (UTC+0700)

Submission ID: 2208757667

File name: MISRO LENGKAP.pdf (1,023.03K)

Word count: 5020

Character count: 27210

Vol. 2 No. 1 (2023): March

ISSN 2962-7842

Journal of MISRO
Mathematics Instruction
Social Research and Opinion

Publisher



Jl. Gagak Dalam No.105,
Bandung City, West Java, Indonesia

<https://journal-gehu.com/index.php/misro>

Publisher



ISSN 2962-7842



Jl. Gagak Dalam No.105,
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Table of Contents Vol. 2 No. 1 (2023): March

The journal, published in March 2023 issue, consists of 7 articles written by authors from 5 countries (Cambodia, Indonesia, Nepal, Philippines, and Tanzania).

Articles	
The Teaching Methodology and the Behavior of Ordinary Secondary School Students in Learning Mathematics Subject: A case of selected Ordinary Secondary Schools in Mbeya, Tanzania Kaula Stephen	1-10
Application of the Promethee II Method for Determining Road Improvement Priorities Mayang Sari, Kosim, Andika Saputra	11-22
A Narrative Inquiry on the Challenges and Coping Mechanism of School Leaders in Higher Learning Institutions Amidst Pandemic John Michael Aquino	23-34
Two Years for an English Teacher to Become a Novice Educational Researcher: Author's Experiences from Writing Opinion Articles to Research Articles Sereyath Em	35-54
What Determines the Capital Adequacy Ratio of Joint Venture Commercial Banks of Nepal? An Evidence from Panel Data Analysis Purna Man shrestha	55-64
Model Deployment Realistic Mathematic Education to Improve Student Learning Outcomes Grade 5 Tobroni, Rasilah, Widiyanti	65-74
Slingshot: Between Traditional Games and Learning Mathematics Ach. Naura Zibran Izza Zulviansyach, Faisal Kurniawan Risaldi, Sugi Hartini, Rachmaniah Mirza Hariastuti	75-88



Slingshot: Between Traditional Games and Learning Mathematics

Ach. Naura Z.I. Zulviansyach¹, Faisal K. Risaldi², Sugi Hartini³, Rachmaniah M. Hariastuti⁴

^{1,2,3,4}Universitas PGRI Banyuwangi, Indonesia

Article Info

Keywords:

Traditional game
 Slingshot
 Ethnomathematics

ABSTRACT

Traditional games are part of the culture that contains various concepts of knowledge, one of which is the slingshot game. Among the knowledge concept contained in traditional games is mathematics. This study aims to explore slingshot games and identify mathematical concepts in them. The research was conducted qualitatively with five informants from the slingshot game community in Banyuwangi (CODOT), Indonesia. Data was collected using participatory observation, in-depth interviews, and cultural documentation. The data analysis was carried out qualitatively and triangulated based on data sources. The research results show that there are concepts of measurement, two-dimensional shapes, three-dimensional shapes, lines, parabolas, angles, and whole-number arithmetic operations. The results of this research can be developed in learning by integrating slingshot games as a representative medium.

22

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Corresponding Author:

Rachmaniah M. Hariastuti ¹²
 Faculty of Math and Science, Universitas PGRI Banyuwangi, Indonesia
 Email: rachmaniah@unibabwi.ac.id

1. INTRODUCTION

Indonesia has various cultures, one of which is traditional games. Traditional games are games that contain cultural values [1]. Traditional games have various forms and variations and tend to utilize tools or objects in the environment without buying them, requiring high imagination and creativity [2]. One of them that utilizes objects in the surrounding environment is a slingshot.

The Indonesian traditional children's games encyclopedia states that the slingshot is also known as *slepetan* in Betawi [3]. This game begins with looking for a strong, two-pronged wooden branch-like letter "Y," which is cut 5 to 7 cm long. Then the base of the wood is cut along 8 cm, serving as a handle. Then cut the rubber with a length of about 40 cm and a diameter of 0.5 to 1 cm. One end of the rubber is tied around the wood, while the

other is tied to the leather (you can use old shoe leather). The game uses bullets made of round wet soil or other round objects the size of marbles. The Online Indonesian Language Dictionary, it is stated that a slingshot is a children's toy whose handle is made of forked branches, both ends are tied with rubber straps, and the other two ends of the rubber strap are tied to leather 3 to 4 cm wide which helps throw small stones [4].



Figure 1. Slingshot made of tree branches (researcher documentation)

Traditional games are symbols of knowledge passed down between generations and have various functions or messages [5]. Traditional games can instill national values such as honesty, discipline, hard work, sportsmanship, love of the motherland, democracy, friendship/communication, independence, patience, creativity, and cooperation [6]. Both understandings show that traditional games contain the knowledge and positive values to be taught and instilled in various circles. Besides that, it can also be seen that traditional games contain a variety of knowledge, one of which is mathematics.

The mathematical concepts embedded in culture are known as ethnomathematics. Ethnomathematics is a mathematical concept in a culture that a group of people carries out as part of everyday life [7]–[9]. D'Ambrosio explained that ethnomathematics is mathematics practiced in cultural groups, such as urban or rural communities, working groups, professional groups, children of a certain age, indigenous peoples, and so on, which can be identified through their various activities [10]. This understanding shows that traditional games, as part of the culture, also contain ethnomathematics.

In previous studies, ethnomathematics identification has been carried out in several traditional games, like the research conducted by Risdiyanti and Prahmana in Yogyakarta to explore the games of *kubuk*, *kubuk manuk*, *dhukter*, *macanan*, and *jeg-jegan* which contain the concepts of numbers, number operations, two-dimensional shapes, congruence, comparison, and relations [11]. The game of marbles contains the concepts of balls, circles, counting, and arithmetic operations [12]. The *dengklaq* game in Mataram contains the concepts of two-dimensional geometry, relationships between angles, cube nets, reflection, logic, and probability [13]. Furthermore, the *selodor bhanteng* game in Madura contains the concepts of two-dimensional shapes, arithmetic operations, and numbers [14].

Exploration of traditional games has also been carried out in Banyuwangi. Research by Jannah et al. explores the firing game [15]; research by Susena et al. which explores the game of *gobak sodor* [16]; research by Supahmi et al. which explores the *seltok* game [17]; and research by Hariastuti et al. which explores the game *patheng dudu* [18]. However, ethnomathematics identification has only been carried out in the *seltok* game, which contains the concepts of two and three-dimensional geometric shapes, sets, relations, measurement, velocity, combinations, and probability [17], and the *patheng dudu* game, which contains the concepts of the polyhedron, polygons, counting, comparisons, measurements, angles, relationships between lines, statistics, sets, distances, time, and functions [18]. Among the explorations carried out in the research above, no one has identified ethnomathematics in slingshot games. For this reason, this study aims to explore slingshot games in Banyuwangi, then identify their ethnomathematics. The results of this research can later be implemented in learning mathematics as part of the media used to make abstract concepts more tangible.

2. METHOD

This research is qualitative with an exploration and identification framework. Exploratory research was conducted from 8 to 12 October 2022. The research informants were five members of the CODOT community who were active in community activities. Data was collected using participatory observation techniques, in-depth interviews, and cultural documentation. Data validation was carried out in the form of source triangulation. Furthermore, the resulting data is used for the ethnomathematics identification process in slingshot games. The data analysis was carried out qualitatively with the stages of data reduction, data presentation, and conclusion.

3. RESULTS AND DISCUSSION

The results were obtained in the form of videos, photos, and interview recordings that were transcribed. Data is validated through source triangulation. After being reduced, the data is presented in a description of the slingshot exploration results.

3.1. Slingshot Game Exploration

Slingshot is one of the traditional games in Indonesia (and in several other countries). In the past, the slingshot was used as a hunting tool. Nevertheless, the slingshot is used more for education and agility contests. Slingshot is now included in the category of traditional sports and has been registered as part of KORMI (*Komite Olahraga Rekreasi Masyarakat Indonesia*), an institution in Indonesia that oversees various recreational sports principles. The slingshot game has also been contested in agility contests to shoot at predetermined targets.

The term slingshot comes from the Greek word *catapult*, which means to throw down. In several other areas in Indonesia, the slingshot is called by various names, such as *plintheng*, *blandring*, etc. In Banyuwangi, the slingshot is more often called *tepel*.

CODOT (*Dolanan Tepel Banyuwangi Community*) is the first slingshot community in Banyuwangi, established in February 2022. This community has around 30 permanent members. Community member training was carried out in the Karangrejo Banyuwangi.

The informants in this study were Mr. Felix (head of the community), Mr. Eko (founder of the community), Mr. Toni, Mr. Edi, and Mr. Jadid (member of the community).



Figure 2. Research Informants (Researcher Documentation)

The slingshot has names on its parts, such as frame, tip, gap, and rubber. These parts are shown in Figure 3. The frame is the whole shape of the slingshot. The tip is left and right to tie the rubber on the frame. The gap is the arch between the two tips. The handle is part of the player's frame to hold the slingshot.

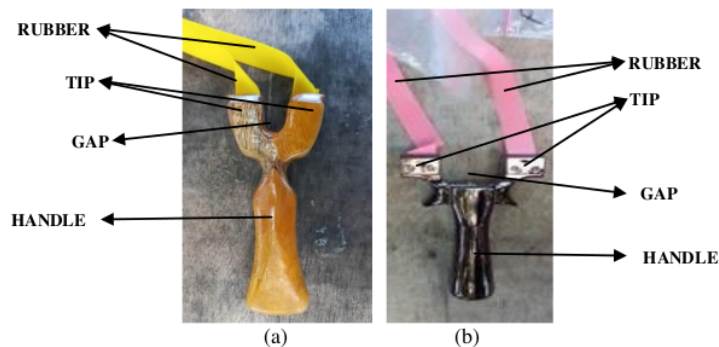


Figure 3. Slingshot Parts (Researcher Documentation)

Rubber is the essential part of the slingshot, which functions to launch bullets. There are two types of rubber used, namely flat rubber, as shown in Figure 4 (b), (c), and (e), or tumbler rubber, as shown in Figure 4 (a). Flat rubber consists of two types: thin flat rubber and thick flat rubber.



Figure 4. Various slingshot models (Researcher Documentation)

In addition, some bullets are ejected/fired. Bullets generally use stones or other objects in the form of small spheres. Nevertheless, in slingshot competitions, the bullets used are *gotri*. *Gotri* is part of the bicycle equipment made of iron in the form of small balls, as shown in Figure 5.



Figure 5. *Gotri* (Researcher Documentation)

The aiming target used in training and matches is called a spinner. Figure 6 shows a spinner which is generally made in the knockdown form. The spinner has a diameter of 8 cm, 7 cm, 6 cm, 5 cm, and 4 cm, respectively. The points obtained are 1, 2, 3, 4, and 5, respectively. In general, in a match, the shooting time limit is used, which is 1 minute for five shots. The standard shooting distance is 10 m for adults and 7 m for children.



Figure 6. *Spinner* (Researcher Documentation)

Several fighting systems exist in slingshot matches, such as a single spinner, target muddling, and cans. The single spinner system uses a spinner with a diameter of 4 or 5 cm by shooting 5 or 10 times in a row (according to set rules). The muddling target system uses all sizes of spinners. At the same time, the can system uses the rule of 10 shots with an assessment of 1 point for each successful shot on target.

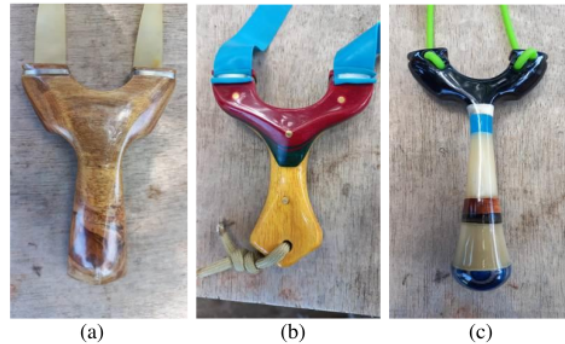


Figure 7. Slingshot of various materials (Researcher Documentation)

Most community members have learned to make their slingshot game tools. The slingshot was initially made of wood. As development progresses, slingshots can also be created from various materials. Figure 7 (a) shows a slingshot made of single wood or a combination of several types of wood glued together and then cut into the desired shape. Various types of wood can be used, such as *durian* wood, teak, guava, pine, jackfruit, and others. Figure 7 (b) shows a slingshot made of wood covered with cloth. The fabric used to make the slingshot is micarta fabric. This cloth is used because it is flexible and more substantial than wood. Micarta cloth is used by stacking several fabrics, gluing them together, and then pressing them. After that, it is cut according to the shape of the slingshot to be made. Figure 7 (c) is a slingshot with various materials; successively from below are laminate wood, oq horn, setigi wood, and ox leg bones. Production time generally varies from one to three days.

Each slingshot has a tip and a place to attach the rubber to the slingshot (frame). There are two types of tips: round tips, as shown in Figure 8 (a), and square tips, as shown in Figure 8 (b). A slingshot with a round tip (circular surface) can eject bullets faster than a square tip (rectangular surface). This happens because the pressure of the rubber is tighter on a round surface.



Figure 8. Types of the tip on the slingshot (Researcher Documentation)

The slingshot has two types of handles, namely, hammer and finger. The slingshot is said to be of the hammer type if it is held in a gripped manner, as shown in Figure 9 (a). Meanwhile, the finger-type slingshot is a slingshot that is held with the focus on two fingers, namely the thumb, and forefinger, as shown in Figure 9 (b).



Figure 9. Slingshot holding type (Researcher Documentation)

The slingshot has several types of shapes, namely Over the Top (OTT), Through the Fork (TTF), and Pickle Fork Shooter (PFS). The OTT type is a slingshot with a width of 8 cm, a grip length of between 11 and 14 cm, a gap length of 4 cm, and a tip length following the width of the rubber of about 2 cm. The slingshot with the OTT model is shown in Figure 3 (b), Figure 6 (a) (b), and Figure 7 (b) (c). The OTT-type slingshot has a rubber attachment pattern above the tip, so the bullet is ejected upwards. The gap on the OTT slingshot must be curved because otherwise, the shooting will hit the slingshot. The OTT-type slingshot has the characteristic anchor point on the player's cheek, as shown in Figure 10.



Figure 10. Aiming with an OTT-type slingshot (Researcher Documentation)

The PFS-type slingshot has a width of 5.2 cm. The tip length generally follows the width of the rubber of about 2 cm, and the length of the gap is about 1.2 cm. The PFS type is shown in Figure 3 (a). The PFS gap is smaller (in fact, there is almost no gap) compared to the OTT type. This causes the bullet to go straight (rather than through the gap). So that the smaller the gap, the target point (anchor point) must be higher. Shooting using a PFS-type slingshot is done by pulling the rubber, twisting it, then the rubber part of the bullet in the thumb position is pushed forward (tuik).



Figure 11. Aiming with a PFS-type slingshot (Researcher Documentation)

This method is done so that the bullet does not hit the frame and returns to the shooter. The shooter's position is also slightly tilted, so the bullets are also twisted. The aiming point is located at the player's eye, as shown in Figure 11.

The TTF-type slingshot is similar to the OTT-type slingshot but uses a thicker type of rubber and is attached to the side of the tip. The TTF-type slingshot is shown in Figure 4 (d). The aiming point for shooting with a TTF-type slingshot is located in the middle of the rubber, as shown in Figure 12 (a). Meanwhile, how to aim using a TTF-type slingshot is shown in Figure 12 (b).

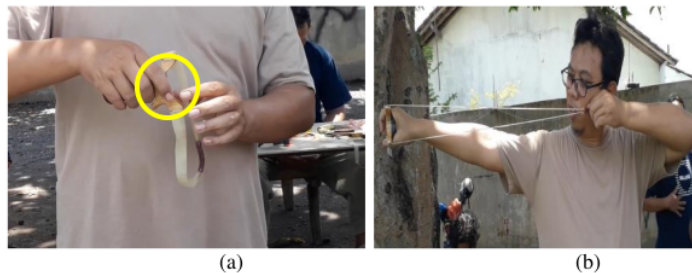


Figure 12. Aim points and methods of aiming with a TTF-type slingshot (Researcher Documentation)

There are several styles of shooting bullets in slingshot games, namely aim, overflow, semi-butterfly, and butterfly styles. Figure 13 (a) shows aiming style shooting carried out by positioning the rubber containing the bullet right at the cheekbone. Figure 13 (b) shows an overflow shot executed by pulling the rubber-loaded bullet to a position behind the player's ear. Figure 13 (c) shows a semi-butterfly-style shot carried out by pulling the rubber up to about 70 cm. Meanwhile, the butterfly style is shown in Figure 13

(d), which is done by pulling the rubber up to 1 or 1.5 m. To do both styles, a lightweight rubber is used to make the withdrawal longer. So the bullets ejected further and harder.

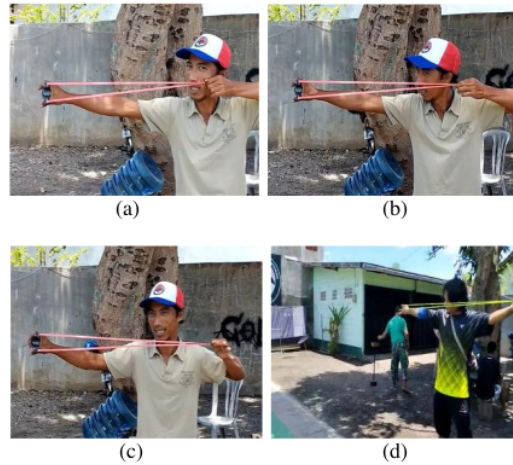


Figure 13. Bullet shooting style (Researcher Documentation)

The slingshot game can also be played without frames. Players can use flat rubber rings, as shown in Figure 14 (a), or stacked rubber, as shown in Figure 14 (b).

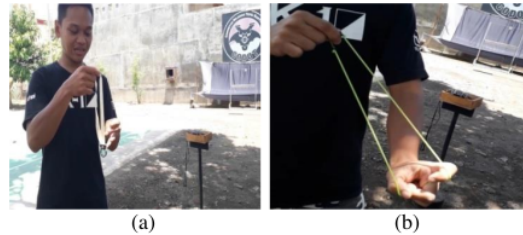


Figure 14. Unframed slingshot game (Researcher Documentation)

3.2. Ethnomathematics of the slingshot game

1 The results of the slingshot game exploration then become material for identifying the mathematical concepts contained in the game. The basis for identification is basic competence in learning mathematics in primary and secondary education, contained in The Minister of Education and Culture Number 37 of 2018 [19] and learning outcomes in the *merdeka* curriculum [20].

According to the size specified for each type of slingshot, there is a concept of measurement in manufacturing slingshots. Measurements are made so that the tip position, gap, and grip length are appropriate and comfortable. Measurements are made to obtain OTT and PFS slingshot types, as shown in Figure 3. Measurement is a process of comparing the measured quantity with other quantities used as units [21]. The measurement concept is also contained in using rubber in the slingshot, pulling the rubber in each shooting style, and determining the distance between the player and the target.

In the slingshot, geometric concepts exist, with two and three dimensions. Figure 8 shows the existence of a circular tip surface (Figure 8 (a)) and a rectangular tip surface (Figure 8 (b)). The tip surface is said to be a circle because it fulfills the requirements of a two-dimensional shape, a collection of points equidistant from a certain point [22]. The tip surface is said to be rectangular because it fulfills the requirements of a quadrilateral which has two pairs of opposite sides of the same length and four right angles [23]. As for the slingshot handle, it tends to show irregular prism or frustum (truncated pyramidal shapes), as shown in Figure 4 and Figure 7. A prism is multiple planes bounded by two parallel planes and several other planes that intersect according to parallel lines [24], while a frustum is part of a pyramid bounded by a base plane and a base parallel plane that intersects the pyramid [24].

The concept of a circle can also be identified from the shape of the target, as shown in Figure 6. The shape of the *gotri*, which resembles a ball, is part of the three-dimensional concept. This concept follows the understanding of a sphere as a three-dimensional shape bounded by a curved plane obtained from a semicircular shape rotated by 360° based on its diameter [25].

Bullets (*gotri*) generally move straight or follow a curve like a parabola. So that in bullet movement, there is the concept of a linear equation curve (line) or a quadratic equation curve (parabola). A line is an object that is not defined in mathematics [26]. However, a line can be made from a set of points that form a straight curve embodiment of a linear equation. The parabola is a set of points that form a curve embodiment of a quadratic equation. Parabola is the locus of points equidistant from a certain point (focus) and a particular line (directrix).

In the aiming process, the slingshot rubber is pulled, showing an acute angle between the rubbers, as shown in Figure 15. The area that forms an acute angle is marked with a yellow curved line. The concept of an acute angle indicates that there are areas in the form of a wedge whose angles are between 0° and 90° [26]. The pull of the rubber when the slingshot is used to aim at the target shows the concept of two intersecting lines. The concept of intersecting lines follows the condition that it has one common point [26], which is the position of the rubber held by the player.



Figure 15. The concept of acute angles on stretching slingshot rubber (Researcher Documentation)

The slingshot game also contains the concept of multiplication and addition of whole numbers. This can be seen in determining the total points earned by players. Figure

16 shows a slingshot target with a predetermined diameter. For example, if a player can knock over targets with a diameter of 8 cm, 7 cm, and 5 cm in the muddling system, the points obtained will be $1 + 2 + 4 = 7$. Meanwhile, if a player can drop a target with a diameter of 4 cm 7 times in a single spinner game, the points obtained are $5 \times 7 = 35$.



Figure 16. Slingshot aim target (Researcher Documentation)

Slingshot competitions also contain the concept of probability. Players can determine the probability of shooting the target if given a certain number of bullets. The probability of an event is a comparison between the many possibilities that arise from an event and the many possibilities that arise in the sample space [27].

The identified mathematical concepts show that slingshot as a traditional game can be integrated into learning mathematics as a media/visual aid. For example, adding whole numbers corresponds to the target of essential competencies in grade I elementary schools, and multiplying whole numbers corresponds to the essential competencies in class II elementary schools [19][20]. This is supported by previous research showing that traditional games can be used by children of various ages in learning arithmetic operations [28], so traditional games can be integrated as fun learning media in elementary schools through teacher development [29].

At a higher level, a slingshot can also represent the concept of probability or parabola as a graph of a quadratic function in middle school learning [19][20]. This condition indicates that traditional games can also be used as a medium for learning mathematics in secondary schools. Previous research on snakes and ladders games in high school trigonometry learning supports that traditional games are effective in increasing student interest and motivation [30].

4. CONCLUSION

Based on the exploration that has been done, it can be seen that the slingshot game is a traditional game that has developed into a traditional sport. Slingshot games have also been contested in various regions in Indonesia and abroad. The identification results show that the slingshot game contains mathematical concepts, such as measurement, two-dimensional shapes, three-dimensional shapes, lines, parabolas, angles, and whole-number arithmetic operations. These mathematical concepts can be integrated into learning mathematics in primary and secondary education. The integration can be in the form of learning media, making learning more exciting and meaningful.

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PAGE 10

PAGE 11

PAGE 12

PAGE 13

PAGE 14

PAGE 15

PAGE 16

PAGE 17

PAGE 18

PAGE 19
