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Ethnomathematical Concepts in the Minangkabau Traditional Game '*Pistol-Pistolan*': An Ethnographic Study

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ABSTRACT

Ethnomathematics research in Minangkabau is still dominated by studies of static cultural artifacts, while traditional children's games that are constructive and involve motor activities have not been widely researched. This study aims to identify mathematical concepts in the traditional game of *"Pistol-pistolan"*, which is made from banana leaves. The research used a qualitative approach with ethnographic methods and was conducted in Bukittinggi city, West Sumatra. Data were collected through participant observation, visual documentation, and semi-structured interviews with elementary school-aged children as players, lecturers and teachers of Minangkabau Natural Culture. The results of the study show that the structure of the pistol-pistolan contains geometric concepts in the form of right triangles and parallel lines, trigonometric concepts through the comparison of the sides of right triangles, and arithmetic concepts in the form of size patterns that form arithmetic sequences in the variations of the length of the handle, barrel, and barrel. These findings indicate that traditional games based on simple constructions can be used as a context for mathematics learning, particularly in geometry, trigonometry, and arithmetic.

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1. INTRODUCTION

Mathematics does not exist solely within classroom settings and formal symbols; rather, it develops organically within the cultural practices of society. This idea forms the foundation of the ethnomathematics approach, first introduced by D'Ambrosio, (1985) as the study of alternative ways of understanding and expressing mathematical concepts based on specific cultural contexts. Rosa & Orrey, (2020) define ethnomathematics as an effort to uncover mathematical practices embedded in various cultural activities. Cultural practices and activities in society are rich in mathematics (Rismawati et al., 2025). Zahar, (2021) emphasizes that mathematics grows and evolves within particular societies and cultures. Ethnomathematics broadens perspectives by asserting that

mathematics is not a single universal system of knowledge, but instead consists of diverse local forms that emerge from human interactions with their environment, nature, and traditions (Bill Barton, 2008). Theoretically, ethnomathematics encompasses various aspects such as number systems, patterns, geometric forms, calculation strategies, and problem-solving methods found in everyday community life (D'Ambrosio, 1985; Knijnik & Leopoldo, 2014). Numerous ethnomathematical studies across different cultures have successfully revealed implicit mathematical practices in batik motifs, woven textiles, traditional musical instruments, vernacular architecture, and folk games (Isnaniah & Imamuddin, 2023; Jabar et al., 2022; Angraini et al., 2021; Risdiyanti & Prahmana, 2018; Prahmana et al., 2012).

Within the Minangkabau cultural context, ethnomathematical research has been conducted on songket motifs, Rumah Gadang carvings, traditional architectural structures, and the matrilineal inheritance system, all of which contain numerical patterns and social logic, (Abdullah et al., 2015; Haryani & Handriyotopo, 2022; Isnaniah & M. Imamuddin, 2022; Isnaniah et al., 2022; Shalika et al., 2020; Z & Muchlian, 2019). The *Rumah Gadang* exhibits symmetrical structures that represent geometric concepts, while its architectural design demonstrates spatial order and proportionality that can be mathematically modeled (Rozi Fitriza, 2018; Irianti, A, & A, 2022; Afriyanto, et al., 2024; Indriani, et al., 2024). Likewise, Minangkabau songket weaving embodies concepts of plane geometry, similarity, symmetry, measurement, and counting (Isnaniah et al., 2022; Isnaniah & Imamuddin, 2023; Yonanda, et al., 2025). However, studies of traditional games as part of Minangkabau culture that incorporate mathematical concepts are still very limited, particularly on constructive and motor-based games such as "*Pistol-pistolan*," made from banana stems. The traditional game "*Pistol-pistolan*" is a cultural activity practiced by children in Minangkabau, particularly in rural areas. In this game, children arrange pieces of banana leaf stems into structures resembling toy pistols or rifles.

Ethnomathematics research on traditional games in Indonesia has been extensively conducted and widely implemented in mathematics education. Kusuma, (2019) for instance, examined the traditional children's game *Ingkek-Ingkek* (a hopscotch-like hopping game) from North Sumatra and concluded that the game promotes students' enjoyment in learning mathematics, particularly in the introduction of numbers, plane geometry, and probability. Similarly, Jabar et al., (2022) investigated *Bahasinan* (a traditional hiding and chasing game) in South Kalimantan and reported that this traditional game can be developed as a meaningful source of mathematics learning in schools. Furthermore, Angraini et al., (2021) conducted a study in Jambi and found that *Macanan* (a tiger-and-prey strategy board game) can serve as an effective starting point for mathematics instruction, especially in teaching concepts related to squares and rectangles. Prasetya et al., (2025) and Aini & Sari, (2024) explored the traditional game *Engklek* (a traditional hopscotch game) and concluded that it offers multiple educational benefits and can be effectively utilized as a medium for mathematics learning. In addition, Rosikhoh et al., (2025) examined *Pesapean Ling-Giling* (a spinning top and circular motion game), a traditional children's game from the Madurese community. Their findings revealed that the game embodies mathematical concepts related to numbers, measurement, geometry, discrete mathematics, as well as proportion and probability.

The authors further emphasized that *Pesapean Ling-Giling* is suitable for use as a mathematics learning medium at both elementary and secondary education levels. Hasanah et al., (2024) investigated *Wayang Umbul* (a traditional illustrated card game) and found that the game is rich in mathematical concepts and can be effectively employed in mathematics instruction. In West Java, Febriyanti et al., (2018) studied the traditional games *Engklek* (a traditional hopscotch game) and *Gasing* (a spinning top game). Their study indicated that these games implicitly incorporate various mathematical concepts, including squares, rectangles, semicircles, counting elements, and cylinders. Moreover, the gameplay process was found to foster character education values such as sportsmanship, honesty, cooperation, and social responsibility. Muslimin & Rahim, (2021) explored traditional children's games from Makassar, South Sulawesi, namely *Dende'* (a traditional chasing game), *Asing* (a throwing and targeting game), *Cangke'* (a stick-throwing accuracy game), and *Gebok* (a hit-and-run team game). Their findings identified mathematical concepts related to geometry, plane

figures, and solid shapes, and the authors recommended these games as effective instructional media for mathematics learning. Harahap & Jaelani, (2022) examined *Engkleng* (a traditional hopscotch game) from East Flores, East Nusa Tenggara, and concluded that the game incorporates mathematical concepts such as circles, angles, vertical and horizontal lines, and cube nets.

Based on these previous studies related to ethnomathematics, particularly traditional games integrated with mathematical concepts and utilized as learning resources, it is evident that traditional games can serve as valid and meaningful sources of learning in formal education (Angraini et al., 2021; Hasanah et al., 2024; Rosikhoh et al., 2025). Traditional games not only provide enjoyment during play but also embody cultural values and mathematical concepts (Jabar et al., 2022). This strengthened our determination to conduct research on the traditional children's game of the Minangkabau people of West Sumatra, "*Pistol-pistolan*." Notably, the game of "*Pistol-pistolan*" has not been explored in ethnomathematics studies, especially in Minangkabau. This research is important because it expands the study of ethnomathematics, which is dynamic and motoric-based, showing that mathematics also lives in children's play experiences. To date, most studies have focused primarily on visual artifacts or static patterns, while the mathematical potential of traditional games has received limited attention (Jabar et al., 2022; Hasanah et al., 2024). By documenting and analyzing the game of "*Pistol-pistolan*", this study shows that mathematics is also alive in children's play activities that are passed down from generation to generation in Minangkabau culture. Increasing evidence suggests that cultural experiences possess substantial potential to enrich pedagogical approaches in mathematics education. Accordingly, this study aims to understand the meanings underlying Minangkabau children's traditional game practices within a mathematical context.

2. METHODS

2.1 Research design

This study is a qualitative study with an ethnographic approach that aims to identify and explore mathematical concepts that arise in the traditional game of "*Pistol-pistolan*" played by Minangkabau children. The ethnographic approach was chosen because it allows researchers to gain an in-depth understanding of cultural practices through direct observation of play activities in their natural context (Spradley, 1997).

2.2 Research Location and Participants

The research was conducted in Bukittinggi City, West Sumatra, specifically in the canteen field, which is regularly used by children in the village as a space for play and cultural activities. The research participants consisted of six elementary school children aged 7–12 years, who were selected using purposive sampling with the following criteria: (1) children who actively played *"pistol-pistolan*" using banana leaves, and (2) the game was played naturally without any manipulation by the researcher. The distribution of participants included six boys. In addition to the children as the main participants, this study involved two supporting informants, namely a lecturer teaching Minangkabau culture and a teacher of Minangkabau culture, who were selected based on their experience and knowledge of traditional Minangkabau children's games.

2.3 Role of the Researcher

In this study, the researcher acted as an observer-participant, where the researcher was involved to a limited extent in the play activities without influencing the course of the game. This role allowed the researcher to gain a contextual understanding of the process of constructing and using *"pistol-pistolan,"* while maintaining the natural behavior of the participants.

2.4 Data Collection Techniques

Data collection was conducted over four weeks using the following techniques.

a. Participant Observation

Observations were conducted in six observation sessions, each lasting 60–90 minutes. The focus of the observations included the process of making *"pistol-pistolan,"* the shape and size of the pistol parts (barrel, handle, and trigger), and the interactions between players during the game. Field notes were used to record details of the activities and social context of the game.

b. Semi-Structured Interviews

Interviews were conducted with 6 children selected from the main participants and 2 supporting informants. Each interview lasted 15–30 minutes for the children and 30–45 minutes for the supporting informants. The interview guide covered the following themes: (a) the process of making toy guns, (b) reasons for choosing size and shape, (c) playing experiences, and (d) the meaning of the game in everyday life. Interviews with supporting informants focused on the cultural context and sustainability of traditional games.

c. Visual Documentation

Documentation was carried out through photographs and sketches of the *"pistol-pistolan"* structures made by the children. This visual data was used to identify geometric shapes, relationships between parts, and size patterns that emerged. Analysis was carried out by linking the results of visual documentation with observation notes and interview results.

2.5 Data Analysis Techniques

Data analysis was conducted simultaneously during and after data collection by following the stages of ethnographic analysis according to (Spradley, 1997), namely: (a). Domain analysis, to identify general categories such as the types of shapes and sizes in the pistol-pistolan structure; (b). Taxonomic analysis, to classify these shapes into mathematical concepts such as geometry, ratios, and measurements; (c). Component analysis, to analyze the relationships between parts, including length comparisons and their relationship to trigonometry concepts; and (d). Cultural theme analysis, to conclude the mathematical meaning contained in the cultural practice of *"Pistol-pistolan"*.

2.6 Data Validity and Credibility

Data validity was maintained through several qualitative accuracy strategies. Technique triangulation was carried out by comparing the results of observations, interviews, and visual documentation. Member checking was carried out by confirming the findings with supporting informants (lecturers and teachers of Minangkabau Natural Culture) to ensure the accuracy of the interpretation. In addition, the researcher conducted peer discussions with fellow researchers in the field of mathematics education to review the analysis process and findings, as well as to compile an audit trail in the form of field notes, interview transcripts, and visual documentation.

3. FINDINGS AND DISCUSSION

3.1 Findings

The game "*Pistol-pistolan*" is one of the traditional children's games in Minangkabau culture that demonstrates significant potential as a source of contextual mathematics learning. Although it is predominantly played by boys, girls also participate, particularly during school holidays. The toy weapons used in this game are constructed from banana leaf sheaths and resemble pistols or rifles. Field observations were conducted in open play areas in Bukittinggi City, where local children continue to preserve this traditional game. To uncover the mathematical concepts in the game "*Pistol-pistolan*" researchers conducted interviews with children who played the game. Researchers are coded P, and children are coded PC. An excerpt from the interview is presented below:

P001	*"Where do you usually start when making the toy gun from banana leaf sheaths?"*
PC001	*"We usually look for leaf sheaths that are already dry but still strong. They're easier to cut and don't break easily."*
P002	*"After that, which part do you make first?"*
PC002	*"I usually make the handle first so it feels comfortable to hold. After that, I make the barrel and estimate the length like this." (gestures with hand)*
P003	*"Do you use a ruler or any measuring tool?"*
PC003	*"No, I don't use any tools. I just estimate it. If the barrel is too long, it becomes difficult to pull the string."*
P004	*"Which part of the toy gun is the most difficult to make?"*
PC004	*"The connection between the barrel and the handle. It has to fit properly and be strong. If it doesn't, it can come loose when the string is pulled."*
P005	*The grips of the "Pistol-pistolan" are triangular, right?*
PC005	*"Yes. The angle looks like a right angle. If it isn't aligned properly, the toy gun ends up tilted."*

Based on the interview excerpts above, the construction of these "*Pistol-Pistolan*" begins with the selection of materials, specifically banana leaf sheaths that are sufficiently dry and sturdy. Children instinctively choose the most suitable parts of the sheath by considering their thickness and flexibility. They then cut and shaped the fronds into "*Pistol-pistolan*", with parts such as the barrel, grip, and simple trigger mechanism made from drawn banana frond fibers. This process demonstrates the presence of spatial ability and visual kinesthetic skills among children. Without using formal measuring tools, children are able to intuitively estimate length, angles, and structural strength. This indicates that through traditional play, children are engaging in early forms of mathematical thinking, particularly in understanding shapes and structures in a concrete manner. Such activities illustrate how mathematical cognition emerges naturally from culturally embedded play experiences.

3.1.1 Geometric Concepts

To identify the geometric concepts embedded in the game "Pistol-pistolan', the researchers observed the banana sheath pistol illustrated in Figure 1.

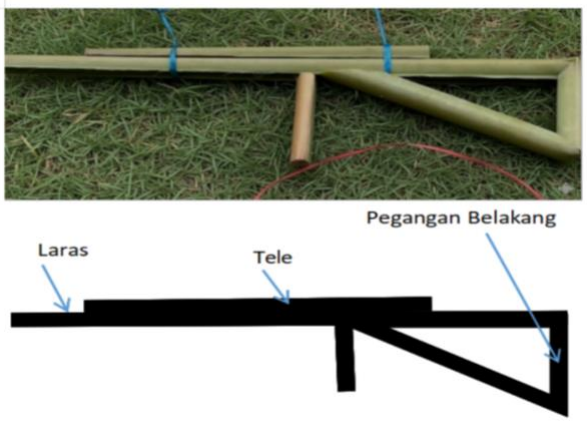

Figure 1. Pistol-pistolan

Through observation and documentation, several geometric concepts were identified in the structure of the "*Pistol-pistolan*", including: 1) types of triangles based on angle measures (right triangles); 2) parallel lines (the trigger bar parallel to the barrel, and the rear handle parallel to the hand grip); 3) properties of plane figures (side lengths and relationships among angles); and 4) relationships among the sides of a triangle. These findings indicate that fundamental geometric concepts can be introduced to students through meaningful and contextual learning media.

3.1.2 Trigonometric Concepts

Trigonometric concepts can be observed in the triangular structure found in the handle section of the toy gun, as shown in Figure 1. For example, if the horizontal part of the pistol is considered the base (adjacent side) and the vertical part as the height (opposite side), then the angle at point A can be associated with trigonometric ratios, as illustrated in Figure 2.

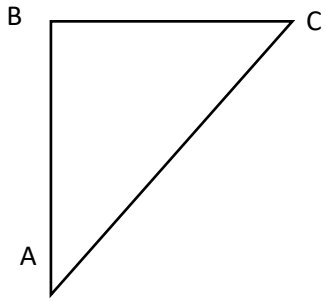

Figure 2. Right Triangle

As shown in Figure 2, a right triangle is formed with the right angle at point B. Trigonometric ratios for angle A can be expressed as follows:

$$\sin A = \frac{BC}{AC};\ \cos A = \frac{AB}{AC};\ \tan A = \frac{BC}{AB}$$

By simplifying the structure into a mathematical model, students can be introduced to angle measurement using a protractor, determination of side lengths using a ruler, and the use of scientific calculators to compute trigonometric values. These concepts become more accessible to learners because they are grounded in concrete activities that are already familiar to them.

3.1.3 Arithmetic Sequences

The size of the toy gun varies depending on the age of the child who plays with it. As shown in Figure 3, toy gun (A) is held and played by children aged 2-4 years. Toy gun (B) is used by children aged 5-8 years, corresponding to elementary school students in grades 1-3. Meanwhile, toy gun (C) is played by children aged 8 years and above. The variations in the sizes of the toy gun are illustrated in Figure 3.

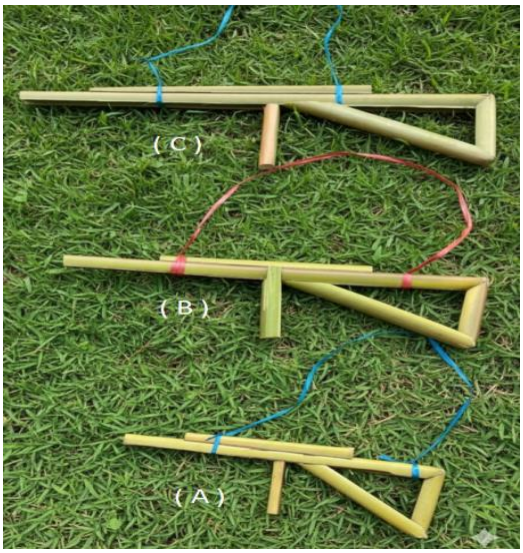

Figure 3. Sizes of the "*Pistol-pistolan*"

Based on the sizes of "*Pistol-pistolan*" (A), (B), and (C) shown in Figure 3, approximate measurement data were obtained and are presented in Table 1.

Table 1. Dimensions of the "*Pistol-pistolan*"

Pistol-pistolan	Rear Handle	Trigger Bar	Barrel
A	12 cm	25 cm	45 cm
B	15 cm	34 cm	60 cm
C	18 cm	43 cm	75 cm

Based on Table 1, which presents the length data of the rear handle, trigger bar, and barrel of the toy gun, it is possible to construct toy gun in various ideal sizes by maintaining proportional relationships among these components. The differences between toy guns (A), (B), and (C) for the rear handle, trigger bar, and barrel are 3 cm, 9 cm, and 15 cm, respectively. These constant differences across successive measurements indicate a consistent pattern. To determine the dimensions of the rear handle, trigger bar, and barrel, an arithmetic sequence can be applied. An arithmetic sequence is a sequence of numbers in which the difference between consecutive terms remains constant, and it can be expressed using the formula Un= a + (n−1)b, (Rohayati et al., 2023). By applying the arithmetic sequence formula, accurate estimations can be obtained for determining the dimensions of the toy gun, as presented in Table 2.

Table 2. Estimated Dimensions of the Toy gun

No	Rear Handle	Trigger Bar	Barrel
1	12 cm	25 cm	45 cm
2	15 cm	34 cm	60 cm
3	18 cm	43 cm	75 cm
:	:	:	:
8	33 cm	88 cm	150 cm
:	:	:	:
N	Un = 12 + (n-1) 3	Un = 25 + (n-1) 9	Un = 45 + (n-1) 15

3.2 Discussion

The findings of this study indicate that the traditional game of "*pistol-pistolan*" played with banana leaves contains mathematical structures that can be identified through children's play activities. These findings reinforce the ethnomathematics view that mathematics is not only present in formal systems at school, but also develops naturally in the cultural practices of communities (D'Ambrosio, 1985; Bill Barton, 2008). In this context, children do not only learn mathematics explicitly, but also interact with shapes, sizes, and comparisons as part of their daily cultural activities. The geometric structures found, such as right triangles and parallel lines, emerged as a response to the functional needs of the game, specifically to create strong and comfortable connections. This is in line with the view of Knijnik & Leopoldo, (2014) that ethnomathematical practices are rooted in solving real problems in specific social and cultural contexts. Thus, the mathematical structures identified in the *"pistol-pistolan"* game represent implicit mathematical practices, not the result of formal learning. The ratio of the sides of a right triangle identified in the *"pistol-pistolan"* structure needs to be understood carefully. This finding does not indicate that children understand trigonometric concepts, but rather shows the potential for conceptual connections that can serve as a bridge to mathematical material at the next level of education. This is in line with the view of Rosa & Orrey, (2020) that cultural practices can serve as an initial context for interpreting more abstract mathematical concepts through a process of mathematization facilitated by teachers.

The findings of patterns of increase in size in the handles, barrels, and barrels of *"pistol-pistolan"* indicate a numerical regularity that can be modeled as an arithmetic sequence. This pattern is not the result of formal mathematical calculations, but rather developed from size adjustments based on the

age and needs of the user. Similar findings have also been reported in various ethnomathematics studies of traditional games in Indonesia, such as ingkek-ingkek (Kusuma, 2019), bahasinan (Jabar et al., 2022), macanan (Angraini et al., 2021), and engklek (Prasetya et al., 2025; Aini & Sari, 2024), which show that traditional games contain mathematical patterns that can be used as a source of contextual learning. Pedagogically, the results of this study indicate that the game of *"pistol-pistolan"* has the potential to be mathematized in learning, for example through activities such as measuring side lengths, identifying right angles, comparing sizes, and exploring similarity and proportional reasoning. This approach is in line with the objectives of ethnomathematics as stated by D'Ambrosio, (2006), namely empowering students to understand mathematics through their own cultural context, while fostering an appreciation for local cultural heritage.

The findings of this study also expand the study of ethnomathematics in Minangkabau, which has so far focused more on static cultural artifacts, such as songket motifs and Rumah Gadang architecture (Abdullah et al., 2015; Z & Muchlian, 2019; Isnaniah & M. Imamuddin, 2022). By examining traditional games that are motoric and constructive in nature, this study confirms that children's play activities are also an important space for the emergence of mathematical practices in local culture. However, this study has several limitations, including the location of the study being limited to one area, the relatively narrow age range of participants, and the seasonal nature of the *"pistol-pistolan"* game. In addition, the interpretation of mathematical structures is highly dependent on the researcher's analysis. Therefore, further research with a wider geographical coverage and direct implementation in the classroom learning context is needed to strengthen the findings and pedagogical implications of this study.

4. CONCLUSION

This study shows that the traditional game of pistol-pistolan played with banana leaves in Minangkabau contains mathematical structures that can be identified through analysis of children's cultural practices. This study reveals the existence of mathematical features that arise naturally in play activities. First, this study identifies geometric features in the structure of the "pistol-pistolan," such as right triangles and parallel lines, which arise as functional requirements in the manufacture of the pistol-pistolan. Second, the concept of trigonometry as a result of comparing two sides of the triangular structure on the handle of the "pistol-pistolan." Third, the increase in size of the rear handle, barrel, and barrel can be represented as arithmetic sequences in mathematical models: Un = 12 + (n-1) 3, Un = 25 + (n-1) 9, and Un = 45 + (n-1) 15. This study expands the Minangkabau ethnomathematics study, which has mostly focused on traditional house architecture and visual motifs, by presenting traditional games based on motor activities as a source of meaningful mathematical practice.

Practically, the findings of this study indicate that *pistol-pistolan* games have the potential to be used as contextual resources in mathematics learning, especially for geometry, measurement, and proportional reasoning in elementary school. The relationship with trigonometry concepts is positioned as a limited possibility for expansion at higher grade levels, rather than as material taught directly at the elementary level. Thus, this traditional game can serve as an initial context for the mathematization process facilitated by teachers.

This study has limitations, including the limited research location to one region and the seasonal nature of the game. Therefore, further research is recommended to: (1) conduct developmental research or teaching experiments that test the effectiveness of *pistol-pistolan* games in mathematics learning; (2) conduct cross-cultural studies between regions to see variations in mathematical structures in similar games; and (3) empirically evaluate the impact of learning on students' understanding of mathematical concepts.

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Conflicts of Interest: The authors each had their own responsibilities in writing this article. The first author was responsible for conceptualizing, collecting data, analyzing, and writing the manuscript. The second author assisted with data analysis, grammar understanding, and editing the article to ensure it was publishable. The third author performed thorough proofreading and editing to ensure the manuscript was ready for submission. I hereby declare that there is no conflict of interest.

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