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Exploration of Ethnomathematics and Geometry in Traditional Agricultural Tools of the Sultanate of Banten

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Abstract: Alat cungkil tanah, cangkul, and mata bajak are one of the relics of traditional agricultural tools of the Sultanate of Banten. The purpose of this study is to explore the heritage of traditional agricultural tools of the sultanate of banten, and analyze the relationship of the heritage of traditional agricultural tools of the sultanate of banten in the material of Flat Plane Geometry. The research method used is qualitative descriptive with an ethnographic approach, a type of research that describes and obtains data in a complete, comprehensive and in-depth manner. The result is an ethnomathematical exploration of traditional agricultural tools from the heritage of the Sultanate of Banten, which represents the mathematical concepts of rectangular flat planes, square flat planes, Isosceles triangle flat planes and the cultural values contained in them. Students can identify and describe the geometric shape of a flat plane on traditional agricultural tools, namely 1) the concept of a rectangle in the traditional agricultural tool, the cungkil tanah, 2) the concept of a square in the traditional agricultural tool, the cangkul, and 3) the concept of an Isosceles triangle in the traditional agricultural tool, the mata bajak.

Keywords: *Exploration, Traditional Agricultural Tools of The Sultanate of Banten, Geometry.*

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A. INTRODUCTION

Indonesia is a country rich in cultural heritage and traditions, including in the field of agriculture. The community's traditional agricultural tools reflect local knowledge passed down from generation to generation. This heritage serves practically and stores mathematical values that can be analyzed through ethnomathematical approaches. One of the regions with a rich agricultural history is the Sultanate of Banten, which has a unique agrarian cultural heritage. In this region, traditional agricultural tools such as ani-ani, mortar, nyiru, and wooden hoe are still used by some people, especially in rural areas. These tools not only serve as tools to support agriculture, but also reflect cultural values that are passed down from generation to generation. Along with the development of technology, traditional agricultural tools are increasingly marginalized and replaced by modern, more efficient machines. However, traditional tools retain important historical and educational value, especially in ethnomathematics and geometry (Tsalasatul Fitriyah et al., 2022).

Ethnomathematics is an approach that examines how a cultural group uses and interprets mathematical concepts in daily life. Ubiratan D'Ambrosio first introduced this concept to bridge the gap between local culture and mathematics learning in formal schools. Traditional tools are important for identifying mathematical values stored in cultural practices in this

context. The Sultanate of Banten, known as a center of trade and agriculture in the 16th century, has various relics of traditional agricultural tools that contain geometric elements, such as Square, Rectangle and equilateral triangle. This research tries to uncover how these concepts are applied in manufacturing and using agricultural tools in Banten and how these concepts can be used in mathematics learning (Aflah & Andhany, 2022).

In previous research, ethnomathematical exploration of traditional agricultural tools has been carried out in various regions in Indonesia, such as the Bugis people in South Sulawesi and the Kampar people in Riau. The study shows that many traditional farming tools have designs closely related to mathematical principles. For example, the shape of a circle on the garbage or nyiru separates rice from the husk with the principle of weight distribution. The rectangular shape on the mortar also shows the concept of flat plane geometry often taught in schools. Therefore, further research on traditional agricultural tools in Banten is important to add insight into the diversity of ethnomathematical applications in various cultures of the archipelago (Zulfa,et.al.2023).

In addition to the cultural aspect, ethnomathematical exploration in traditional agricultural tools also impacts education. In math learning, a culture-based approach can improve students' understanding of geometric concepts and help them connect theory with real life. Many students feel that mathematics is an abstract and complex science to understand, even though in everyday life, mathematical concepts are very close to them. By introducing traditional agricultural tools that have mathematical elements, it is hoped that students can understand the material more easily and contextually. This culture-based learning can also increase a love for local heritage and strengthen their cultural identity (Pramesti, 2023).

However, there are still limitations in research that examines ethnomathematics on traditional agricultural tools in the Banten Sultanate area. Some previous research has focused more on the historical and anthropological aspects without looking at the close relationship between these tools and mathematical concepts. Therefore, this study aims to explore more deeply how geometry is applied in the design and use of traditional agricultural tools in Banten. In addition, this research will also examine how this ethnomathematical exploration can be integrated in mathematics learning to provide benefits both for the academic world and cultural preservation (Subekhi et al., 2021).

With this research, it is hoped that a deeper understanding of the relationship between mathematics and culture in daily life will be created. The results of this study can not only be a reference in ethnomathematics-based mathematics learning, but also as an effort to preserve traditional agricultural tools that are increasingly rarely used. Through this approach, it is hoped that the younger generation will not only understand the concept of geometry theoretically, but also be able to see how mathematics is applied in real life and still appreciate the nation's cultural heritage (Asyam et al., 2024).

B. METHOD

One of the methods used in this study is qualitative descriptive using an ethnographic approach, a type of research that examines and analyzes data thoroughly. When conducting this study, the researcher uses a descriptive design, which is a study that explains every phenomenon that can be observed through the process of observation, documentation, and interviews. Descriptive Research does not offer manipulation, modification, or processing (Sharp et al., 2016). The research subject is Mrs. Rohani, a tour guide at the Old Banten Archaeological Site Museum.

The data collection techniques used in this study are interviews, observations, and docmentation. The data analysis model used in this study is the Spradley analysis model, a qualitative data analysis model proposed by James Spradley in 1980. Spradley proposed four stages in data analysis in qualitative research: Domain, Taxonomy, Component, and Cultural Theme (Aflah & Andhany, 2022). In this study, the researcher made the main instrument in the form of interview guidelines and auxiliary instruments in observation sheets and documentation. Here is a pair of methods with data collection instruments.

Table 1. Research Instruments

Yes	Method	Instrument
1	Interview	Interview Guidelines
2	Observation	Observation sheet
3	Documentation	Documentation sheet

C. RESULTS AND DISCUSSION

1. Domain Analysis Results

This analysis technique is used to analyze the general picture of the research object, often applied in exploratory research.(Budiyono & Rahtwo, 2022) The researcher gathers what is needed to get an overview of the group's formation, culture, communication skills, and entrepreneurial leadership skills.(Suyitno.2020) To get data through observation, there are several stages or steps in making a domain analysis (spradley,1979) one of them is: Solving a single semantic relationship: There are various semantic relationships including type, spatial (place), causal relationship, rational, function, way of sequence/step and attributes/characteristics. A single semantic relationship will look like the following table:

Table 2. Single Sumatic Relationship

Sumatic Relationship	Traditional Agricultural Tools
Kind	Soil prying tool
	Hoe
	Plow Eye

2. Taxonomic Analysis Results

Taxonomy differs from domains in only one thing, namely, that taxonomy shows the relationship between all the original language terms that are incorporated into a domain. Taxonomy reveals a subset of various native language terms and how that subset is associated

with that domain. In other words, taxonomic analysis techniques are part of the domain analysis results (Suyitno, 2020). Taxonomy on Traditional Agricultural Tools, namely:

a. Prying Tools
b. Hoe
c. Plow Eye

3. Results of Computational Analysis

The third step in analysing ethnographic data with the Spradley (1979) model is componential analysis. Componental analysis emphasizes an attempt to search for themes related to cultural categories systematically. Every cultural realm always has several members, categories or elements that are included in it that are found when conducting domain analysis. In component analysis, the entire process is contrast-sought, classified, grouped and included in the image to test its correctness through participant observation and interviews.

4. Results of Analysis of Kurtural Themes

Cultural theme analysis is an effort to find a common thread from integrating across existing domains (Faisal, S. 1990). By finding the common thread of domain analysis, taxonomic analysis, and component analysis, it is possible to construct a construction of the social situation that was previously still dark. Then, after the research was carried out according to the input from some of these analyses, the research became clear. To analyze cultural themes, several strategies can be put forward by Spradley (1979) as follows:

a. The researcher dissolves himself as long as possible in the group being studied so that he can appreciate the nature of the mind or value orientation of the business group
b. The researcher conducted a multi-domain componential analysis to understand the contrasting dimensions between all domains
c. The researcher identifies domains that tend to have much information from other domains.
d. Create a schematic diagram of the scene to help visualize the relationship between the realms
e. Seeking universal themes that include (1) social conflicts, (2) cultural contradictions, (3) focusing attention on how people control their social behavior, how to comply with societal values and norms, through activities this will be identified, (4) managing social relations because in certain cities or places people develop a determined way of relating to others, (5) gaining and maintaining status, Through how the society being researched obtains and obtains status will produce cultural themes, and (6) solve various problems. The researcher uses triangulation as the final support of the four data analyses and data collection techniques used in this ethnographic research.

Triangulasi pada hakikatnya merupakan pendekatan multimetode yang dilakukan peneliti when collecting and analyzing data (Mudjia, 2010). The basic principle of this theory is that the phenomena studied can be well understood, leading to high altitudes if studied from various angles. A single phenomenon from different points of view will allow reliable truth. Therefore, triangulation is the process of analyzing data or information obtained from a variety of different sources in a way that reduces the amount of potential bias that may arise during data collection and analysis.

Traditional agricultural tools in the Sultanate of Banten include soil prying tools, hoes, and steel blades. The form of ethnomathematical concepts contained in agricultural tools has similarities and relevance to the concept of mathematics taught at the elementary school level. The results of ethnomathematical exploration of traditional agricultural tools in the Sultanate of Banten contain mathematical concepts in the form of (a) the concept of Rectangle, (b) the concept of square, and (c) the concept of an isoscele triangle. The traditional agricultural tools of Kampar Regency are explained in detail as follows :

a. Soil Prying Tool

   A soil prying tool is a manual tool used to pryoke, dig, or move soil or other objects embedded in the soil, such as rocks or roots. This tool helps make farming, gardening, or small-scale construction work easier and reduces the labor required in excavation. Using it is quite simple: sticking the tool's tip into the ground, then pry or pry it using the handle.

Figure 1. Soil Prying Tool

   Ground prying tools are usually made of strong metal materials such as iron or steel at the ends, and wood or light metal at the handle for comfortable use.

b. Hoe

   A hoe is a traditional farming tool used to loosen, flip, and clean the soil of weeds or plant residues. This tool is handy in the land cultivation so that the soil becomes more fertile and ready for planting. The way it is used is by swinging the hoe eye to the ground surface, then pulling it back to lift or cut the soil and wild plants

Figure 2. Hoe

Hoes are usually made of strong metals such as steel at the eyes, and have long handles made of wood or light metal so that they are easy to use and do not tire quickly.

c. Plow Eyes

The plow blade is one of the main components of the plow tool used in agriculture to turn and loosen the soil before planting. The plow eye serves to cut, flip, and chop the soil to make it looser, ready for planting, and help remove weeds and previous plant debris. This tool is handy because it can speed up the land tillage process and increase soil fertility through better air and water circulation. The plow blade is attached to a plow tool pulled by animals such as buffaloes, cows, or modern tractors. When the plow is pulled, the blade will go into the ground and turn the top layer of soil.

Figure 3. Plow Eye

The plow blade is generally made of tough and rust-resistant steel, as it must withstand high friction with soil and small rocks on agricultural land. The steel used has usually been hardened to ensure its durability over a long period.

DISCUSSION

1. Rectangular Concept on Soil Prying Tool

Based on the exposure to the research results, it can be seen that there is a concept of flat planes in traditional agricultural tools of Soil Prying Tools. The shape of the Soil Prying Tool in figure (4a) can be modeled geometrically in figure (4b) below.

Figure 4a. The Land of the Dead

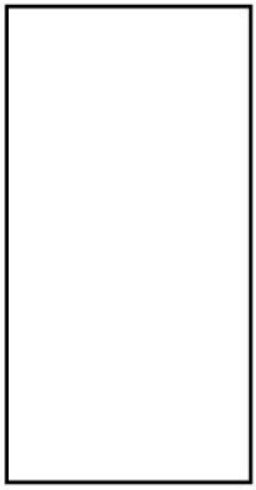

Figure 4b. Modeling of Soil Prying Tools

Figure 5b shows that the modeling is a flat shape, namely a Rectangle. Next, the researcher analyzed the concept of building the rectangle flat.

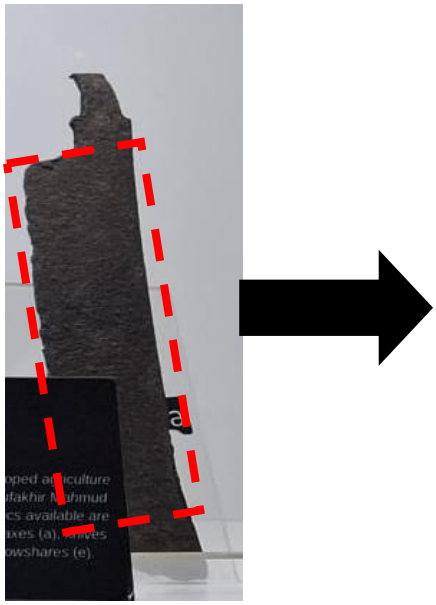

Figure 5a. Soil Prying Tool

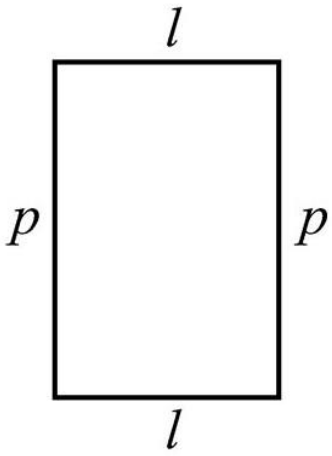

Figure 5b. Analysis of the shape of the Soil Prying Tool

Based on the analysis in figures 5a and 5b, the properties of the Rectangle contained in the shape of the Soil Prying Tool *are as follows* :

a. Has 4 sides
b. Opposite sides Length and parallel

c. It has 4 angles of the elbow – elbow = 900
d. The total number of corner bees is 3600
e. Has 2 equal diagonal lines Length
f. Has 2 symmetrical axes
g. Has 2 symmetrical folds
h. Has 2 symmetrical swivels

The concept and properties of the Rectangle above, which is contained in the traditional agricultural tool of the Sultanate of Banten, namely the Soil Klucking Tool, has relevance to mathematics learning materials on the subject of flat plane geometry taught at the elementary school level.

2. The concept of a square on a hoe

Based on the exposure to the results of the research, it can be seen that there is a concept of flat planes in traditional agricultural tools of Hoes. The shape of the hoe in figure (6a) can be modeled geometrically in figure (6b) below.

Figure 6a. Hoe

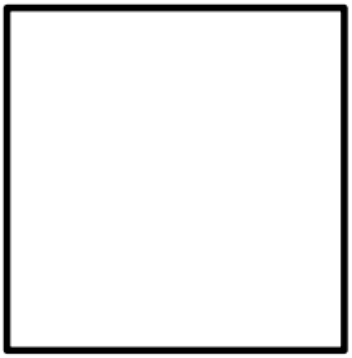

Figure 6b. Hoe Modeling

Figure 7b shows that the modeling is a flat shape, namely a Square. Next, the researcher analyzed the concept of building a square flat.

Figure 7a. Hoe

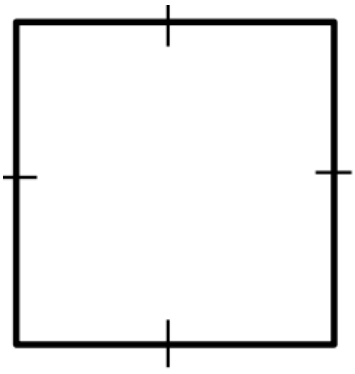

Figure 7b. Hoe shape analysis

Based on the analysis in figures 7a and 7b, the properties of the Square contained in the shape of the hoe *are as follows* :

a. Has 4 equal sides Length
b. It has 4 angles of the elbow – elbow = 900
c. The total number of corner bees is 3600
d. Has 2 pairs of parallel facing sides
e. It has 4 folding symmetries
f. Has 4 rotary symmetries

The concept and properties of the above square, which is contained in the traditional agricultural tool of the Sultanate of Banten, namely the hoe, has relevance to mathematics learning material on the subject of flat plane geometry taught at the elementary school level.

3. The concept of equilateral triangles on the plow eye

Based on the exposure to the results of the research, it can be seen that there is a concept of flat plane in the traditional agricultural tool Mata bahi. The shape of the plow blade in figure (8a) can be modeled geometrically in the following figure (8b).

Figure 8a. Plough eye

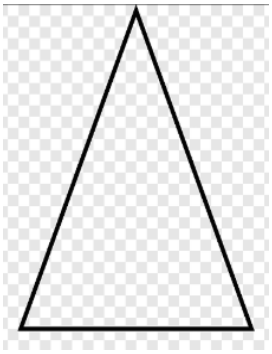

Figure 8b. Plow Eye Modeling

Figure 9b shows that the modeling is in the form of a flat building, namely an isosceles triangle. Next, the researcher analyzed the concept of building an isosceles triangle flat.

Figure 9a. Plow Eye

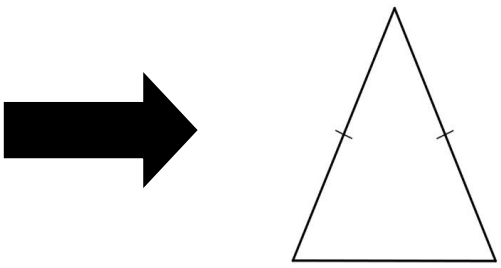

Figure 9b. Analysis of the shape of the Plow Eye

Based on the analysis in figures 9a and 9b, the properties of the isosceles triangle found in the shape of the plow eye *are as follows* :

a. Have two sides of equal length
b. Have two equally large angles in front of the sides – sides of the same length
c. It has a single symmetrical axis that divides the triangle into two equal parts
d. It has three corners where the two corners are equally significant.

The concept and properties of the Triangle of the same as the above contained in the traditional agricultural tool of the Sultanate of Banten, namely the plough blade, has relevance to mathematics learning materials on the subject of flat plane geometry taught at the elementary school level.

D. CONCLUSIONS

Based on the description above, it can be concluded that the Soil Prying Tool, Hoe, and Plow Eye are one of the traditional agricultural tools in the Sultanate of Banten. The result is an ethnomathematical exploration of the Traditional Agricultural Tools of the Sultanate of Banten, representing mathematical concepts including the Rectangular Flat Plane, Square and Isoscele Triangle and their cultural values. Based on these implementations, students can identify and describe the shape of flat plane geometry on Traditional Agricultural Tools, namely 1) Rectangular Concept on Traditional Agricultural Tools Tilling Soil; 2) Square Concept on Traditional Agricultural Tools Hoe; and 3) Concept of Equistriated Triangle on Traditional Agricultural Tools Plow Eyes.

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