Exploration of Ethnomathematics in The Components of Traditional Boats of The Makassar People as a Source of Learning Geometry Concepts

Widiastika Suartawa[1], Andi Kusumayanti[2], M. Ariel Fazli[3], Maulana Syakira[4],Suharti[5]
[1,2,3,4,5]Universitas Islam Negeri Alauddin Makassar
Author Correspondence Email: andi.kusumayanti@uin-alauddin.ac.id

ABSTRACT

Indonesian culture is inseparable from mathematics. Mathematics and culture are something that cannot be avoided in everyday life, because culture is a whole and comprehensive unity, prevailing in a society while mathematics is the knowledge used by humans in solving everyday problems. In the context of boat culture, people unconsciously apply ethnomathematics in everyday life, where it becomes the source or basis of mathematics in various fields, including boats found in Makassar society, namely Lepa-lepa boats and Lambo boats. Lepa-lepa boat is a traditional canoe originating from the eastern region of the Indonesian archipelago, mainly used in Makassar waters. This boat is generally used as a means of transportation for fishermen over short distances, but can also be used for inter-island voyages. Lambo boat is a means of transportation used by some Selayar people who have the character of an accomplished nomad and sailor. The purpose of this study is to find out the concept of geometry contained in the traditional boat components of the Makassar community. The method used in this study is qualitative research with an ethnographic approach. Data collection techniques were carried out using observation, interview, and documentation methods. The results showed that there are ethnomathematical concepts of geometry contained in Lambo boats and Lepa-lepa boats. Therefore, the potential of geometry in mathematics learning found in traditional Makassar boats is the concept of triangle and trapezoidal geometry found on the lambo boat sail and oval flat build found on the lepa-lepa boat oars.

Keywords: Ethnomathematics, Geometry, Boat

1). INTRODUCTION

Education is an important foundation in the formation of individuals and the development of society. Education is "a conscious and planned effort to create a pleasant learning and learning atmosphere so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble morals, and skills needed by themselves and society"

(Pristiwanti et al., 2022). Regarding the development of students' potential through education, mathematics is considered the basis of part of the educational process, where mathematics is seen as a source of thinking concepts that can support daily problem solving (Dhiki & Bantas, 2021). Thus, education and mathematics are closely related.

Mathematics is an important basic science in human life, both in the fields of science, technology, economics, and daily life. Mathematics education is an important part of education, which learns about systematic, logical, and hierarchical organized mathematical concepts as well as effective and fun teaching strategies to help students understand the material better. Therefore, education and cultural values cannot be separated (Fiskha Dwi Patri & Heswari, 2022). The two are interrelated and support each other. Education is the foundation for culture, while culture will enrich education. Mathematics is often applied in everyday life which is used to solve problems in mathematics as well as problems in everyday life.

Indonesia's culture is inseparable from mathematics. Mathematics and culture are something that cannot be avoided in daily life, because culture is a complete and comprehensive unity, applicable in a society while mathematics is the knowledge that humans use in solving daily problems (Astuti & Nurmitasari, 2021). Community activities are also very related to mathematical concepts, such as measurement, trade, various regional building designs, and their application in solving life problems (Rahmawati & Muchlian). One of the things that is able to bridge mathematics and culture is ethnomathematics.

Ethnomathematics is a field of study that studies the relationship between culture, society, and mathematics. Ethnomathematics is a form of mathematics that is influenced or based on culture (Andriono, 2021). In general, ethnomathematics can be interpreted as a form of mathematics applied by a special cultural group. Through the ethnomathematical approach, the way of thinking of the people who create mathematical concepts can be revealed, so that there is a union between the mathematical elements contained in the culture and the mathematical concepts taught in schools (Ratuanik & Filindity, 2021). In the realm of mathematics, ethnomathematics is still classified as a relatively new field, but it has great potential to be used as an innovative foundation in contextual learning approaches. In addition, ethnomathematics can also be an effective means to introduce Indonesia's cultural richness to students. Cultural awareness has a significant influence on individual behavior and plays an important role in the development of individual understanding, including in the

context of mathematics learning (Iraratu et al., 2021). Thus, ethnomathematics is considered important for students by introducing Indonesia culture in the scope of mathematics.

It illustrates that a variety of mathematical concepts can be found in culture, affirming that mathematics and culture are interrelated; Mathematics can arise from culture, and culture can be a concrete source of teaching available to students (Sulasteri et al., 2020). This agrees with those Marsigit et al., (2018) who explain that ethnomathematics aims to describe the relationship between culture and mathematics. Thus, ethnomathematics is a study that aims to understand how mathematical concepts are adapted from a specific cultural context. As part of Indonesia's cultural diversity, a boat is a water vehicle that is used in certain areas by symbolizing their culture. In the Great Dictionary of Indonesian Language (KBBI), a boat is defined as a means of water transportation that generally does not have a deck, has a pointed shape at both ends, and is wide in the middle. For the inhabitants of the archipelago, where the islands are connected by the sea, boats have been a vital aspect of traditional people's lives for thousands of years (Ahmad & Purnawibawa, 2021). Until now, many tribes or regions in Indonesia still maintain the existence of boats as an effort to maintain the authenticity of their cultural values from the influence of modernization culture.

In boat culture, people unconsciously use ethnomathematical concepts in daily life, which is the basis of mathematics for various fields, including traditional boats such as Lepa-lepa and Lambo found among the people of Makassar. Lepa-lepa boats are traditional canoes originating from the eastern region of the Indonesia archipelago, mainly used in the waters of Makassar. These boats are generally used as a means of transportation for fishermen over short distances, but they can also be used for inter-island cruises. Lepa-lepa has a special meaning in the people of Makassar, not only as a means of water transportation, but also as a symbol of ancestral heritage. There is a village called Lepa Lepa in Galesong-Takalar, and the legacy of a Makassar sailor in northern Australia called Lipa-Lipa (Yolngu), which is now housed in the Darwin Maritime Museum, Australia. Today, Lipa-Lipa (Lepa-lepa) is one of the 250 heritage languages of Makassar that have been passed down to the Yolngu people of Aboriginal Australia (World Encyclopedia, 2020).

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Figure 1. Personal Documentation of the Lepa-lepa Boat at the La Galigo Museum

In addition to lepa-lepa boats, another boat culture in Makassar is the Lambo boat. The lambo boat is a means of transportation used by some of the people of Selayar who have the character of a nomad and an accomplished sailor. At first glance, the Lambo and Phinisi boats have similarities that many people know as traditional boats from Bulukumba Regency which is adjacent to the Selayar Islands Regency (Disparbud Selayar, 2020). Researchers made observations on Lepa-lepa and Lambo boats at the La Galigo Museum. La Galigo Museum is a South Sulawesi provincial museum which is one of the tourist attractions that presents various kinds of historical collections in South Sulawesi (Sitoningrum, 2023).

Figure 2. Personal Documentation of the Lambo Boat at the La Galigo Museum

Based on the results of observations of the Lepa-lepa boat and the Lambo boat from a mathematical perspective, the shape of the boat contains elements and forms that are suitable to be applied in the context of mathematics, especially in the concept of geometry. Geometry is one of the branches of mathematics that focuses on the study of points, lines, planes, and the construction of space (Purwaningrum, 2019). Thus, geometry can be considered as a science related to space. In addition, there is research that supports the ethnomathematics of geometry in boats, namely a study conducted by Ratuanik & Filindity in 2021 which states that the concept of geometry in the rock boat

culture of the Sangliat Dol Village community is an ethnomathematical study that relates geometric concepts to the real context of students.

In facing the cultural aspects of Lepa-lepa boats and Lambo boats, it is very important to explore the concept of geometry contained in the form of Lepa-lepa boats and Lambo boats of the people of Makassar. Therefore, learning mathematics, especially on geometry concepts, has a deeper meaning for students because it can be connected to culture as a real context in understanding geometry concepts. Therefore, the researcher is interested in studying ethnomathematics in the components of the traditional boat of the Makassar community with the title "Exploration of Ethnomathematics in the Components of the Traditional Boat of the Makassar People as a Source of Learning Geometry Concepts" with the aim of finding out the concept of geometry contained in the components of the traditional boat of the Makassar people.

2). METHODS

The method used in this study is qualitative research with an ethnographic approach. This research is included in the type of exploratory research that seeks to explore or identify characteristics related to the mathematical concept of geometry in the parts of the boat. The approach used in this study is an ethnographic approach, which is an empirical and theoretical approach aimed at obtaining an in-depth description and analysis of culture through in-depth field research (Dinata & Junaidi, 2022).

This research was conducted at Fort Rotterdam, which is located on Jl. Ujung Pandang, Bulo Gading, Ujung Pantai District, Makassar City, South Sulawesi. Data collection techniques are carried out using observation, interview, and documentation methods. The data analysis technique used in this study is a qualitative data analysis method that has been developed by Miller and Huberman. The data analysis technique is a systematic data collection process to make it easier for researchers to reach conclusions. The stages in this method include data reduction, which is the step of selecting and abstracting coarse data from the results of field research. Data reduction takes place continuously during qualitative research-oriented projects. The data that has been reduced aims to provide a more focused picture of observations. After being reduced, the next stage is to display or present the data to have clearer visibility. The presentation of the data referred to here can be as simple as a neatly formatted table, graphs, charts, and the like. Through the presentation of the data, the data is

organized, arranged in a relationship pattern, so that it is easier to understand. The reduced data is systematically arranged according to information that has the potential to provide a conclusion. After the data presentation process, the next step is to interpret the data through data analysis.

3) RESULTS AND DISCUSSION

According to the mythology of the Makassar Bugis people, the first boat building occurred during the time of Sawerigading, a king of the Ancient Luwu Kingdom. The role of boats as one of the elements of Makassar Bugis culture has developed since ancient times and has succeeded in increasing the reputation of South Sulawesi as an archipelago sailor. There are two traditional ways of making boats by the Makassar Bugis people:

1. It is made of a single log that is chopped up, commonly called a garonggang or mortar boat. These types of boats include Sampan (from Chinese Senpan), Lepa-lepa, Sande, Soppe (Sope, Javanese), Balolang, Jarangka, and Lesung boats which are generally used in lakes or rivers.
2. The boat is made from boards, using bitti or teak wood which is neatly arranged with seppu wooden nails, mangroves, and kanrungs. This type of boat is larger than a mortar boat and has a higher carrying capacity, even reaching 200 tons. Some of the famous boats in this category include Pajala boats, Patorani boats (used to catch flying fish), Pagatan boats, Baggo boats, Lete boats, Padewakan boats, Galle boats (used for war), Lambo boats, and pinisi boats or palari boats.

Boats made from a single log, called garonggang, batangeng, or mortar boats, are generally used for fishing and transportation activities around the coast. On the other hand, boats made of planks such as lete, lambo, and pinisi boats are used as a means of transportation between islands or between continents. In this study, we will discuss the results of research on Lambo boats and Lepa-lepa boats that can be used as a source of learning geometry concepts.

Lambo Boat

The "Lambo" boat is a type of boat known in the Bugis and Makassar regions, functioning as a means of transportation between islands with a fairly large cargo capacity. Lambo boats have similar shapes and terms of equipment to Pinisi boats, but there are some differences between the two. The difference is mainly seen in the shape, position, and number of screens, as well as the number of grand pillars.

In general, the Lambo boat is almost identical to the Pinisi boat, but the main difference lies in the configuration of the sail and the mast. The Pinisi boat has several sails consisting of two shapes

(trapezoidal and triangular), as well as two majestic poles. Meanwhile, the Lambo boat is only equipped with two right-angled sails and one mast. Both Lambo screens are installed on the front and back of the grand pillar. Another difference lies in the smaller size of the front screen compared to the screen behind the grand pole.

- Application of Geometry Concept to Lambo Boat

The sail is an important component of the lambo boat because the sail concentrates the wind which makes the boat develop thrust and in addition the sail can also control the speed of the boat. The Lambo boat is a boat with 2 masts and 7 sails.

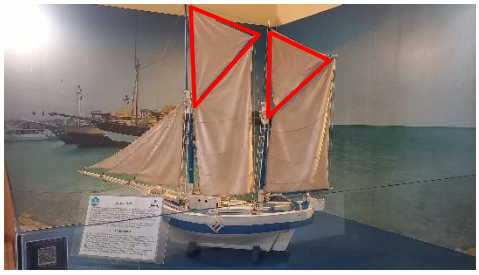


Figure 3. Personal Documentation of Miniature Lambo boat

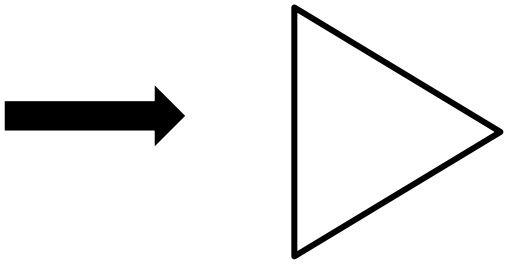


Figure 4. Modeling the shape of a boat sail

The application of geometry to Lambo boats can be seen in the image above. Some Lambo boats have a triangular-shaped sail. The researcher then analyzed the concept of triangles. Based on the researcher's analysis, the triangular properties found in one of the sails of the lambo boat were obtained, as follows:

1. Has three sides
2. Has three corners

Figure 5. Personal Documentation of Miniature Lambo boat

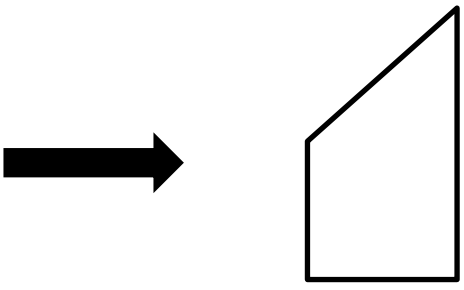


Figure 6. Modeling the shape of a boat sail

In addition to being triangular, there are also trapezoidal sails. Trapezium is a flat shape that has four sides, with two sides that are parallel and two sides that are not aligned. The parallel side is referred to as the parallel side, while the two non-aligned sides are referred to as the non-aligned side or the oblique side. The angle between the parallel sides is referred to as the top angle, while the angle between the non-aligned sides is referred to as the bottom angle.

Lepa-Lepa Boat

In the Bugis language, the term "lepa-lepa" literally refers to something flat, indicating the bottom of a boat that has a flat shape. This type of boat belongs to the category of jukung or outrigger, and is generally used for short-distance voyages (Alamsyah et al., 2020). Some lepa-lepas have an outrigger only on one side, while others have a double outrigger. The manufacture of lepa-lepa involves carving wood to create space in the hull of the boat. Larger lepa-lepas are usually equipped with sails as a source of power driven by the stern wind. Meanwhile, small lepa-lepa can even be operated without a outrigger, just using a paddle.

The function of the paddle as a boat propulsion device, so making the paddle requires the selection of a rather heavy wood and wide paddle cheeks to be moved quickly (Mote et al., 2016). Most fishermen today tend to choose to use boat engines or paddles as a means of moving their boats. Thrusters on boats are often considered a very effective alternative to replacing the use of sails, but this is not the case with rowing (Saqroth, 2015). In some remote coastal areas, such as Nusa Tenggara, the coast of Sulawesi, and other areas, some small fishermen only rely on paddles as a tool to move their boats.

- Geometry Concept in Boat Tools

On one of the boat tools, there is a geometric concept in the form of an oval on the oars of the Lepa-lepa boat.

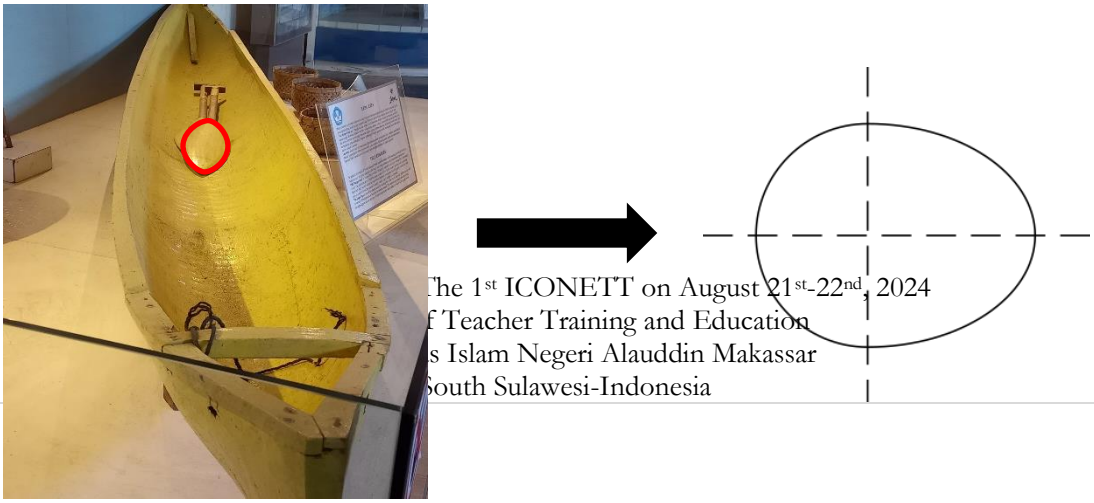


Figure 8. Miniature Lepa-lepa boat

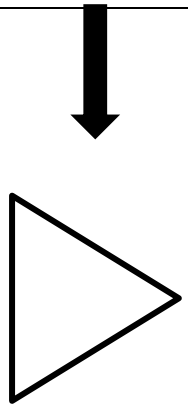
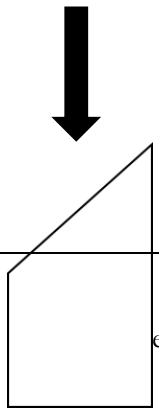
Figure 9. Modeling the shape of a boat paddle

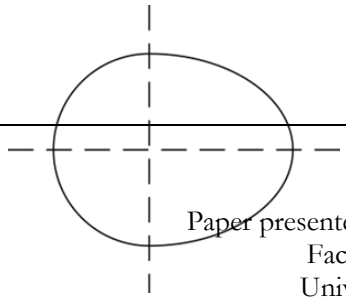
Based on the analysis in the figure, the characteristics of the oval flat building found in the Lepa-lepa boat paddle are as follows:

1. Flatten the oval has two axes
2. The length axis of an oval is the longest distance from one point to another in the curved line
3. The short axis of an oval is the shortest distance from one point to another in the curved line
4. The flat build area of an oval can be calculated by using the formula or $\pi \times sumbu\ panjang \times sumbu\ pendek/4\pi \times r_1 \times r_2/4$
5. The circumference of an oval flat build can be calculated using the formula $\pi \times [3(r_1 + r_2) - \sqrt{((3 \times r_1 + r_2) \times (r_1 + 3 \times r_2))}]$

In addition to the analysis of the images of the lambo boat and the lepa-lepa boat above, from the history of the lambo boat and the lepa-lepa boat can form a problem as follows:

It	Picture	Concepts of Etnomamatica	Questions and Answers
1		Triangle	**Question** Take a look at the image of the lambo boat. On the sail of the lambo boat is in the shape of a triangle. If the length of the screen mat is 50 cm and the height is 25 cm. If the size of the

			beveled sides is 30 cm. What is the area and circumference of the triangle? **Answer** How to calculate the Area of a triangle $L = \frac{1}{2} \times a \times t$ $L = \frac{1}{2} \times 50 \times 25$ $L = \frac{1}{2} \times 1250$ $L = 625\ cm^2$ So, the area of the triangle is $625\ cm^2$. How to Calculate the Circumference of a Triangle $K = s + s + s$ $K = 30 + 30 + 30$ $K = 90\ cm$ So, the circumference of the triangle is $90\ cm$.
2	 	Trapezoid	**Question** On some lambo boat sails, in addition to being triangular, there are trapezoidal sails. With a base length of 3m and 6m, then the height of the trapezoid is 4m. What is the circumference of the trapezoidal building? **Answer** Trapeze Area:

			$= \frac{1}{2}(Alas\ a + alas\ b) \times t$ $= \frac{1}{2}(3+6) \times 4 = 18\ m^2$ To find the circumference of the trapezoid, first locate the beveled side using phytagoras. So, the circumference of the trapezoid is $= a + b + c + d$ $= 3 + 4 + 6 + 5$ $= 18\ m$
3	  	Build an oval flat	**Question** Lepa-lepa boats are traditional canoes used in Makassar waters as a means of transportation for fishermen in short distances or inter-island voyages. Lepa-lepa boats are usually operated using paddles. In the framework of the oars form an oval flat shape that has a long axis of 32 cm and a short axis of 16 cm. Calculate the area and circumference of the paddle! **Answer** Dik: $r_1 = 32\ cm$ $r_2 = 16\ cm$ Dit: Wide and circumference of the paddle?

			Solutions: **Paddle area** $\Rightarrow \pi \times r_1 \times r_2/4$ $\Rightarrow 3{,}14 \times 32 \times 16/4$ $\Rightarrow 1607{,}68/4$ $\Rightarrow 401{,}92\ cm$ **Around the paddle** $\Rightarrow\ \pi \times [3(r_1 + r_2) -$ $\sqrt{((3 \times r_1 + r_2) \times (r_1 + 3 \times r_2))}]$ $\Rightarrow 3{,}14 \times [3(32 + 16) -$ $\sqrt{((3 \times 32 + 16) \times (32 + 3 \times 16))}]$ $\Rightarrow 3{,}14 \times [144 - \sqrt{((112) \times (80))}]$ $\Rightarrow 3{,}14 \times [144 - \sqrt{8960}]$ $\Rightarrow 3{,}14 \times [144 - 94{,}65]$ $\Rightarrow 3{,}14 \times [49{,}35]$ $\Rightarrow\ 154{,}959$ cm So, the area of the paddle is 401.92 cm and the circumference is 154, 959 cm.

The results of research on one of the Makassar Bugis cultures that have been carried out show great potential to be applied in mathematics learning. (Rudyanto et al., 2019) explained that the ethnomathematics-based learning trend is a challenge faced in mathematics teaching, which provides wide opportunities for students to develop students' knowledge and abilities. According to the statement (Kuswidi et al., 2021), mathematics learning associated with cultural context can serve as a bridge for students in understanding mathematical concepts. Integrating elements of local culture that are familiar in people's lives into mathematics learning can make the learning process more meaningful

and interesting for students. In addition, this approach can also indirectly increase the love for local culture.

Ethnomathematics-based mathematics learning can be developed through the use of traditional boats such as Lepa-lepa and Lambo. These boats not only served as a means of transportation, but also stored mathematical concepts and cultural values. This exploration of traditional boats can be used as geometry learning material in elementary schools. In addition to helping students understand the concept of geometry, this learning also allows them to get to know local cultures that are beginning to be forgotten in the midst of the advancement of the times. In line with the opinion (Fauzi et al., 2020), an ethnomathematical approach to mathematics learning can encourage conceptual changes in the understanding of geometry as well as increase students' awareness of the culture around them.

The results of the analysis show that the traditional boats of Lepa-lepa and Lambo have mathematical elements, so they can be used as a learning medium, especially in flat building materials such as triangles and trapezoids. In addition to helping students understand mathematical concepts, the use of traditional boats as a learning medium can also instill character values. By introducing traditional boats in mathematics learning, students are indirectly invited to love and preserve traditional culture.

4). CONCLUSIONS

Based on the results of the research that has been carried out, it can be concluded that there is a geometric ethnomathematical concept contained in the Lambo boat and the Lepa-lepa boat. These concepts involve geometric shapes such as triangles and trapezoids on the sails of the Lambo boat, as well as geometric concepts in the form of ovals on the oars of the Lepa-lepa boat. The ethnomathematical concept of geometry found on the Lambo boat and the Lepa-lepa boat has similarities with the concept of geometric mathematics taught in elementary school. Therefore, Lambo boats and Lepa-lepa boats have the potential to be interesting geometry learning materials at the elementary school level.

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