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Exploration of Phinisi Ship Components as a Source for Learning Elementary School Geometry: Ethnomathematics Study

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Abstract

Mathematics is still seen as a non-cultural subject. Mathematics and culture are two aspects that have a strong relationship. Culture provides a natural means for students to access a framework for conceptual understanding in mathematics. One of the important cultural objects in Indonesia is the Phinisi. The phinisi is a traditional wooden ship originating from Bulukumba Regency, South Sulawesi province which is recorded as a world cultural heritage. This study explores the concept of ethnomathematics geometry on phinisi ships. The method used in this research is an exploratory-descriptive method through an ethnographic approach to explain and analyze the ethnomathematical concepts of geometry on the components of the phinisi. Research data were collected through a literature review, direct observation of the shape and process of making phinisi, and interviews with expert phinisi shipbuilders. The results showed that there are geometric ethnomathematical concepts in the form of flat shapes and spatial shapes on several phinisi components. This ethnomathematical concept is relevant to the formal mathematical concepts learned in school so it has the potential to be a source of learning mathematics.

Keywords: Phinisi ship, Ethnomathematics, Geometry, Elementary school

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INTRODUCTION

The cultural aspect has not gotten a good place in mathematics classes in schools today (Akbar et al., 2021; Pathuddin et al., 2023). Students in some math classes are not allowed to develop a personal understanding of mathematics so values, traditions, beliefs, language, and customs that reflect student culture are often overlooked (D'Ambrosio, 2001). This condition is because today's teachers view mathematics as a non-cultural subject so the presence of cultural objects in mathematics classes is very rare (d'Entremont, 2015). This can be seen in several classes where the teacher does not give students permission to build their understanding of the mathematics presented (Rosa & Orey, 2011). In situations like these, the way children can find personally meaningful conceptualizations is not respected.

Mathematics is not a culture-free discipline (Ergene et al., 2020; Prahmana & D'Ambrosio, 2020). It can be said that all cultures are rich in artifacts that demonstrate mathematical concepts. Mathematics is not a universal domain of formal knowledge. Mathematical knowledge in students' cognitive systems is knowledge obtained through the process of cultural construction. That is, mathematics is a collection of combinations of symbolic representations and procedures built through social and cultural processes (Prahmana & D'Ambrosio, 2020).

Students in practice develop representations and procedures in their cognitive systems through a series of activities that are built on social and cultural activities (Rosa & Orey, 2011).

In other words, the math skills that students learn at school are not built logically based on abstract cognitive structures but are forged from a combination of previously acquired knowledge and skills and new cultural inputs. In addition, it can also be said that mathematics arises from the needs of an organized society, which cannot be separated from the activities and practices developed by people in a global society (D'Ambrosio, 2001).

Low achievement in learning mathematics is caused by the absence of cultural objects in mathematics classes (Ilono C & J.I, 2013; Mirnawati et al., 2020). The low learning outcomes in mathematics are because mathematics in classrooms is often separated from the culture of students, which should be an important object in learning mathematics (Adam, 2004). Integrating cultural symbols or objects in learning mathematics will make learning mathematics more enjoyable (Harding-DeKam & Ben-peretx, 2015). This is because culture provides natural means for students to access frameworks for conceptual understanding in mathematics. In addition, students can understand mathematics through the initial knowledge that students bring to class.

The process of learning mathematics will make it easier for students when the teacher creates a mathematics learning situation that is integrated with cultural experiences because it will make it easier for students to understand formal mathematical concepts (Mania & Alam, 2021). Thus, integrating cultural aspects into learning mathematics will have long-term benefits for students. Culture-based mathematics learning will help students demonstrate consistent mathematical processes when students reason, solve problems, communicate ideas, and choose appropriate representations through the development of everyday math practices. Several studies have shown that integrating culture into learning will improve the ability to think creatively in mathematics (Sariningisih & Kadarisma, 2016), develop critical thinking skills (Martyanti & Suhartini, 2018; Mirnawati et al., 2020), and can increase students ' mathematical understanding (Sarwoedi et al., 2018).

Mathematics and culture are two aspects that have a strong relationship (Ergene et al., 2020). Culture is the whole way of life in a society. This way of life includes the relationship between people, values, practices, and symbols, to how to apply mathematical ideas and concepts in daily activities. In other words, mathematics is the result of cultural construction and is an integral component of all cultural contexts (d'Entremont, 2015).

The relationship between mathematics and culture is expressed in terms of ethnomathematics (D'Ambrosio, 2001; Prahmana & D'Ambrosio, 2020). Ethnomathematics can be considered a way for society in carrying out the process of mathematizing in life. This means that mathematical ideas are processed and used in daily activities. Ethnomathematics is mathematics that emerges from cultural practices. Ethnomathematics is described as a way for social groups to use certain cultures in mathematical concepts to deal with the relational and spatial aspects of their lives (Side et al., 2020). Thus, ethnomathematics exists as a new category in the conceptual discourse of mathematics education and as an interaction between mathematics and culture.

One of the important cultural objects in Indonesia is the traditional phinisi boat. The phinisi ship is a wooden ship originating from Bulukumba Regency, South Sulawesi province. In the manufacturing process, this ship is made without prior planning processes in the form of drawings or mathematical calculations on paper. The Phinisi ship is thought to have sailed before 1500 AD (Hastuti et al., 2018). Since December 2017, the art of phinisi shipbuilding has been designated as an intangible world cultural heritage by UNESCO. The important thing that must be underlined from the UNESCO determination is the tradition and knowledge system skills of the people of Bulukumba to build phinisi boats.

The features of the phinisi ship have attracted the interest of many researchers to conduct research related to the phinisi ship. Hastuti et al. (2018) for example, have researched Weber's perspective approach to the rationalism of phinisi boat building. This research shows that the making of the phinisi boat still has religious mystical nuances, starting from the determination of the day of manufacture to the process of launching it at sea. Other studies have also been carried out by Lantara (2014) who conducted studies related to the development of the total cost model for the phinisi sailing ship production system using the critical path method (CPM). Through the exploration process of the phinisi ship production system, it was found that the critical path method (CPM) method can reduce the time and cost of making phinisi ships (Lantara, 2014). Other studies have also concluded that the resonant frequency analyzed on the phinisi hull if it is shifted to a lower frequency will increase the speed of the phinisi ship (Mahmuddin et al., 2015).

Based on the presentation of the research results above, most of the current research and literature focuses on the phinisi ship from the aspect of its historical existence and development in the modern world. As for studies related to the relationship between phinisi ships and formal mathematical concepts studied at school, they have never been studied. Therefore, researchers feel the need to conduct research related to geometric ethnomathematics on phinisi ships. The purpose of this research is to explore and analyze the concept of geometric ethnomathematics on phinisi ship components. In the next section, this study will begin by laying out general concepts related to phinisi ships, both historically and geographically. In the core section, a study related to geometric ethnomathematics concepts contained in the phinisi ship will be presented.

METHOD

This research is exploratory research with an ethnographic approach. Ethnographic research is research that studies and describes the culture of society (Spradley & McCurdy, 1989). Explorative research in this study is research that seeks to explore or identify the characteristics of the geometric mathematical concepts contained in the phinisi ship components in Ara Village and Tanah Beru Village, Bonto Bahari District, Bulukumba Regency.

The ethnographic approach aims to describe, explain and analyze geometric mathematical concepts contained in the Phinisi ship. Data collection techniques were carried out using observation, interview, and literature review methods. The observation method was carried out by observing the shape of the components and the process of making a phinisi ship at the phinisi shipbuilding center in Bulukumba Regency. Interviews were conducted by asking directly to people who work as Lopi committee members. Panrita lopi is a term used by local people to refer to expert phinisi boat builders. This study involved three *panrita lopi* who were interviewed during the research process. Interviews were conducted to obtain detailed information regarding the concept of geometry on phinisi ships. Meanwhile, the documentation method is carried out by collecting data in the form of images, videos, and previous research results for data analysis and literature review. The data analysis technique used is a type of interactive model that classifies data analysis into three stages, namely data reduction, data presentation, and concluding.

RESULTS AND DISCUSSION

Phinisi is a traditional wooden ship originating from Bulukumba Regency, South Sulawesi Province. This ship uses a schooner sail with two masts and seven sails(Lantara et al., 2018). In the manufacturing process, phinisi is made without being preceded by a planning process in the form of drawings or mathematical calculations on paper. Phinisi is a cultural product as well as a manifestation of the local knowledge of the people of Bulukumba in adapting to their environment in harmony (Kurniasari et al., 2013). Phinisi ships are thought to have sailed before 1500 AD (Mairering et al., 2020). Since December 2017, the art of phinisi shipbuilding has been designated as a UNESCO intangible world cultural heritage. The phinisi ship as an extraordinary work has become a symbol of pride not only for the people of Indonesia but also for the world community. In addition to recognition from UNESCO, this world recognition is also evidenced by the high demand for phinisi ships from abroad (Kurniasari et al., 2013).

Figure 1. Phinisi ship manufacturing process

The phinisi ship is one of the traditional typical ships and a masterpiece of the Indonesian people which is still widely used today. The phinisi ship is an important work for Indonesia because it is not only a testament to the existence of a system of local knowledge and traditional shipping, but is also a legacy that has been passed down from generation to generation (Fadillah et al., 2020). Phinisi ships are listed as criteria for traditional craftsmanship. Although physically the phinisi ship is classified as a work of objects that can be touched, what is interesting is not the work of the object itself, but the traditional knowledge and expertise during the manufacturing process are far more important (Mairering et al., 2020). Therefore, the existence of the knowledge of the people of Bulukumba about how to make a phinisi ship is far more important than the phinisi ship itself physically.

Sail

The sail is an important component of the phinisi ship. Phinisi ship is the name of a ship using a type of schooner sail with two masts and seven sails.

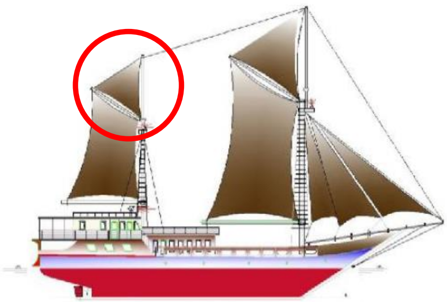

Figure 2. Phinisi sketch and sail

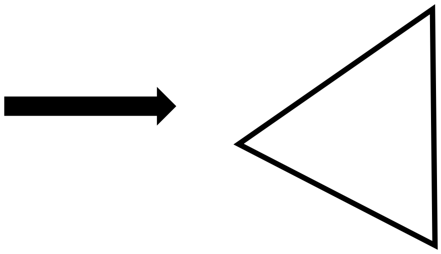

Figure 3. Modeling the shape of sail surface

Based on Figure 3, it can be seen that the modeling is in the form of a triangular flat wake. Next, the researcher analyzed the concept of the triangular flat shape.

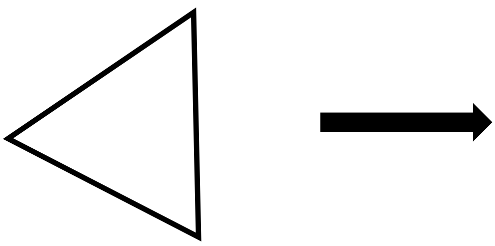

Figure 4. Modeling the shape of the ship's sails

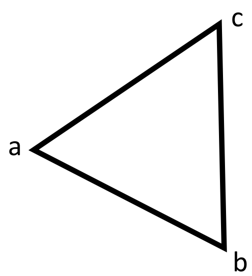

Figure 5. sails shape analysis

Based on the analysis in Figure 5, the triangular properties found on one of the phinisi sails are as follows:

a. Has three sides
b. Has three corners

Ship Keel

The keel is the lowest structural element of the ship. The keel serves hydrodynamic purposes and counterbalances against waves during sailing. Installation of the keel is the first step in phinisi boat construction. The keel also functions to protect the bottom of the ship when there is a shift or friction with the bottom of the waters or when it runs aground. The keel of the phinisi ship is in the form of a block made of wood. The size of the keel depends on the size of the ship. The keel of the phinisi ship also serves as the starting point for making the hull of the phinisi ship.

Figure 6. Cutting off a keel beam

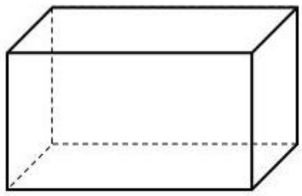

Figure 7. Phinisi keel sketch

Based on Figure 6 above, it can be seen that there is a geometric concept in the form of a beam on the keel of the phinisi ship. Next, the researcher analyzed the geometrical concept of the blocks.

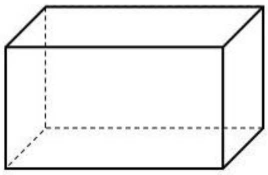

Figure 8. Phinisi keel sketch

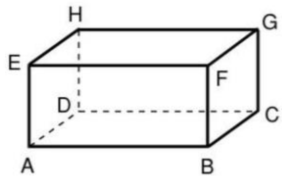

Figure 9. Phinisi keel shape analysis

Based on the analysis in Figure 9, the properties of the beam found in the phinisi keel are as follows:

a. Has 12 ribs
b. Has 6 side planes
c. Has 8 corner points
d. It has 4 diagonal spaces
e. It has 12 diagonals

Hull

The hull is the body of the phinisi ship. The hull serves to provide buoyancy which prevents the ship from sinking. Ship hull design is important in making ships because it will affect ship stability, ship speed, fuel consumption, and the projected depth required concerning the port basin. In the manufacture of phinisi ships, the manufacture of the hull is the second stage of the process after making the keel. The hull of the phinisi ship is made of wooden planks which are connected or strung together using wooden pegs or wooden nails.

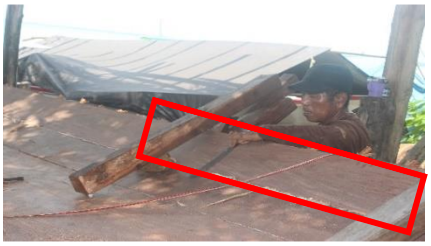

Figure 10. Installation of the hull

Figure 11. Sketch of the hull board

Based on Figure 11, it can be seen that there is a flat geometric concept in the form of a rectangle on the wooden board of the Phinisi hull. Next, the researcher analyzed the concept of the rectangular shape.

Figure 12. Phinisi hull sketch

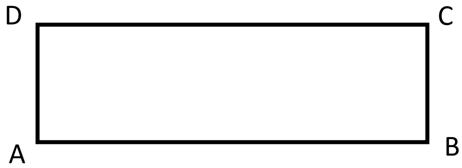

Figure 13. Analysis of the hull board

Based on the analysis in Figure 13, the rectangular properties of the phinisi hull boards are obtained as follows.

a. Choose 4 sides
b. It has 2 pairs of sides that are the same length, AD=BC, and AB=DC
c. It has four equal angles of 90^0
d. It has 2 diagonals of the same length, namely AC=BD

Peg

One of the features of the phinisi shipbuilding process is that the parts of the ship are joined together without using iron nails or bolts but using wooden pegs taken from used pieces of wood. This wooden peg is shaped in such a way that it has the shape of a cone which functions like a nail to unite and glue the ship's components.

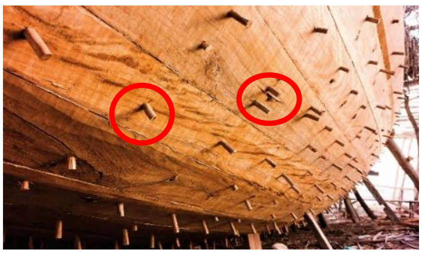

Figure 14. Wooden pegs in the hull

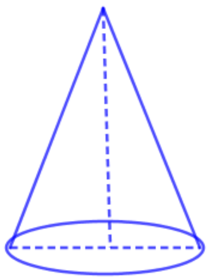

Figure 15. Sketch of peg shape

Based on Figure 15 above, it can be seen that there is a geometry concept in the form of a cone on the pinisi ship components. Next, the researcher analyzed the concept of the cone.

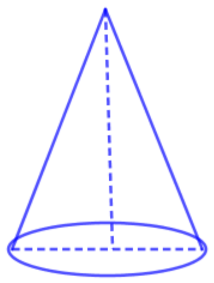

Figure 16. Sketch of ship pegs

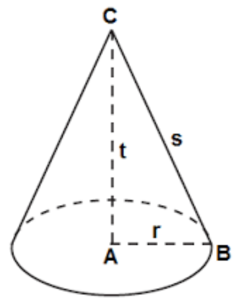

Figure 17. Analysis of the ship's peg sketch

Based on the analysis in Figure 17, the rectangular properties of the cone on the pinisi ship are obtained as follows:

a. Have the rest of the base in the shape of a circle
b. Has a breaking point
c. It has a curved side (blanket).

Phinisi as a Source for Learning Geometry

Learning geometry is one of the compulsory materials in elementary schools. Unfortunately, several previous studies have found several learning obstacles experienced by students while learning geometry (Amal & Supiardi, 2023; Hermawan et al., 2021; Novianda, 2022; Rizki R et al., 2022). Learning obstacles are obstacles experienced by students during the learning process so that learning objectives are not achieved properly (Dani & Badarudin, 2019; Novianda, 2022). Learning obstacles consist of three types, namely ontogenic obstacle caused by psychological aspects, epistemological barriers, namely obstacles that occur due to limited knowledge possessed by students in certain fields, and didactic barriers that arise due to the inability of teachers to present learning material. through the right method or approach (Brousseau, 2002)

Learning obstacles experienced by students in learning geometry include ontogenic obstacles, didactic obstacles, and epistemological obstacles (Novianda, 2022; Rizki R et al., 2022). Ontogenic obstacles occur due to students' lack of interest in learning geometry. Didactic obstacles are caused by the teacher's inability to explain geometric concepts well to students. Epistemological barriers occur due to the lack of prerequisite material that students already have to learn ongoing material and the material being taught is not associated with several different contexts.

Leaning obstacles experienced by students in learning geometry can be reduced by integrating ethnomathematics concepts in learning (Amal & Supiardi, 2023). The Phinisi ship is one of the cultural products of the people in South Sulawesi which contains ethnomathematics elements. In this context, integrating the ethnomathematics concept of phinisi ships in learning mathematics is a strategy to reduce learning obstacles in learning geometry in elementary schools. Many empirical studies have found that learning mathematics involving ethnomathematics concepts has several advantages such as increasing student interest in the lesson, making class fun, increasing critical and creative thinking skills, and developing student learning independence (Ergene et al., 2020; Saironi, 2022; Sariningisih & Kadarisma, 2016; Suhartini & Martyanti, 2017).

CONCLUSION

Based on the description above, it can be concluded that there is a geometric ethnomathematics concept in several phinisi ship components. These concepts are geometric concepts in the form of beams on the keel of the ship, spatial geometry concepts in the form of cones on the ship's pegs, geometric concepts in the form of triangles on the sails of the ship, and geometric concepts in the form of rectangles on the hull boards of the ship. The geometric ethnomathematics concept contained in the phinisi ship has the same characteristics as the formal geometric mathematical concept in elementary school education units. Therefore, the phinisi ship component has the potential to be used as a source of learning geometry in elementary schools.

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