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Ethnomathematics Implementation of Acehnese Culture Based in Traditional House Architecture

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Abstract. Mathematics has been considered a complex subject to learn and understand. In addition, people also still consider mathematics to be free with values. Therefore, mathematics and culture are often perspective differently. This study aims to describe matters related to mathematics in the architecture of the Acehnese traditional house. This type of research was a qualitative study using an ethnographic approach. Data collection techniques used in this study were interviews, observation, and documentation. The Data Analysis used in the study is the Spradley Model with techniques, namely domain analysis, taxonomic analysis, compositional analysis, and analysis of cultural themes. This study showed that there are mathematical elements, including counting activities, community measuring activities, and geometric shapes in the architecture of the Acehnese traditional house. The implementation of ethno-mathematics in mathematics learning can be applied by introducing cultural values related to flat and spatial shapes, measuring and counting objects, and painting objects. The results of this study could be improved as an innovation in mathematics learning.

INTRODUCTION

Mathematics has been considered a complex subject to learn and understand. It can be through the comparison of the value of mathematics lessons with other subjects [1]. The low value obtained by students in mathematics is due to anxieties which can reduce learning motivation and self-confidence in answering questions in mathematics. As a result, student achievement will also decline [2]. Education is a conscious and planned effort to create an atmosphere, teaching, and learning process to develop their potential to have religious-spiritual strength, personality, intelligence, noble morals, and skills needed for themselves and society [3]. Education aims to lead students towards changes in behaviour both intellectually, morally, and socially. Therefore, the purpose of education has two functions, including being able to provide direction for all educational activities and is something that all education wants to achieve [4].

Education and culture are interrelated since they mutually advance each other. It is the same as the relationship between humans and culture, which is also a unity where humans are supporters of the culture itself and will be passed on to future generations [5]. One part of the education given in school, both primary and secondary schools above, is

mathematics education. Mathematics is a science that deals with or examines abstract structures and those associated with them [6]. Mathematics is a part of the culture that is applied to analyze something innovative. mathematics also tends to use a linear way of thinking related to theorems, but when integrated with something soft, such as culture, that thought will become flexible [7]. Various cultural heritage products show artistic creativity that contains mathematical values [8]. For example, in carved ornaments and architectural forms in traditional houses that contain three-dimensional geometric shapes. This cultural heritage can be used as inspiration to be developed by the current learning context. Nowadays, counting, measuring, designing, explaining, and playing both individually and in groups are a means of developing symbolization and conceptualization in mathematics. When other cultures develop, it will create other mathematics [9].

However, some people still think that mathematics is knowledge that is free of values and culture [10]. People still think that mathematics is often identified with things that are always related to numbers. Student's cognitive abilities, learning abilities, and attitudes towards learning can be improved by maintaining a learning atmosphere related to cultural backgrounds. A sociocultural perspective is essential for understanding the role of values in mathematics learning [11]. Learning mathematics is good if there is socio-cultural interaction through dialogue, language, and negotiation of the meaning of symbolic representations between teachers and students [12]. The cultural world of mathematics will encourage students to think about mathematics as integration of everyday life, increasing their abilities. Students in making or linking mathematical concepts in different contexts can build understanding in students' environment by solving mathematical problems either independently or collectively [13].

Ethno-mathematics and its elements grow and develop from society's culture so that the existence of ethnomathematics is often not realized by its users. Ethnomathematics often looks more straightforward than the form of mathematics commonly found in schools. Mathematics in this culture is usually not equipped with definitions, theorems, and formulas like those in schools [14]. The ethnomathematics approach seeks to make school mathematics more relevant and meaningful for students. Mathematics is provided as a cultural response to student needs by making connections between cultural background and mathematics. The ethnomathematics approach is not only to investigate the facts, concepts, and practices of mathematics that exist in a particular society but also to use the results of cultural investigations to teach mathematics as well as cultural values to students [15].

A study shows that culture-based learning is needed in mathematics learning. Because it is not only understanding mathematical concepts that must be mastered, but the introduction of culture is also required from an early age [16]. This is also confirmed by other research, which shows that the learning outcomes and memory of students taught with a culture-based learning approach are higher than the memory of students who were taught using conventional approaches. Students feel that learning is more relevant, meaningful, and fun [13]. The concept of Acehnese culture in mathematics learning is hoped to improve students' ability to understand mathematics more efficiently. One of the parts of Acehnese culture used in this study is the traditional house of Aceh. The architecture of the buildings contained in Acehnese traditional houses will be described and will be linked to mathematics. In this case, apart from being a form of introduction to the architecture of Acehnese traditional houses, the mathematical values in it will also be studied so that it is hoped that by seeing concrete objects in real life, students can increase their enthusiasm for learning to study mathematics. The results of this study can be used as an innovation in future mathematics lessons.

RESEARCH METHOD

This type of research is a qualitative study using an ethnographic approach. This research was conducted using four stages: pre-field, implementation, making analysis, and reporting the results. This study used three data collection techniques; interviews, observation, and documentation. The location and sample of the study were carried out using the purposive sampling technique; the informant is very knowledgeable about the architecture and history of the traditional Aceh house and the implementation of mathematics. The data analysis technique used in this study is the Spradley model analysis, namely domain analysis, taxonomic analysis, component analysis, and theme analysis. The data validity technique used triangulation methods and member checking.

RESULTS AND DISCUSSION

Architecture of the Acehnese Traditional House

Aceh Province is a province located at the tip of the island of Sumatra. The Acehnese have a distinctive culture like the other tribes in Indonesia. One of them can be seen in traditional buildings. The basic concept of a typical Acehnese culture building is a building in the form of a stage. The form of the stage aims to avoid problems from the environment that could threaten the existence of its inhabitants. There is a model in the design of houses and the habits of Acehnese people related to mathematics, as the results of Pathuddin's [17] research found that the shape of the traditional bugis package contains mathematical value.

The Acehnese traditional house is one of the traditional houses in Aceh province. Acehnese houses are made using natural materials, such as wood, planks, bamboo, palm fiber, thatch leaves, and stones. This is because these materials are easy to obtain and durable. Even though it is made with the same material, the techniques for making traditional houses in each province in Indonesia are still different [18]. Acehnese traditional houses are shaped like stilt houses and consist of several rooms, including *seuramoe ukeu* (front foyer) , *Rumoh Inong*, which has two rooms, namely a girl's room and parents' room, *seuramo likot* (back foyer), and a kitchen. The construction of the Acehnese house was carried out jointly by the craftsman (*utoh*) and other communities.

FIGURE 1. Acehnese Traditional House

The Acehnese traditional house consists of three components. The three main structural components that are the center of the robustness of the building include the foundation (foot component), which is used as the most prominent building load center, then the poles and beams between the poles (body components) as load distribution from above and from the side, and the roof frame (head component) which used as a load to support element at the top of the building and from the top side.

Ethno-Mathematics Indicator

Counting Activity

Counting activity is an activity related to the question "how much" or in Acehnese "*padumlheu*". Measuring instruments used by the community in the past were several parts of the body and surrounding objects. The members of the body that are often used for measuring instruments are usually the fingers. For example the thumb indicates one, the index finger indicates two, the middle finger indicates three, the ring finger indicates four and the little finger indicates five. The other limbs are used such as the fist of the fingers which is called one collision, then the elbow and other limbs. Pronunciation counts the numbers 1,2,3,4,5,6,7,8,9, and 10 which indicate a place value about the existence of the number itself which indicates a certain value. This activity of counting is always found in Acehnese traditional house buildings. This was obtained by researchers from the results of interviews with informants who stated that in the past the Acehnese used limbs in measurements and used numbers to calculate a certain size. Acehnese people's habit of determining numerical values has its own unit, but can be accepted in various kinds of trading and financial activities such as "tumpok" which means a collection of several objects at a certain price agreed between the seller and the buyer. another example "beureukah" is an uncertain count but some objects are long and bound in units. This custom is still valid in various regions even though the tools for weighing and measuring are also commonly used by the community. in Acehnese it has a designation for numbering as Table 1, but verbally has the same meaning as international numbering.

TABLE. 1 Pronouncing Numbers from 1 to 10 by Acehnese people

Symbol	Pronounce	Symbol	Pronounce
1	*Sa* (One)	6	*Enam* (Six)
2	*Dua* (Two)	7	*Tujoh* (Seven)
3	*Lheeu* (Three)	8	*Lapan* (Eight)
4	*Peut* (Four)	9	*Sikureung* (Nine)
5	*Limong* (Five)	10	*Siploh* (Ten)

In this case, we can use the concept of arithmetic in early childhood by introducing numerical designations in Acehnese. The teacher can invite students to visit Acehnese traditional houses and introduce various objects found in Acehnese traditional houses, such as poles. The teacher can invite students to count the number of poles; then, the teacher can name the number of poles using the Acehnese language. So that students not only recognize objects and numbers, but students can also learn local languages. In addition, other objects that can be introduced to students are the steps where the teacher invites students to learn to count using stairs in Acehnese traditional houses. The teacher can explain that the number of steps at the bottom of the stairs can be considered number one. Moreover, if the stairs go up, the value will also increase. In addition to the introduction, this is also done to strengthen the concept of numbers. According to Schwartz, children learn from concrete to representational, to abstract thinking [19]. So children are taught mathematics with natural objects first before being introduced to more abstract mathematics.

Measuring Activity

In addition to counting, the implementation of ethnomathematics in Acehnese traditional houses is also found in measuring activities. Measurement determines the quantity, dimension, or capacity that has a standard or unit of measurement. *Measuring* is an activity that is usually carried out in buying and selling, designing shapes, determining length, height, circumference, area, speed, and so forth 20. The measurements used by the people of Aceh in ancient times used body parts such as fingers, or you could also use measuring instruments in the form of items available in nature such as pieces of wood to measure length and cans to measure volume. The unit of measurement used in the measurement is also adjusted to the measuring instrument, such as units of cubits, lengths, feet, cans, mash, etc. This measuring activity is found in building an Acehnese traditional house, namely in determining the height of the poles, the length of the wooden planks in each building construction, measuring the depth of the foundation in traditional house buildings, making wall brackets in buildings, and other development needs. Even with a simple measuring instrument, the people of Aceh were able to make a house that was the right size so that each side was balanced. Measurement activities in the daily life of the Acehnese people also have characteristics and are often used until now, even though long measuring instruments are widely available. For example, the size of "*deupa*", "*haeh*", "*jeungkai*," and "*kulah*" which are length measurements.

Geometrical Shape

Geometry is defined as a branch of mathematics that studies points, lines, planes, and shapes along with their properties, sizes, and relationships to one another. Geometry can also be viewed as a mathematical science that studies physical space concerned with shapes and forms. For this reason, the concept of geometry is closely related to historical remains in the form of architecture in a certain tribe. This architectural form is also found in traditional houses in Indonesia. Especially in the Acehnese traditional house on which it has a close relationship, it can be used as a concept in the realm of discussion in geometry. In some of the components of the Acehnese traditional house building, there is a geometric form that explains the concept of the line, according to the results of the informant's interview and all the aspects contained in the interior of this Acehnese traditional house building which shows the relationship between man and his God.

Flat Shape (two-dimensional geometry)

A flat shape is a part of a plane bounded by straight and curved lines. A flat area only has two dimensions, namely length, and width. A flat shape is divided into eight types: square, rectangle, triangle, trapezoid, parallelogram, kite, rhombus, and circle. In the architecture of traditional Aceh house buildings, there are very many flat building elements. There are also many types of flat shapes on the inside and the outside of the Acehnese house.
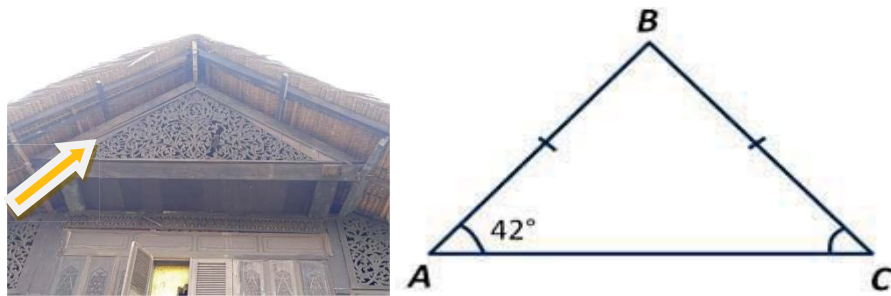
FIGURE 2. Triangle concept in roof construction

Space Geometry (three-dimensional geometry)

The geometry of space is the set of all points, lines, and planes in three-dimensional space located in a closed part along with the entire bounding surface. Space constructions are divided into two categories, namely flat-sided and curved-side spaces. Build a flat side space including a cube, block, prism, and pyramid. Meanwhile, the curved side space includes balls, tubes, and cones. In the Acehnese traditional house building components, the concept of building space used is a tube shape. The tube is a curved side chamber consisting of a lid and a base in the form of a circle of the same size, and a rectangle circles its sides. The tubes themselves are found on the pillars of Acehnese traditional houses and are also found in rice barns around the Acehnese traditional houses. The concept of building space that is applied in Acehnese house building is not many. As far as the researchers found, only the shape of the tube was found. Researchers have not found the others.
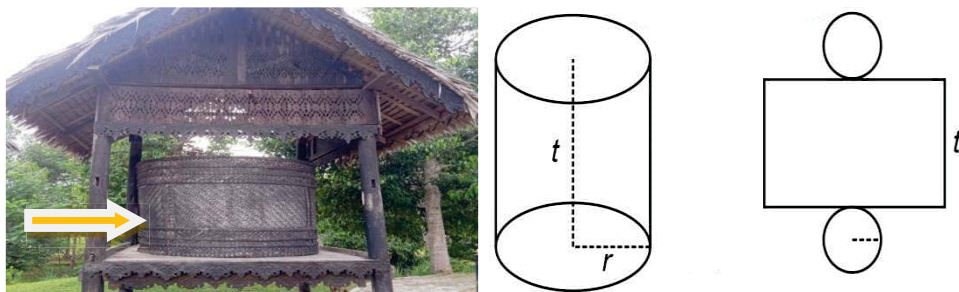

FIGURE 3. The concept of three-dimensional geometry in the Aceh house

Implementation of Ethno-Mathematics in Mathematics Learning

The teacher can invite students to see the forms of flat shapes and spatial shapes directly. The teacher can explain the types of flat shapes found in many Acehnese traditional houses, including triangles, squares, rectangles, circles, parallelograms, and trapezoids. The teacher can also explain to students the forms of space. The teacher can immediately show how the shape of the point, line, plane, and shape of the space as a whole is equipped with an explanation of the shape is shown. Explanations in class can be further clarified by bringing students to visit these attractions and see directly the real objects that have been described in class [21]. The current learning process, especially for numeracy, must use contextual learning methods. for this purpose, the teacher often uses objects around to introduce measurements and calculations to students [22]. In the daily life of the Acehnese people, many crafts have mathematical values, such as *reungkan* as a place to serve food in the form of fractal geometry. This craft is often used as homework for students to get used to thinking in a patterned manner in numeracy [23].

In Acehnese's house, teachers can invite students to learn to count and measure. Kindergarten and Elementary schools teachers are more likely to do this. The teachers can show natural objects such as house poles that have a certain number. The teachers can guide students to try to count from 1 to the following number. Previously in class, the teacher could explain to students how to write numbers and try to read them together. When students are invited to see real objects, the teachers can also explain what is said to be two, what is said to be three, and so forth. For example, the object used is a pole or a staircase. The teachers can show seven wooden steps and 24 poles by counting them together with the students. Another thing that the teachers can do is to invite students to measure the objects they

find in the Acehnese house. For example, the teacher invites students to measure the length of the distance between the front and back of the house. In this activity, the teachers can use a measuring instrument that has been prepared in advance and take set this measurement with the students. The expected to increase students' motivation to learn mathematics [24]. Another example, the teachers invite students to calculate the volume, surface area, and area of the tube blanket. The teachers can show them the shape of the tube that is close to the Acehnese house. They can explain how to count using natural objects that are still cultural. In addition to knowing its function in culture, students also understand its use in mathematics.

CONCLUSION

Based on the research results and discussion of the traditional house of Aceh and its mathematical concepts, there is an ethnomathematics implementation of the counting activity that the Acehnese people did in the past to state an amount and state something that was a lot. In addition, there is also the concept of numbers in the staircase of Acehnese traditional house. The measuring activities conducted by the people of Aceh in the past to build Acehnese traditional houses. By using simple tools, namely limbs and measurement units at that time, the people of Aceh were able to make Acehnese houses a balanced house with accurate measurements. There is a geometric concept in the traditional house of Aceh, namely first dimension (straight lines, parallel lines, angles, flat shapes, and spatial shapes).

ACKNOWLEDGMENTS

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