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Conceptual Design of Ethnomathematics-Based Student Worksheets at the Keraton Kesultanan Kadariah Pontianak

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Abstract

Ethnomatematics can be used as an alternative method for teachers in facilitating learning so that students understand mathematics more easily. By ethnomathematics it is hoped that students can further improve their critical thinking, metacognitive, and problem solving abilities. The aims of this study were (1) to describe the conceptual design of Ethnomatematics-based Ethnomatematics Mathematical Worksheets at the Keraton Kesultanan Kadariyah Pontianak, to introduce the mathematical concepts found in Keraton. This research is a type of literature study. The instruments used in this study were questionnaires, and validation sheets. Based on the literature review that has been carried out, ethnomatematics-based student worksheet should be used in learning process.

Keywords: Interactive learning, Lectora inspire, Learning media.

INTRODUCTION

Ethnomatematics is defined as knowledge that combines mathematical concepts with cultural elements. The uniqueness of local culture and character is expected to help students learn and adapt to mathematical concepts that are integrated with local wisdom so that students feel that mathematics is part of the culture (Dahlan & Permatasari, 2018). Learning mathematics and its integration with local culture is expected to guide students to understand mathematical concepts and feel that mathematics is a part of life.

One of the interesting conversations about the issue of education that has always been going on in the larger community is in the area of mathematics. Daily tasks often involve mathematics, however occasionally this is not the case. However, the majority of people believe mathematics to be challenging. In the age of globalization and modernization, mastering mathematics plays a crucial role in helping students develop their critical, logical, analytical, and creative thinking abilities.

However, we are currently dealing with a number of issues and challenges that negatively impact academic performance, including low motivation to learn math, challenges with grasping and understanding difficult mathematical concepts, codes, and values, attention and concentration deficits in the classroom, and more. Ethnomathematics is the study of the connection between mathematics

and culture in the context of mathematics education. It frequently has cultural connotations. It is also related to the type of mathematics that is practiced by recognized cultural groups. A large group of concepts, including various numerical and mathematical systems and multicultural mathematics education, are referred to as ethnomathematics.

Learning mathematics is based on the local culture correlated to ethnomathematics. When pupils are taught directly at the sites or locations where the culture develops and flourishes, the instructor may better control the learning process. This is experiential education. According to Hagen's research, the students appear to like participating in outdoor activities. They like the mathematical assignments that the pupils found challenging. In the attitudes of all students toward nature, a turning point was seen. With time, students grew accustomed to, less frightened of, or extremely excited about nature. This attitude shift might affect how much fun the pupils have.

Students used a mathematization technique based on ethnomathematics to solve mathematical issues. They were aware that ethnomathematics served as the foundation for all horizontal mathematical activity. After controlling for the students' starting skills, students who utilized the conventional learning technique instead of the ethnomathematics-focused materials demonstrated more mathematical understanding than those students who used the realistic mathematics learning approach.

Students who are taught utilizing material that is ethnomathematics-oriented have better mathematical communication abilities than students who are taught non-ethnomathematics. On the other hand, students who are taught using inquiry learning models have worse mathematical representational skills than students who are taught using traditional learning models if the mathematics content they are given is not ethnomathematics-based. The idea of mathematical literacy primarily focuses on the mathematical and sociological needs to student capabilities because ethnomathematics stressed how student competence develops in different cultural groups in their everyday lives.

Following the control of students' baseline abilities, students who studied non-ethnomathematics material had a lower capacity to understand mathematics than students who studied material directed toward ethnomathematics. Students are supposed to learn from this using practical methods for studying mathematics. Therefore, it is appropriate to incorporate and integrate ethnomathematical mathematics into the curriculum in schools.

Students are solely employed as learning objects because education is still teacher-centered and uses the lecture approach for arithmetic instruction. They should be able to develop instructional objectives that are pertinent to the applicable curriculum if these values can be minimized. As a result, the 2013 curriculum requires instructors to use

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their creativity to create lesson plans that are unique, varied, engaging, relevant, and based on the needs of the individual students. Education therefore plays a significant impact in affecting students' capabilities.

Numerous aspects of life, including communal culture, have been incorporated with mathematics. Certain communities utilize various mathematical concepts depending on the culture. According to sociocultural studies, each group has historically created a certain type of mathematics unique to its culture and past. Social values, religious beliefs, and scientific knowledge, including an understanding of mathematics, are only a few of the significant components that make up culture.

The field is known as Ethnomathematics because it aims to connect mathematics with the community's pre-existing culture. Etnhomathematics is a field of study that examines the connection between math and culture. The term "ethnomathematics" refers to methods and procedures used to discover, comprehend, articulate, and control the reality experienced by various ecological, social, political, or cultural (ethno) contexts. It is generally accepted that ethnomathematics is the practice or method of comprehending mathematics in its numerous social expressions. Mathematical knowledge that evolves and expands inside a nation's culture is known as ethnomathematics.

Indonesia is a multicultural country with very high cultural diversity. Each culture has its own characteristics and uniqueness. Indonesia, which is an archipelagic country, has a diversity of cultures, arts, tribes, regional languages, races, religions, and so on. In this case (Rahmawati & Marsigit, 2017), Indonesia claims to have many historical heritages. Culture can be applied through mathematics lessons. For example, the material for the number pattern at the Keraton Kesultanan Kadariyah Pontianak.

Ethnomatematics can be used as an alternative method for teachers in facilitating learning so that students understand mathematics more easily. By ethnomathematics, it is expected that students can improve their critical thinking, metacognitive, and problem solving abilities.

In the context of learning mathematics, ethnomathematics is learning that uses cultural symbols to create mathematical concepts. As for the study of cultural elements that are integrated into learning, it is better if it is carried out starting from environmental culture. This is in accordance with the principle of contextual learning where learning uses objects in the environment. One of the best cultural places to study ethnomathematics is Keraton Kesultanan Kadariyah Pontianak.

Keraton Kesultanan Kadariyah Pontianak is the palace of the Sultan of Pontianak which was built between 1771 and 1778. Sayyid Syarif Abdurrahman Al-Qadrie was the first sultan to live in the Keraton. Keraton is located near the center of Pontianak in West Kalimantan. As the forerunner to the birth of the city of Pontianak, the Kadariyah Palace

became a historical tourist spot. Various cultural elements that can be studied at the Kadariyah Palace include historical buildings with high architectural art, historical antiques and heirlooms.

Ethnomathematics is important to apply in shaping the noble cultural character of students, therefore it is necessary to carry out research related to the conceptual design of ethnomathematics-based student activity sheets at the Keraton Kadariyah Pontianak. From the explanation above, this study aims to describe the conceptual design of Ethnomatematics-based Student Worksheet at the Keraton Kesultanan Kadariyah Pontianak.

METHODE

This research is included in the literature study. Literature study is a type of research based on library data collection methods, reading, collecting references, and processing literature studies related to research materials. Literature study is also an activity in searching for theoretical references that are relevant to the problems and issues found or researched.

This study was held in June 2022. The conceptual design of the math worksheet in Keraton Kesultanan Kadariyah Pontianak contains (1) Cannons which discuss the concepts of area and circumference of a circle, volume of cones and volumes of cylinders, (2) Mirrors which discusses the reflection of light on a flat mirror and the minimum length of the mirror so that all images are seen in a plane mirror, (3) Number patterns that discuss the area and perimeter of rectangles (length and width), and calculation of number patterns on the steps of the throne (Arithmetic number patterns).

As for this literature study research, it is expected that it will be able to produce a conceptual design of an ethnomathematics-based student worksheet of Keraton Kesultanan Kadariyah Pontianak which can be implemented during learning process.

RESULTS AND DISCUSSION

Preliminary Research

Based on the results of observations during the learning takes place, the findings can be seen from the Table 1.

Based on table 1 above, it can be seen that the average of the percentage of learning implementation is 81.3%, this level of implementation has reached the minimum limit on practical Student Worksheets namely 75%, however in each meeting, the results are slightly different. For the first meeting, the implementation was lower compared to the next meeting. This is because the first meeting students are still adapting to learning activities. Students are not familiar with the worksheets being developed, and students are also reluctant or embarrassed to ask questions.

Table 1. Results of Material Validation

Activity	Percentage	Average
Meeting 1	68%	
Meeting 2	82%	81.3%
Meeting 3	94%	

Result of Conceptual Design Worksheet

As one of the cultural heritage

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Figure 1. Area infront of the palace

Figure 2. Area inside of the palace

Figure 3. The Long Yellow Cannon

buildings in West Kalimantan, Keraton Kesultanan Kadariyah Pontianak (Figure 1 & Figure 2) stores many valuable objects and has historical value. The objects that are still stored in this palace are the relics of the previous sultans.

The sultan's heritage includes cannons of various sizes, from small to large, and are scattered around the palace, besides cannons there is also the most charming of Kadriah, namely, a thousand glass made in France which is quite large, so it can make the palace look magnificent. In the Kadriah palace, the thrones of the former sultans are still kept, complete with thrones
for his sons and daughters who are still well groomed.

Kadriah, is the name of the palace of the Pontianak kingdom, which was founded by Sultan Syarief Abdurrahman in 1771, which is located in Kampung Dalam, Tanjung Hilir, East Pontianak. Now the Palace is being used as a valuable building for the province of West Kalimantan, which is also protected by the State. Apart from being used as a valuable and protected building, Kadriah is also used as a museum which is open to the public, with the aim of imparting historical knowledge to current generations. In addition, there are elements or cultural values of mathematics contained in the royal court, such as:

a). Cannon

One of the historical heritages of Keraton Kesultanan Kadariyah Pontianak which stood in Pontianak is the Cannon. Cannon is generally large in size made of metal and shaped cylindrical (tube), which use powder ingredients pusher another to fire projectile.

The ancient cannon had only one other hole in the muzzle for the bullets to eject. While the modern cannon has two holes, one of which is used as a place to insert bullets, which is behind and where the bullets come out in front. Cannons come in various sizescaliber, range, angle of fire, and firepower. More than one type of

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Figure 4. The Throne Stairs

cannon is generally used in battle field.

Furthermore, there are four cannons in the palace consisting of three large ancient cannons and one small yellow ancient cannon in the yard.

This small yellow cannon is located in the courtyard of the royal palace. In this cannon there are elements of mathematics.

- Identify Area and Around Circle (Diameter, radius)
  - WideCircle = π.r2
  - Circumference = π. d
- Calculating the Volume of a Scapular Cone
  - V = 1/3 πt (R2 + rR +r2).

Meanwhile, the long yellow cannon (Figure 3) is also found on the yard of the palace by side with the little yellow Cannon. In this yellow Long Cannon there is an element of mathematics namely:

- Identifying the Area and Circumference of a Circle (Diameter, radius)
  - L = πr2
  - K = π.d
- Calculating Tube Volume

V = π x r2 + t

b). Throne Stairs

Stairs are part of multi-storey buildings that function to connect circulation between floors of multi-storey buildings by walking up or down using traps (stairs).

In general and commonly known, stairs consist of two types, namely the main stairs and emergency stairs. As the name implies, the main staircase is a trajectory that is traversed at any time. On the other hand, emergency stairs are traversed at certain times.

The staircase on the thronem (Figure 4) is in the form of a block consisting of three steps which are used as a pedestal when you want to go up or down from the throne. Each rung has a different size, the lower rung is 341 cm long and 29 cm wide, for the middle rung has a length of 285 and a width of 29 cm, then on the top step has

a length of 229 cm and a width of 29 cm. so that the length of each rung can form a pattern of arithmetic numbers.

On the steps of this throne are in the royal palace room. This throne ladder has a mathematical element, namely:

- Identify the area and perimeter of a rectangle (length and width).
  - Area = length x width
  - Circumference = 2 (length+ width)
- Complete the calculation of number patterns on the throne (Arithmetic number patterns)
  - Determine the formula for n
  - Determine the sum of the first three terms

c). Mirrors

Plane mirror is a mirror that has a flat surface like a straight line. The image of an object formed by a flat mirror (Figure 5) has the same dimensions (length and width) as the object's dimensions. The distance formed between the object and the mirror is the same as the distance between the mirror and the image. The properties of the image formed by a plane mirror are virtual, erect and the same size. An example of using a flat mirror as in a make-up mirror.

Plane mirror or plane mirror made from a flat surface. But on the outside or inside parts, it is composed of a cylindrical or spherical surface with an infinite radius. Plane mirror itself reflects the files that parallel when the incident light becomes reflected light rays parallel to each other.

There are plane mirror properties when subjected to a beam of light as follows:

Figure 5. Mirrors in The Keraton Kesultanan Kadariah

1. The image on the object will be erect and pseudo.
2. A pseudo image is an image that can be seen in a mirror, but where the image is, no light is found.
3. In the image, the size and height are the same as the size and height of the actual object.
4. The image distance of the object is equal to the distance between the object and the mirror.
5. On part right the image is the left side of the actual object and vice versa.

An example of object reflection in a flat mirror, which we are familiar with in the form of virtual images. This image is called virtual because the light does not actually come from the position of the image. The light comes from two light rays tracing the

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object at each reflection, where the angle of incidence is equal to the existing reflection angle. In a simple geometry, we see that the image is the same size as the object (ab = A'B').

So the magnification is +1, where the '+' indicates that it is the correct way. If the objects are at the same distance from the mirror, we can observe that line AB is half the length of ab. So, to look at ourselves in the mirror from head to toe, we need a mirror that is half our height or to get a complete image of our reflection, we need a mirror half the height of ourselves.

This mirror is in the room that is hung or attached to the wall of the royal palace. This mirror has a mathematical element, namely:

- Reflection light on mirror flat

$$n = \frac{360}{\alpha}$$

Note:
n = many shadow formed
α = the angle formed by the two mirrors

- Identifying the minimum mirror length in order for the entire image to be visible on a plane mirror, the length of the mirror (p) is half of the height of the object ($h0$)

$$p = \frac{1}{2} \times h0$$

Note:
p = mirror length(m)
$h0$ = object height (m)

The emergence of mathematics as a topic that is taught in every school in the world is evidence that understanding its principles is the key to advancing civilisation. Every other branch of knowledge, including engineering, agriculture, economics, and even astronomy, uses mathematics as its primary tool. Understanding mathematics entails giving civilizations the chance to demonstrate their existence. History also records that colonialization, which took place in many regions of the world, had an effect on the dominance of culture. According to some experts, this condition cannot be dissociated from the mathematics that Europeans introduced to their colonies while adopting a Eurocentric mindset and disregarding the expertise of indigenous peoples.

Indigenous peoples' usage of mathematics can be studied thanks to the term "ethnomathematics." Asia, Africa, and Latin America are ranked last in the world for having the lowest levels of mathematics literacy, according to the PISA results (OECD, 2018). The majority of these nations are former European colonies that accept Eurocentric mathematics in their educational practices. According to ethnomathematicians, linguistic and terminological hurdles prevented indigenous people from understanding the mathematics that was formally introduced by Europeans. On the other hand, there are more intricate historical issues like racism, cultural dominance, and disparities in political orientation.

Math learning can be successful if several factors, including the student's cultural background, are taken into account in the pedagogical aspect. Students are able to understand mathematics more realistically by using a cultural context. However, there are also a lot of important issues and difficulties to

be tackled when considering the cultural context of mathematics. criticism of ethnomathematics, focusing in particular on the issue of how ethnomathematics differs from mathematics, the philosophy supporting ethnomathematics, and the extent to which culture can influence one's mathematical skills.

Experts in ethnomathematics attempt to explain their stance in the alternative philosophy of mathematics, despite the fact that this demonstrates that there are various ways to interpret the concept of ethnomathematics (Cimen, 2014). However, it seems that ethnomathematics has gained some traction in the recent three decades in bringing up a number of concerns, particularly those pertaining to multicultural mathematics education, the incorporation of ethnomathematics into the curriculum, and indigenous mathematics. Additionally, since CERME 2003, the subject of ethnomathematics has been brought up as a research study in actual mathematics teaching (Francois, 2010). Many ethnomathematics research projects around the globe demonstrate significant efforts to take into account the connections between mathematics and culture that can be used in the classroom.

While social and cultural origins and mathematics education are closely intertwined in ethnomathematics, some issues do not seem to be entirely tied to classroom mathematics. Though they can help students gain local knowledge and practical skills, ethnomathematical concepts in schools are not very helpful in the increasingly competitive academic mathematics field. Studies in ethnomathematics present an anthropological picture of how behavioral factors use and disseminate mathematics.

CONCLUSION

Based on the literature review that has been carried out, this study resulted in a conceptual design of Ethnomathematics-based worksheets related to Keraton Kesultanan Kadariyah Pontianak which can be implemented in the mathematics learning process.

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BRIEF PROFILES

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