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TRIANGLE CONCEPT CONSTRUCTION THROUGH ETHNOMATHEMATICS-BASED ONLINE LEARNING OF KALAMATA FORT ARTIFACTS

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ABSTRACT

This study aimed to construct a triangle for junior high school students through online learning based on the Ethnomathematics of Kalamata Fort Artifacts. This research is descriptive qualitative research with a case study type. The data collection methods used are concept understanding tests and interviews. The subjects of this study were three students who were grade VII junior high school students with high (S1), medium (S2), and low (S3) abilities. In this study, the data analysis conducted was descriptive. The data analyzed in this study are the results of concept understanding observations and interviews conducted by researchers on research subjects. The results showed that constructing the concept of triangles through online learning based on the Ethnomathematics of Kalamata Fort Artifacts had a good impact on the concept understanding ability of grade VII junior high school students.

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1. INTRODUCTION

The COVID-19 pandemic has provided many experiences in online mathematics learning for educators in Indonesia. Online learning can be interpreted as internet-based learning where teachers and students are in separate locations, both direct interaction and indirect interaction [1]. Studies report that if technology is used to enhance mathematics learning at all levels, students will be better prepared to use technology appropriately, fluently, and efficiently in the technology-rich environment in which they learn and work in the future [2]. Other studies have also revealed that students learn math better when effective and appropriate technology tools are applied [3]. It is evidenced by many studies in the COVID-19 pandemic era, which show that online learning has a positive effect on students in learning mathematics, including interest in learning mathematics [4], achievement, and motivation to learn mathematics [5]. However, there are some situations where online learning cannot provide the desired results due to technical problems and lack of adequate learning resources [6]-[8]. In determining the learning resources used in mathematics learning, the following rules need to be adhered to. 1) Support the local curriculum; 2) Develop by teachers who have adequate competence; 3) Follow the age, emotional, material development, abilities, learning styles, and conditions of students; 4). Contains beauty, social, and literacy values [9]. Using mathematics learning resources that contain cultural values is known as ethnomathematics. D'Ambrosio made initiations related to ethnomathematics as one of the solutions in mathematics learning [10]. Learning based on ethnomathematics is innovative learning [11], [12]. As an innovative solution, ethnomathematics can be used by teachers as a mathematics learning resource to provide conceptual understanding contextually with a cultural approach to students. One of the artifacts that teachers can utilize is the Kalamata Fort artifact, which is located in South Ternate District, Ternate City, Indonesia. According to Marsigit, materially, mathematical objects can be in the form of concrete objects, pictures or models of cubes, colorful symbols, large or small numbers, square pools, pyramid roofs, pyramids in Egypt, triangular roofs of houses, circular wheels, and so on [13]. The Kalamata fort can help students learn the concept of triangles because the shape of this fort can be constructed like a triangle.

Minister of National Education Regulation number 21 of 2016 [14] on Content Standards, one of which aims for students to have the ability to understand mathematical concepts, explain the relationship between concepts, and apply concepts or logarithms flexibly, accurately, efficiently, and precisely in problem-solving. Mastery of concepts allows students to solve problems better because solving problems requires rules based on existing concepts [15]. The importance of concept understanding is also stated by Santrock, who states that concept understanding is a crucial aspect of learning [16].

In Indonesia, especially in Ternate City, the availability of network infrastructure is quite adequate, as evidenced by the implementation of online learning during the COVID-19 pandemic. However, more is needed to guarantee student progress in the cognitive domain, especially in concept understanding. It is due to the constraints during learning that have been explained above. Based on the explanation that has been described, understanding mathematical concepts is a cognitive domain that every student must own. By integrating technology and ethnomathematics-based learning, researchers are interested in studying how to build mathematical concept understanding of grade VII students through ethnomathematics-based online learning on Kalamata Fort artifacts.

2. RESEARCH METHODS

This research method is qualitative research with a case study design. The research subjects were 3 students with high (S1), medium (S2), and low (S3) abilities in class VII of Junior High School. Data collection was carried out through observation and interviews. The results of student interviews were then analyzed descriptively from the aspects of concept understanding in this study. The research flow is needed to make it easier to understand the implementation of this research, as in **Figure 1**.

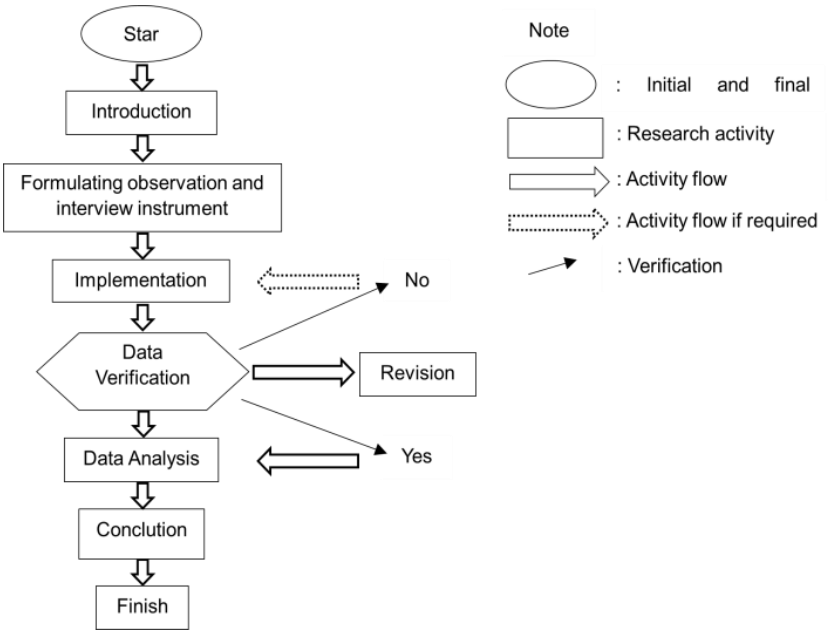


Figure 1. Research Flow

In **Figure 1**, the steps of the research conducted can be explained: 1) Introduction: This step consisted of determining the class used in the teaching and learning process (PBM) and ethnomathematics artifacts, namely junior high school students in South Ternate District, Ternate City, and artifacts of Kalamata Fort, Ternate City, 2) Making observation guidelines and interview guidelines, in the form of an outline of questions about what the researcher wants to know. Observation guidelines and interview guidelines made did not pass the validation stage; 3) Implementation: this stage consisted of collecting data through observation, namely by teaching the concept of triangles through online learning using Zoom meetings and Mathigon website tools based on Kalamata Fort artifacts, and interviews with 3 students who were research subjects, 4) Data analysis, describing the results of observations and interviews regarding the concept of triangles at Kalamata Fort, 5) Making conclusions, analyzing data obtained from interviews regarding the concept of triangles in Kalamata Fort, 6) Data summarization, at this stage concluding the results of data analysis that had been carried out at the previous stage.

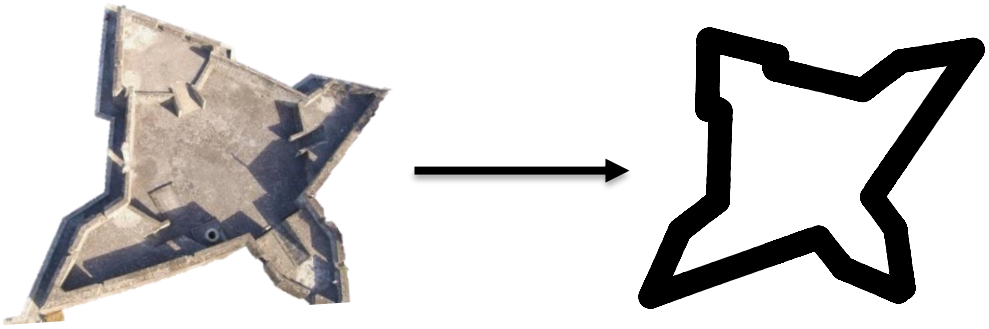
3. RESULTS AND DISCUSSION

3.1 Ethnomathematics-based Learning Resources Kalamata Fort Artifacts

Kalamata Fort is a fort built by the Portuguese in 1540. Kalamata Fort is also known as Fort Kayu Merah. It is called Fort Kayu Merah because it is located in Kayu Merah Village, South Ternate District, Ternate City. Initially, this fort was named Santa Lucia, but later became famous as Kalamata Fort. Kalamata itself comes from the name of Kalamata Prince, the younger brother of the Sultan of Ternate Madarsyah **[17]**. The shape of Kalamata Fort can be seen in **Figure 2**.

Figure 2. Kalamata Fort

Based on its form, ethnomathematics-based learning resources that can be used as mathematics learning media can be in the form of measuring length, area, volume, tiling, shape, pattern, common multiples, common dividers, and multiplication [18]. This is in line with several research results that show that the length measurement at the foot of Asu Temple which is rectangular in shape obtained results of 97 cm for the longest side and 48 cm for the shortest side, so that the circumference of the foot of Asu Temple is 290 cm^2 [19]. In addition, ethnomathematical studies at Borobudur Temple show that there are cube-shaped stupas with a size of 15 cm × 15 cm totaling 36 pieces, so that in formal mathematical calculations, the surface area of the entire cube can be known, which is 36 × the surface area of square blocks = 36 × (15×15) = 36 × 225 = 8,100 cm^2 [20]. Meanwhile, learning resources at Kalamata Fort can also be identified and built formal mathematical concepts by constructing them first, as shown in the following figure.



(a) **(b)**

Figure 3. Reconstructing the Shape of Kalamata Fort (a) Initial Construction, to (b) Construction 1

The artifacts used in mathematics learning must also be attractive to students, so the Kalamata Fort artifact can be made, as shown in Figure 4 below.

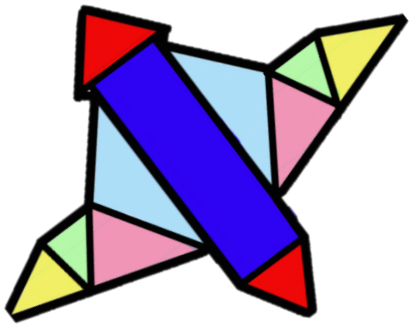


Figure 4. Construction 2

Based on the existing construction, a table can be made related to the competencies and student activities in the Benteng Kalamata learning resource.

Table 1. Competencies and Student Activities from Kalamata Fort Artifact Learning Resources

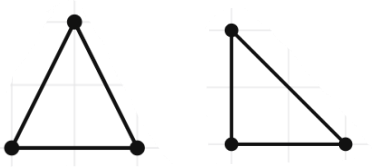
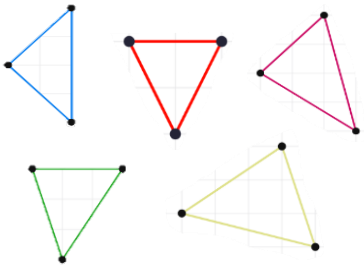
Competence	Student Activities
Triangle Concept	Measure the lengths of the sides of a triangle, determine the base of a triangle, calculate the perimeter of a triangle as the sum of the lengths of its sides, and determine the area of a triangle.
Rectangle	Discover the concept of a rectangle and its relationship with the triangle area formula.
Geometry	The concept of reflection.

Table 1. above displays some of the competencies teachers can use to build an understanding of mathematical concepts in students. In this study, the competency that will be used is the concept of triangles.

3.2 Triangle Concept

The concept of triangles that can be built from the Kalamata Fort artifacts is to reconstruct students' conceptual understanding that triangles are not limited to one or two shapes, as shown in Table 2 below.

Table 2. Triangles and Concepts that can be Constructed From the Kalamata Fort Artifacts

Triangle	Concept
Triangular shapes are not just limited to the following shapes: 	

3.3 Student Activity in Online Learning

3.3.1 Students' Initial Activity

In the introductory stage, the researcher gave greetings and asked students to pray carefully, then continued checking attendance. Then, the researcher gave apperceptions related to what types of triangles the students already knew, followed by the researcher conveying learning objectives and providing motivation.

When providing apperception, the researcher started by displaying an image of the Kalamata Fort artifact as a picture before and after being constructed. Then the researcher asked, "What is the shape of the flat that you see?" Students answered triangles. The researcher asked again, "Besides triangles, are there other flat shapes?"

When asked if there were other flat shapes, students seemed hesitant to answer. It is due to the shape of the Kalamata Fort that still needs to be reconstructed. Furthermore, the researcher displayed a picture of the Kalamata Fort artifact that had been constructed, then asked the students again, "what are the shapes of flat shapes that you can see from the following picture?"

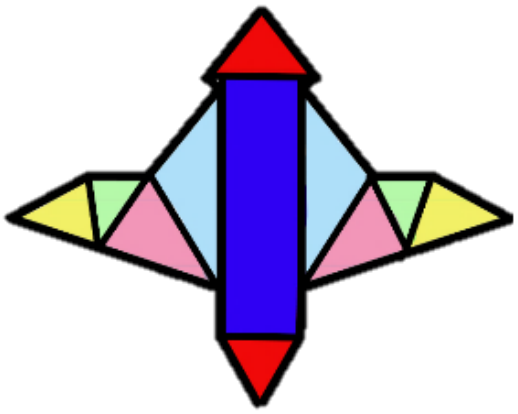


Figure 5. Construction of Kalamata Fort

Here, students did not hesitate to answer triangles and rectangles. Then the researcher asked again, try to count; how many triangles are there in Kalamata Fort? Students then calculated the number of triangles in the Kalamata Fort by obtaining 10 triangles in constructing the Kalamata Fort image. With the assistance of the Mathigon website, the researcher directed students to redraw the existing triangles separately on the polypad menu. The following are the results of students' drawings with the assistance of researchers.

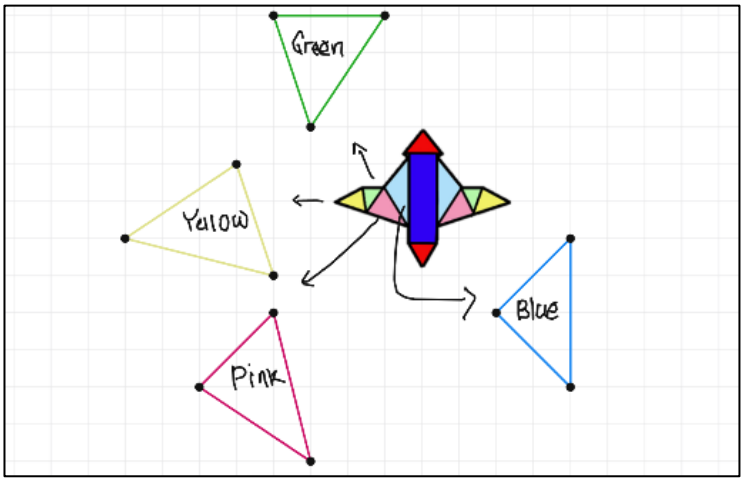


Figure 6. Drawing Results of Students S1, S2, and S3

Student S3 drew a pink triangle, student S2 drew a yellow triangle, and student S3 drew a green triangle. The blue triangle is drawn carefully.

Furthermore, students were asked to mention what types of triangles they already knew. Students S1, S2, and S3 could answer correctly, namely acute triangle, obtuse triangle, right triangle, isosceles triangle, equilateral triangle, and arbitrary triangle. The researcher then continued the question, the types of triangles above, if grouped, which ones belong to the group of types of triangles in terms of the size of the angle and the group of types of triangles in terms of the length of the side. Here, the three students still needed clarification in answering. The researcher then reconstructed this concept by grouping the types of triangles that had been mentioned into groups of triangles in terms of angle magnitude and side length.

3.3.2 Key Student Activities

At this stage, the researcher asked the students questions, "What is the perimeter?", "why the formula for the area of a triangle is $^1/_2 \times base \times height$?." Students seemed unable to answer this question. This is in accordance with Groth's view that few students are able to write down and understand geometric proofs, one of which is the concept of triangle area. [21]. The researcher then used one of the triangles above to explain the answer to the question. By using the Mathigon website tool, the researcher started by illustrating the triangle image on the polypad menu. The following display is presented.

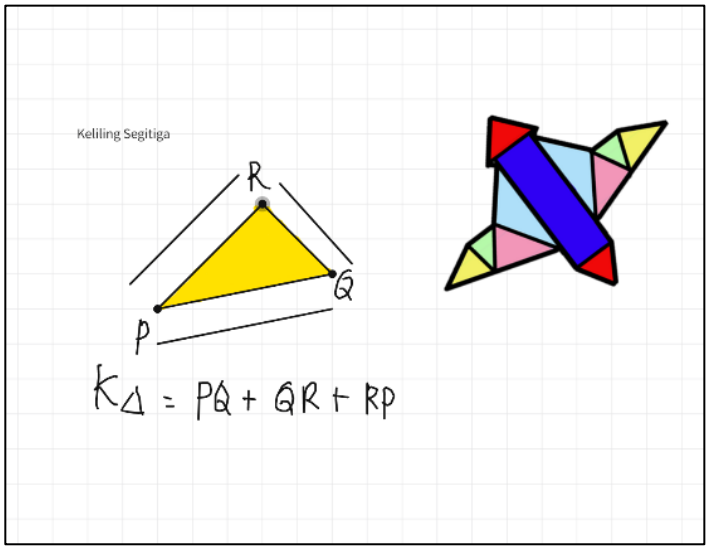


Figure 7. Concept of Triangle Perimeter

Building the concept of the perimeter of a triangle began with constructing the meaning of perimeter in students' minds. The researcher gave an example: if student S1 wants to circle PQR, then he starts walking from point P to Q and does not return to point P, is he called the circumference? All students answered no. Therefore, what is circumference? The researcher explained that the choice meant by circumference is one round of an object. The researcher continued, "can anyone conclude the circumference of Δ PQR?" Student S2 then answered the length of side PQ + QR + RQ. It can be seen that

S2 students can already understand what the circumference is in a triangle.

To answer why the formula for the area of a triangle is $^1/_2 \times base \times height$? The researcher started by constructing the image on the Kalamata Fort artifact, namely by taking a pink triangle. After that, the students were asked to mention the formula for the area of a triangle; students S1, S2, and S3 jointly answered LΔ = 1. $^1/_2 \times base \times height$. Then, the researcher began to reconstruct the triangular shape into a rectangular shape. That way, it can be concluded that triangles have a relationship with rectangles. In this concept, namely, the area of a triangle is equal to the area of a rectangle. **Figure 8** is related to the concept built using Mathigon learning media tools.

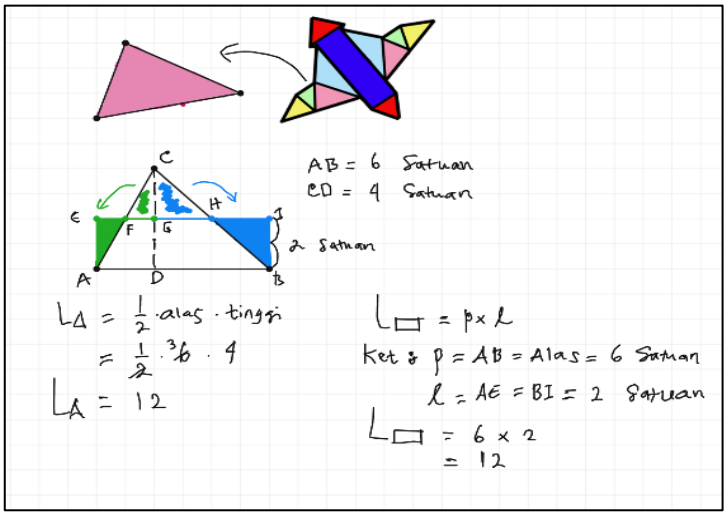


Figure 8. The Concept of a Triangle Area

3.3.3 Students' Final Activity

At this stage, the researcher directs students to summarize the material discussed jointly.

4. CONCLUSIONS

Based on the results of the analysis and discussion, it can be concluded that the Kalamata Fort artifact can be used by teachers in building an understanding of the concept of triangles in grade VII junior high school students. However, there needs to be attention to the application or learning technology used by teachers as a tool in building concepts through online learning. The application or learning technology used should make it easier for students to understand the concept of triangles. Given students are often bored and uninterested, the learning application used needs to be simplified. In addition, student involvement in the use of technology also needs particular attention because meaningful learning begins when students are directly involved in building concepts in mathematics, in this case, the concept of triangles.

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