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Gedhek, When Culture Teaches Mathematical Concepts

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ABSTRACT
Gedhek, a wall material for *Using*'s house, which is still used in Banyuwangi, Indonesia. The existence of *gedhek* in The Banyuwangi Community has never been associated with school knowledge. This makes *gedhek* known only as objects that are dividing the house (wall). Even though the process of making up to installing *gedhek* contains various learning concepts, especially mathematics. These mathematical concepts need to be identified through a qualitative research framework. Research data obtained by the method of participatory observation, in-depth interviews, and cultural documentation, then analyzed according to the steps of the ethnographic approach. The results showed that in the process of making *gedhek*, the concepts of numbers and number patterns, geometry, sets, fractions, measuring objects with non-standard units, congruence, transformation, and arithmetic can be found. From these mathematical concepts can be identified the existence of mathematical activities, such as counting, measuring, designing, locating, and explaining.

Keywords: *Gedhek, Using's House Banyuwangi, Ethnomathematics, Mathematical Concepts.*

1. INTRODUCTION

The traditional house of the *Using* Banyuwangi tribe is known as the house of *Using* or *Using*'s house. Banyuwangi is a regency on the island of Java, Indonesia. The walls of *Using*'s house are still made of woven bamboo which is called *gedhek*. Bamboo is the basic material for making house walls because it is a local plant in Java that is easy to grow and easy to cultivate. Bamboo is used as a source of building materials because it is renewable, cheap, and widely available in various countries, especially in Asia, Africa, and South America [1]. Bamboo has the advantage of being able to grow quickly with high yields and ripen quickly, can be planted abundantly at low costs, so its use is more economical [2].

Bamboo is a plant with strong characteristics, but light and flexible [1]. The strength of bamboo increases with age due to the hardening of the bamboo culm walls [3]. Therefore, bamboo can be used as a material for making houses, such as floors, ceilings, walls, windows, doors, fences, roofs, frames, and rafters [1], as well as structure and construction of houses in the form of walls and partitions [4].

The bamboo wall in *Using*'s house is constructed with a combination of cement at the bottom to make it more durable from insect attack, it is called bamboo plaster. The term "bamboo plaster" is referred to as a wall construction that uses a combination of bamboo and cement material to have a longer resistance against fungal and insect attack [5]. In the construction of the original *Using*'s house, the side and rear walls and partitions still use *gedhek* without windows [6]. Cosmologically, the existence of a wall that does not use a window makes air circulation and lighting less than optimal, so that the condition of the room is considered comfortable as a place to find peace or rest [7].

Figure 1 The Using House in Kemiren Village with Bamboo Plaster

The outer walls of *Using*'s house generally use gedhek with *piphil* motifs without windows [8]. *Gedhek piphil* motif in Figure 2 shows the geometric shape, especially a rectangle. Besides, the geometric patterns on *gedhek* also show the congruence of shapes and transformations of rectangular shapes. Rectangles, congruence, and transformations are mathematical concepts that can be found in *gedhek* woven patterns. The existence of mathematical concepts in *gedhek* is a form of ethnomathematics.

Figure 2 Variety of *Gedhek Piphil* Motifs

Ethnomathematics is expressed as "the study of the mathematical ideas of traditional peoples" [9]. Ethnomathematics is also defined as "the mathematics practiced by cultural groups, such as urban and rural communities, groups of workers, professional classes, children in a given age group, indigenous societies, and so many other groups that are identified by the objectives and traditions common to these groups" [10]. The existence of ethnomathematics is considered to expand the horizons of mathematics so that cultural diversity becomes a contribution that makes humans better understand they are culture through a mathematical perspective [11]. Ethnomathematics also helps teachers find pathways fostering student engagement through concepts and supporting learning approaches mathematics by connecting to student culture [12].

A mathematical idea is a product of various cultural processes or activities that have different characteristics from one culture to another [13]. For this reason, mathematical connection skills are needed, one of which is the ability to connect mathematical ideas with cultural activities that are part of the daily life of students [14]. Based on this opinion, it is necessary to explore the culture and mathematical ideas contained in that culture, which can then be applied in mathematics learning as a form of connecting mathematical ideas with culture.

The mathematical idea known from the *gedhek* pattern shows that the traditional process of making *gedhek* also contains other mathematical ideas. For this reason, further research is needed to identify ethnomathematics in *gedhek* as a connection between mathematics and culture, which then becomes the basis for the application of mathematical ideas in learning. The identification of mathematical ideas is adjusted to six mathematical activities contained in the culture, such as counting, measuring, locating, designing, playing, and explaining [13]. Ethnomathematical identification can be adapted to the mathematical concepts taught in mathematics learning from elementary to intermediate levels.

2. METHOD

This research is based on qualitative with an ethnographic approach and was conducted from January to September 2020. The object of the study was woven bamboo used for walls in *Using*'s house, called *gedhek*. The research is aimed at exploring the process and results of making *gedhek* and identifying mathematical concepts contained in this culture. The informants were *gedhek* makers, one person from *Tamansari* Village, and two from *Macanputih* Village. The three of them were chosen because they have at least 5 years experience in making *gedhek*.

Data collection was carried out by participatory observation, in-depth interviews, and cultural documentation, by the characteristics of the ethnographic approach [15]. The participatory observation was carried out using observation guidelines, starting from the process of selecting bamboo to weave. In-depth interviews were conducted with three informants in the form of descriptive questions, structural questions, and contrast questions, using interview guidelines. Cultural documentation was collected in the form of photos, videos, and transcripts of interviews. The data obtained were analyzed qualitatively based on ethnomathematics indicators.

3. RESULT AND DISCUSSION

3.1. Gedhek Making Process

The *Using*'s house is a traditional house of the Banyuwangi tribe which is still made of available materials, such as wood and bamboo. The *Using*'s house in Figure 3, uses wood as the frame of the house, woven bamboo as the sidewall and partitions of the house, wood at the front of the house called *gebyok*, tiles made of clay, and floors made of soil or cement.

The walls of *Using*'s house are made of woven bamboo, called *gedhek*. The type of bamboo that is usually used is *Benel* bamboo, as shown in Figure 4. *Benel* bamboo has sections with an average length of 40 to 50 cm. Bamboo is cut 2 to 2.5 meters long or contains about 4 to 5 sections. The bamboo cutting is adjusted to the *gedhek* to be made.

Figure 3. *Benel* Bamboo as a Woven Material

Interviews and observations with informants show that *gedhek* is usually made with a width of 2 or 2.5 meters. While the length is made to order. *Gedhek* ordered to be used as sidewalls and partitions in the house.

Figure 4 shows that the *gedhek* at the side of the house consists of two parts, namely *gedhek penangkur* and middle *gedhek*. *Gedhek penangkur* is usually made with a size of 2.5×3 meters, while the middle *gedhek* is usually made up to 3.5 meters long. *Gedhe penangkur* is generally cut in the form of a rectangular trapezoid. The middle *gedhek* is the combination of a rectangular shape and a triangle shape.

Figure 4. *Using's* House Walls

The process of making *gedhek* starts from cutting the bamboo (as shown in the series of Figure 5) with a length of 2 to 2.5 meters. The selected bamboo has a diameter of between 6 and 7 cm.

Figure 5. Bamboo Splitting Process

Each piece of bamboo is divided into 10 sheets which have a width of about 2 cm, as shown in Figure 6. In this splitting process, the protrusions of bamboo joints are cleaned and flattened to make them tidier for use in plaiting.

Figure 6. The Width of The Bamboo Slit

Each bamboo slice is then divided according to its thickness into 3 to 4 slices, depending on the need. This process is known as "*ngirat*" and the result is called "*iratan*". Not all parts of *iratan* can be used. The innermost part of *iratan* is usually not used because it is uneven (consist protrusions of bamboo joints). So that used the outer part of *iratan* (in green) and the middle part of *iratan*.

Figure 7. *Ngirat* Process

In general, the cut used for *gedhek* has a thickness of about 0.2 cm as shown in Figure 8. If more than that, the weaving process will be difficult to do.

Figure 8. The Thickness of the *Iratan*

Furthermore, the bamboo strips are dried to reduce the moisture content in the bamboo. The purpose is that bamboo does not shrink after becoming *gedhek*. Shrinkage in the size of the bamboo weave without drying will cause the webbing to loosen and look untidy or hollow. These holes cause the entry of animals such as mosquitoes, flies, fleas, and others into the house. Also, the condition of the bamboo that has not been dry will grow fungi that can damage the *gedhek*.

Iratan that have been dried usually shrink in width and length of about 0.1 cm. The dried *iratan* is then

woven into *gedhek* in a certain pattern. There are several versions of the weaving patterns that are generally made for *gedhek* in Banyuwangi, namely the "step 2" patterns (as in the middle figure 9), the "step 3" pattern (as in the left figure 9), and the "step 4-2" pattern (as in the right figure 9).

Figure 9. Banyuwangi *Gedhek* Woven Pattern

The "step 2" pattern is a weaving pattern alternating two slices being lifted or placed. The "step 3" pattern is a weaving pattern alternating three raised or places slices. Whereas the "step 4-2" pattern is a weaving pattern alternating four slices being lifted and two slices inserted. These patterns were chosen because they were considered neat and tight so they were suitable to be used as house dividers (walls).

One sheet of *gedhek* 3 m long and 2.5 m wide is usually sold for Rp. 60,000.00 to Rp. 70,000.00. The use of *gedhek* as the wall of the *Using*'s house is adjusted in size to the frame of the house that has been previously made. Order *gedhek* in the form of rectangular sheets. If other forms are needed according to the shape of the house frame, the *gedhek* can be cut as needed.

3.2. Discovering Cultural Themes in Mathematical Concepts

Making *gedhek* includes four main processes, namely: (1) splitting the bamboo; (2) *ngirat* and drying; (3) weaving; and (4) installation of *gedhek*. These four processes are the domain of the *gedhek*-making process. Based on the domains that have been obtained, a taxonomic analysis can be determined based on the syllabus of mathematics learning from elementary and middle levels.

Before being split, bamboo can be shown as a shape resembling a tube with a circular surface, as shown in Figure 10.

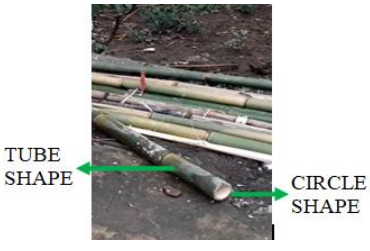

Figure 10. Bamboo Forms Before Splitting

Meanwhile, the split bamboo shows a shape similar to a rectangle, as shown in Figure 11.

Figure 11. Bamboo That Has Been Split

Bamboo that will be used for making *gedhek* has a minimum length of 2 m. Informants generally use the size of many bamboo joints to cut them. To get a minimum length of 2 m, the bamboo used has 4 to 5 sections with lengths between 40 and 50 cm. The terms used are part of the measurement with non-standard units in mathematics.

Splitting a bamboo resulting in ten slits indicates a tithe portion of each of these cleavages. The split results can be said one by one as a number. Meanwhile, the number of parts of each bamboo can be formed as a set.

The discussion about the process of splitting bamboo shows the concept of 2-dimensional geometry, 3-dimensional geometry, non-standard units of measurement, fraction, counting, and sets. These concepts are also part of mathematics learning in Elementary and Middle Schools.

After splitting the bamboo, it goes into the *ngirat* process. Each bamboo that has been split is then separated into 3 to 4 *iratan* depending on the thickness of the bamboo to be woven. One of these, the innermost one, is not used, leaving 2 to 3 *iratan* for weaving. The number of *iratan* can be said to be one by one, while the shape of the *iratan* resembles a rectangle as in Figure 12. The *iratan* from each part of the bamboo shows that there is a division of the same shape as many as 3 or 4 parts.

Figure 12. *Iratan* Bamboo in The Drying Process

After the drying process, *iratan* will shrink in thickness. However, the shrinkage is so small that it is difficult to measure. The discussion of the *ngirat* and drying process shows the concept of 2-dimensional geometry, fractions, and counting. These concepts exist in elementary and middle school mathematics learning.

In the weaving process, there is a rectangular shape and a tiling pattern which shows the concept of congruence as shown in Figure 13. *Gedhek* also shows a rectangular shape for the size of 2×3 m and a size of 2.5×3 m.

Figure 13. The Concept of Congruence in The *Gedhek* Pattern

The *iratan* are arranged in a sequence which can be mentioned one by one to determine the weaving sequence. The weaving process also forms number patterns as shown in Figure 9. In *gedhek* with a "step 2" pattern, it shows that every one *iratan* woven in a horizontal position must pass through two *iratan* in a vertical position.

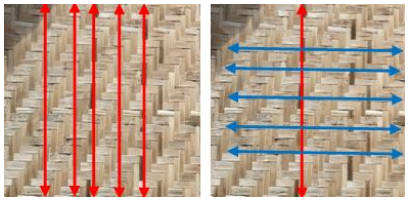

Figure 14. The Concept of Congruence in The *Gedhek* Pattern

In *gedhek* with a "step 3" pattern, it shows that every step of one *iratan* in a horizontal position must go through 3 *iratan* in a vertical position. Meanwhile, the *gedhek* with the pattern of "steps 4-2" shows that each stepping 2 *iratan* in a horizontal position must pass through 4 *iratan* in a vertical position. This process shows the concept of a number pattern, the position of horizontal and vertical lines, and the position of parallel and intersecting lines.

Gedhek also contains a rectangular shape by the concepts of translation, reflection, and rotation, which are part of the concept of geometric transformation. If *gedhek* is rotated by 180^0 and 360^0 then the shape will return to its original position. This shows that there is a concept of rotational symmetry in *gedhek*.

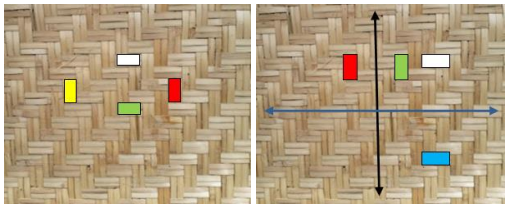

Figure 15. The Concept of Translation and Reflection on *Gedhek*

The weaving process shows the concept of counting, 2-dimensional geometry, congruence, number patterns, relationships between lines, and transformations. All these concepts, except congruence and transformation, are part of mathematics learning in elementary schools. The concept of 2-dimensional geometry, number patterns, congruence, and transformation is contained in mathematics learning in Junior High Schools. Especially in the concept of transformation, it is also a part of mathematics learning in Senior High Schools.

To construct a *gedhek* into an outer wall of the house, it takes more than one sheet of *gedhek*. The number of *gedhek* used can be said as needed. *Gedhek* is constructed according to the required shape as shown in Figure 16. For the middle *gedhek*, a rectangular and triangular shape is needed, while for the *gedhek penangkur*, a trapezoidal shape is needed.

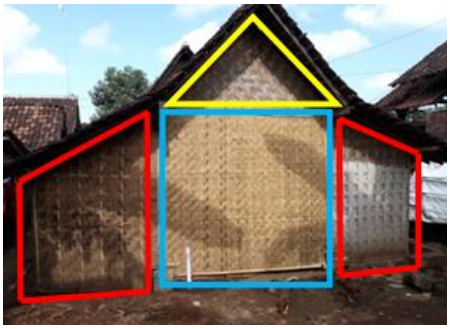

Figure 16. The Concept of Congruence in The *Gedhek* Pattern

To get the shapes referred to as in Figure 16, it is necessary to measure the standard unit, namely meters, to obtain a match between *gedhek* and the frame of the house. This measurement causes the installer to estimate the demand for *gedhek* to be used and the costs required according to the unit price of the *gedhek*.

The discussion of *gedhek* installation process shows the concept of counting, measuring, 2-dimensional geometry, and social arithmetic. All concepts, except social arithmetic, are part of mathematics learning in elementary schools, while 2-dimensional geometry and social arithmetic concepts are part of mathematics learning in secondary schools.

Exploring of making *gedhek* shows that there are cultural themes that contain mathematical concepts such as tubes, circles, rectangles, triangle, trapezoid, non-standard units of measurement, counting, sets, fractions, congruence, number patterns, parallel lines, the intersection of the lines, translation, reflection, rotation, calculations in the buying and selling process. The tube is part of the concept of 3-dimensional geometry, while circle, rectangle, triangle, and trapezoid are part of the concept of 2-dimensional geometry. Parallel and intersection lines are part of the relationships between lines. Translation, reflection, and rotation are part of the transformation concept. While calculations in the buying and selling process are part of the social arithmetic concept.

3.3. Discovering Cultural Themes in Mathematical Activities

As Bishop conveyed about mathematical activities in culture [13], the concepts of mathematics as a cultural theme in *gedhek* can be grouped according to their mathematical activities. Based on the results obtained on the discovery of the concept of mathematics as a cultural theme, it can be determined that there is counting activity in the concept of numbers, measuring objects with non-standard units, weaving *iratan* with a certain pattern, and the buying and selling process. Measuring activities can be found in the concept of measurement with non-standard units, as well as the process of cutting *gedhek* in the form of triangles, rectangles, and trapezoids to be used as walls.

Design activities are contained in the concept of cutting *gedhek* in the form of triangles, rectangles, and trapezoids, weaving *iratan* in a certain pattern so that they show the shape of parallel lines and intersecting lines, also emerging concepts of transformation. Locating activities can be found in the process of grouping slices as a set, determining which parts of *iratan* are mutually congruent in the *gedhek*, as well as *iratan* in the *gedhek* that have translation, reflection, and rotation relationships. Meanwhile, explaining activities can be found in various mathematical concepts that have been discovered in the process of making *gedhek*.

From the six mathematical activities described by Bishop, there are playing activities that are not found in the process of making gedhek. So that only five mathematical activities were found, namely counting, measuring, designing, locating, and explaining.

3.4. Discussion

Gedhek is part of *Using*'s house which has become the culture of the Banyuwangi community. Culture becomes a form of representation of life in a society that can provide a lot of learning. Culture can be presented as jargon, code, myth, symbol, and manner reasoning and deducing, manifesting in form practices such as interpreting and counting, measuring, classifying, ordering, summing up, modeling, and so on, which one is ethnomathematics [16]. Ethnomathematics studies the cultural aspects of mathematics by presenting mathematical concepts related to student culture and daily experiences, to improve students' abilities in developing meaningful connections and deepening understanding of mathematics [17].

Ethnomathematics identification in *gedhek*, shows the existence of mathematical concepts, such as 2-dimensional geometry (circle, rectangle, triangle, trapezoid), 3-dimensional geometry (tube), the relationships between lines, congruence, transformation, measurement with standard and non-standard units, counting, number patterns, fractions, sets, and social arithmetic. These concepts can be classified into corresponding mathematical activities, including 2-dimensional geometry, 3-dimensional geometry, congruence, and transformation are part of designing activities; the concept of counting, number patterns, fractions, and sets are part of counting activities; measurement concept is part of measuring activity; the concept of transformation and the relationship between lines is part of the locating activity, and social arithmetic concepts are part of explaining activities [13].

Previous research has shown that the *Using*'s house framework can be applied in contextual learning, especially the Pythagorean concept [18]. Mathematical concepts that can be identified in *gedhek* can also be applied in mathematic learning, especially in thematic frameworks. Thematic teaching is based on the idea that knowledge can be obtained maximally if it is coherently studied as a whole, and that the results learned can be related to the real world [19].

So that ethnomathematics can be presented as a counterweight to the impression learning mathematics in schools is too formal, it is necessary to provide content or a bridge between mathematics in everyday life based on local culture and school mathematics [20]. Based on these opinions it can be said that culture, especially *gedhek*, is needed as a form of cultural theme which can then be developed within a thematic learning framework by linking several appropriate subjects.

4. CONCLUSION

Culture is an interesting study from various points of view. *Gedhek* is a part of the *Using*'s traditional house from Banyuwangi which contains mathematical concepts, including 2-dimensional geometry, 3-dimensional geometry, relationships between lines, congruence, transformation, measurement, counting, number patterns, fractions, sets, and social arithmetic. These concepts are contained in mathematical activities counting, measuring, designing, locating, and explaining. Mathematical concepts and activities that have been identified from *gedhek* can be used as a basis for developing thematic learning through integrating mathematics with learning themed "*gedhek*".

AUTHORS' CONTRIBUTIONS

The first author contributed to the research process, data processing, and writing this article. While the second and third writers contributed as guides during the research and article writing process.

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