EXPLORING LOCAL WISDOM: ETHNOMATHEMATICS IN WONOREJO POTTERY EDUCATIONAL TOURISM

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ABSTRAK

Budaya dijadikan sebagai sarana untuk belajar dari kehidupan sehari-hari. Matematika dapat dikaitkan dengan kehidupan sehari-hari, yaitu dapat dipelajari melalui budaya. Istilah matematika dalam budaya disebut dengan etnomatematika. Setiap daerah memiliki budaya masing-masing. Termasuk pada desa Wonorejo juga terdapat warisan yang sudah turun temurun yaitu gerabah. Tujuan penelitian ini adalah untuk mengeksplorasi konsep matematika yang terdapat pada Wisata Edukasi Gerabah Wonorejo, sehingga dapat dijadikan sumber belajar dalam pembelajaran metematika. Jenis penelitian ini adalah penelitian kualitatif dengan pendekatan etnografi. Pengumpulan data dilakukan dengan cara studi kepustakaan, metode pengamatan, metode wawancara, dan metode dokumentasi. Instrument yang digunakan yaitu berupa pedoman observasi, pedoman wawancara, dan dokumentasi, maka dapat disimpulkan bahwa konsep matematika yang terdapat pada Wisata Edukasi Gerabah Wonorejo adalah konsep menghitung, konsep mengukur, konsep mendesain, konsep lingkaran, konsep bangun datar, konsep bangun ruang. Etnomatematika dapat mempermudah siswa memahami permasalahan sehari-hari.

Kata Kunci: Etnomatematika, Gerabah, Konsep Matematika

ABSTRACT

Culture is used as a means to learn from everyday life. Mathematics can be linked to everyday life, that is, it can be learned through culture. The term mathematics in culture is called ethnomathematics. Each region has its own culture. Including Wonorejo village, there is also a heritage that has been passed down from generation to generation, namely pottery. The aim of this research is to explore mathematical concepts contained in Wonorejo pottery educational tourism, so that it can be used as a learning resource in mathematics learning. This type of research is qualitative research with an ethnographic approach. Data collection was carried out by means of literature study, observation methods, interview methods, and documentation methods. The instruments used are in the form of observation guides, interview guides, and documentation, so it can be concluded that the mathematical concepts contained in the Wonorejo pottery education tour are the concept of calculating, the concept of measuring, the concept of designing a circle, the concept of flat shapes, the concept of building space. Ethnomathematics can make it easier for students to understand everyday problems.

Keywords: *Ethnomathematics, Pottery, Mathematical Concepts.*

INTRODUCTION

Culture is a complex heritage of symbolic behaviour containing knowledge, beliefs, arts, morals, laws and customs, and abilities that humans acquire as members of society (Pertiwi & Budiarto, 2020). Quoting from Kluckhohn (1953), dividing the elements of culture into 7 elements, namely. Language, is a means of communication used by members of a society to cooperate, interact, and identify themselves. Technological system or Tools and Equipment of Human Life, is everything needed by humans in everyday life such as means of production, food and drink, clothing and jewellery, shelter, and means of transportation (Wahyuni & Harisman, 2021). Livelihood system, is a system used for humans in fulfilling their needs, especially food such as cattle breeding, and farming. Social system or organisation, is a system created due to human awareness, that they still have shortcomings so they need help from other humans in the way they have to live and get along. Art, is a place where humans are free to express and express their creativity. Art refers to the element of beauty that comes from the human heart. Knowledge system, can simply be interpreted as everything that humans know about objects, properties, conditions, and expectations. Belief system or religious system, is a system where humans believe in something that is considered higher than them (Werdiningsih, 2022).

Maths is a compulsory subject taught at every school level. However, many students think that maths is a difficult subject. Contextual learning can help deal with students' mathematics learning difficulties. Culture is something that we cannot avoid in everyday life, because culture is a comprehensive unity of various behavioural manifestations of society (Pertiwi & Budiarto, 2020). Therefore, educators have a great influence in shaping the boundaries between the two fields, namely formal mathematics or more commonly called mathematics in schools and ethnomathematics, which is a comprehensive mathematical activity in everyday life or outside of school.

This research aims to preserve the pottery culture in Wonorejo village, which initially occurred due to community concerns about the decreasing number of pottery craftsmen so that in 2018 Wonorejo Pottery Educational Tourism was established which can survive and develop until now. The role of

ethnomathematics in learning mathematics is very important, ethnomathematics is included in the curriculum and has the same relative role to mathematics. In addition, ethnomathematics can promote more culture and at the same time for mathematics learning. This research discusses the exploration of ethnomathematics, where mathematics is not only taught at school but mathematics can also be taught in everyday life. This research will also explore how mathematical concepts can be applied to pottery. This is done to describe the results of the exploration of ethnomathematics forms and document the culture of Wonorejo pottery.

This research uses qualitative research using an ethnographic approach. The ethnographic approach is an empirical and theoretical approach that aims to obtain descriptions and analyses of culture with intensive fieldwork. This ethnographic approach is carried out by systematically collecting data on the way of life and social activities and various cultural objects from the community. In this case, ethnography is related to how an object is designed and made, so that in this study, a kebiatan that is not widely known to others is chosen (Werdiningsih, 2022). The research conducted aims to explore information about ethnomathematics at Wonorejo Pottery Educational Tourism which includes the concept of mathematics in pottery. The informants in this study were the manager of Pottery Educational Tourism in Wonorejo village, namely Mr Sigit Rohmatullah and pottery craftsmen in Wonorejo village. Data were obtained in several ways, namely observation, interviews, and documentation. The analysis carried out is to analyse the mathematical form and classify it according to the existing mathematical concepts.

DISCUSSION

Wonorejo Pottery Educational Tourism is located in Wonorejo village, Wonopringgo sub-district, Pekalongan district, before the establishment of this tour, many Wonorejo villagers had already produced pottery. This village is often visited by several schools directly to the homes of pottery craftsmen, the process of making pottery is done next to the kitchen of the craftsman's house. Seeing the increasing number of schools visiting with a less extensive land situation, the

community took the initiative to establish a special place that aims to maintain and preserve cultural heritage in pottery making, especially as a forum for the creation of a generation of young people who are able to continue this cultural heritage. Then a special place for Educational Tourism was provided in 2018 which was initially used as a test site. This special place was named 'Wisata Edukasi Gerabah Wonorejo' which began to be used officially after covid-19 ended with around 30-40 people. The Pottery Education Tour itself is temporarily located at the private residence of the Wonorejo Village Head, precisely in RT 13 Wonorejo Village. Where currently it has empowered several local residents to play an active role in it. One of the advantages of pottery educational tourism in Wonorejo is that it still maintains traditional raw materials, motifs and products. So that not only knowledge about pottery making is obtained, but also the history and originality of ancestral heritage crafts.

Figure 1. Wonorejo pottery educational tour

Based on the results of our exploration, this educational tour produces several types of pottery including jugs, pots, vases, cups, lemper, cobek, money box, teapots, and others. How to make pottery with clay base material taken from the fields of Wonorejo villagers who are brought to the clay processing plant, then the soil is mixed with water and then ground using a machine, once ground produces 1 basket for approximately 1 hour until smooth. In the manufacture of pottery needed a tool called perbot. Perbot is a rotating tool for making pottery that has a geometric shape that is a circle and there is no other shape other than a circle because in making pottery the average has a cylindrical shape, because perbot has a circular shape so it is easier to rotate and the circle also has a focal point or centre point. Pottery craftsmen always put the clay position right in the

middle of the perbot if it is not right at the centre point then in the process of forming uneven pottery.

The way craftsmen to determine the midpoint on the perbot is to use the craftsman's index finger when the perbot position is rotating, when the perbot is rotated the index finger traces the direction of the perbot rotation so that the index finger becomes the midpoint by itself. Activities carried out by pottery craftsmen when looking for the centre point of the circle is something that is always done by craftsmen when determining the centre point of the perbot. Basically, finding the centre point of a circle is one of the mathematical concepts that can be learned from daily life activities.

Furthermore, the drying process that has been formed, in this drying process is carried out for 5-6 days in a place that is not exposed to direct sunlight to avoid cracks in the pottery. After passing the drying process, the next stage is firing. The firing process is carried out for 8-10 hours using a furnace consisting of a large furnace or a small furnace. The fuel used in the burning process is straw or dry leaves, burning is only done when the weather is favourable, because if there is rain it can cause damage to the pottery.

The next process is pottery colouring, pottery is coloured using special pottery dyes. The tools and materials used during colouring are: turntable, paint, brushes, plastic and sterofoam as a tool for pottery to be coloured. The last process is packaging, packaging is done using clear plastic so that various forms of pottery can be seen and attract visitors' purchasing power. But there are also pottery that is not packaged using plastic such as jugs, vases, cobek, lemper, and teapots. A detailed overview of pottery making can be seen in Picture 2.

Figure 2. Pottery making process

In the observations we have made, there is ethnomathematics in pottery making activities at Wonorejo Pottery Educational Tourism including the concept of counting, the concept of measuring, the concept of designing, and the concept of building space.

1. **The Concept of Counting**

     The concept of counting during the material processing process appears when the pottery craftsmen determine the amount of clay and water needed to make clay. The concept of counting then appears when craftsmen estimate the amount of pottery that can be produced in one processing process. In this Pottery Educational Tourism can produce approximately 200 money box per day, where 1 pikul of clay which weighs about 5 kg can produce 50 money box. This results in a ratio of clay to money box produced per day of $1 : 10$.

Picture 3. Drying the pottery

     Drying the pottery in the wind (Figure 3) takes 5 days, which will then be followed by drying in direct sunlight for half a day. So the length of time for the pottery drying process is $x = 5 + \frac{1}{2} = 5 \frac{1}{2}$ days. In this activity, the concept of mathematics appears in the form of counting operations, other ethnomathematics also appears in the activities of craftsmen when burning pottery, in the combustion process, craftsmen need fuel in the form of wood and straw for burning.

     For one firing process, craftsmen need 2 pikuls of wood and 1 bunch of straw, so it has a ratio of $2 : 1$. In the combustion process, the pottery that can be accommodated by the kiln depends on the size of the pottery being burned. For one firing process, the furnace can accommodate 300 jugs, while for

money box it can accommodate 400 money box, and for cobek it can accommodate 700 cobek. Firing is done more than once if the pottery burned exceeds the capacity of the kiln, so the firing process for an order of 800 jugs is $x = \frac{800}{400} = 2$ equivalent comparisons. In addition, there is the concept of inverse value comparison on the size of pottery with the amount of pottery that can be accommodated by the kiln.

In the process of making pottery, craftsmen also exceed the size of $2 - 3$ centimetres from the size ordered by the buyer. The additional size is done because during the drying process there will be shrinkage in the pottery. This means that if there is an order for cobek with a diameter of 21 cm, the craftsman must produce cobek with a diameter of $x = 21 + 3 = 24$ cm. In this activity, the concept of mathematics appears in the form of counting operations.

2. **The Concept of Measuring**

Measuring activities appear when craftsmen determine the length of the diameter and height of the pottery. Measurement is an activity aimed at identifying the size of objects or symptoms. Measurement can be done in two ways, namely using standard tools and using non-standard tools. Defines simply that measurement consists of rules for imposing numbers on an object to represent the quantity of attributes on that object (Mekanikal, 2023).

In the process of making pottery at Wonorejo Pottery Educational Tourism for sale in stores or for general sale, craftsmen do not use measuring instruments when making pottery but only rely on estimates. However, if there is a special order by requesting a certain diameter and height, the craftsman uses a ruler measuring tool. Usually if the pottery has been formed, the diameter will be measured with a ruler, if the length is the same then continue the process of making pottery repeatedly. Craftsmen already understand and know the size, so craftsmen will get used to it so they don't need to re-measure the sizes ordered. Ethnomathematics is seen when craftsmen use non-standard measuring aids. Even though the craftsmen do not measure the diameter to be made, the craftsmen can determine what the right size is so that the pottery has a strong construction.

There are a lot of pottery produced at Wonorejo Pottery Educational Tourism, one of which is a jug (Picture 4). In the process of making jugs, the size of the body diameter and height is made not too far away so that the pottery is balanced. When measuring the height of the jug, craftsmen usually use a tool whose size has been adjusted. This is in accordance with Suryandari who stated that there is a measuring activity when craftsmen determine the ratio used between the diameter of the base and lid (Dewi Suryandari et al., 2018)
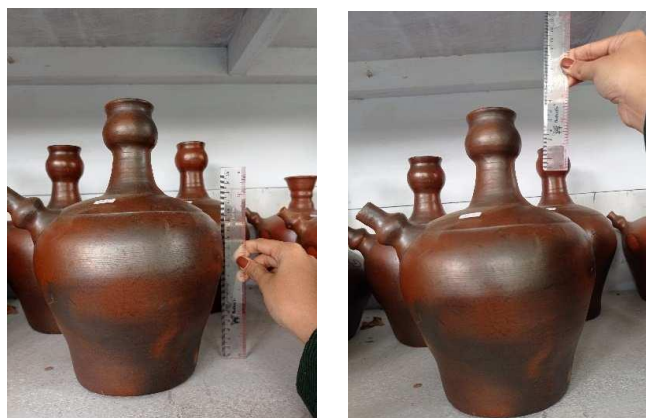

Figure 4**.** Jug

Ethnomathematics appears in the activity of making pottery of different sizes but with the same type, there are mathematical concepts used. The ethnomathematics emerges in the making of lemper. There are lemper with sizes $13.5\ cm, 17\ cm, and\ 18\ cm$. The shape of the lemper is not too flat and also not too curved like a bowl. The shape is like a plate but a little flatter. This shape can be applied to learning the concept of rotating objects. The exploration results show that the lemper has two circles centred on one point, the centre point. These two circles are the edge circle of the lemper and the inner circle of the lemper.

Figure 5**.** Lemper

Based on the results of the exploration, it can be seen that the sizes of the lemper form a number pattern. When craftsmen make similar pottery that has the same diameter and height, there is a mathematical concept of congruence. When craftsmen make pottery of the same type but the size of the height and diameter is different with a certain ratio, commonly called small, medium and large sizes, there is a mathematical concept contained, namely the concept of congruence.

Figure 6**.** The concept of congruence

In the process of making flower vases craftsmen have various shapes. In measuring flower vases craftsmen also use a ruler measuring tool (Picture 7). For small flower vases measuring $10\ cm$.

Figure 7**.** Flower vase

In pottery making there are elements of the circle, for example in the making of pots. The base and lip of the pot are circular with a base diameter of $6.5\ cm$ and a lip of $7\ cm$ (Picture 8). (Nasryah & Rahman, 2020) says a circle is the set of all points on a flat plane that are equidistant from a fixed

point on the plane. The difference between the base and the lip of the pot is 1 *cm*.

Figure 8**.** Vase

3. **The Concept of Designing**

The maths activity of designing appears in the pottery making process when designing the pottery to be produced. On educational tourism wonorejo pottery in designing goes through several processes, after being formed as desired until drying the next stage is the colouring of the pottery starting with being painted using a white base colour (Picture 9).

Figure 9. Basic colouring

After the basic colouring process, we enter the colouring stage using special pottery paint, the paint is poured into a special paint holder and then applied using a brush according to the predetermined size.

Figure 10. Paint

Figure 11. Paint tray   Figure 12. Brushes

In the activity of designing pottery, there are mathematical concepts in the form of number patterns, and the concept of congruence. During the process of making pottery, craftsmen do not have a specific design, but there are differences in size for each pottery produced. There are several shapes of flower vases that can be used as learning materials in mathematics. In addition, carvings on flower vases can also be used as a means of learning the concept of transformation, namely reflection as in Picture 13.

Figure 13. Reflection

(Pertiwi & Budiarto, 2020) says reflection is a reflection of an object with the same distance and size. The exploration results show that the size contained in the pottery uses the concept of geometric transformation, namely reflection, because if one centre line is taken, the right side will be the same as the left side. The pottery craftsmen also said that for the pottery produced,

the results will not be the same as other pottery. This is because when making pottery craftsmen only rely on estimates only.

4. Concept of Building Space

Based on the results of the exploration, there are several kinds of money box shapes that contain curved side spaces, as for the ethnomathematics contained, namely:
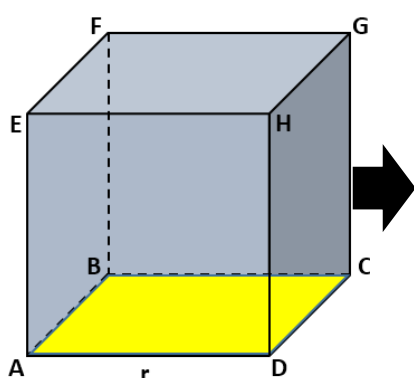

Figure 14.	Figure 15.	Figure 16.
Shape of the Cube	Money box Width	Money box Height

This ka'bah-shaped money box has ethnomammatic elements in the form of a cube (picture 1) with the height and width of its side $\pm 9\ cm$ with this we can find the volume and surface area of the money box by applying the volume formula V = s x s x s with the side we have got then $V = 9\ x\ 9\ x\ 9 = 729\ cm^3$, then the cube surface area formula is $L = 6\ x\ s\ x\ s$ so that $L = 6\ x\ 9\ x\ 9 = 486\ cm$. However, the formation of pottery is often tailored to customer orders, the measurements used also use non-standard measurements or usually craftsmen use moulds in accordance with customer requests.

Figure 17. Other cube-shaped money box

In addition to cubes, there is also a form of money box in the form of a tube. (Nasryah & Rahman, 2020) says that a tube is a shape formed by the combination of all line segments connecting points on two congruent circles where the two circles are parallel. The results of the research on this umbrella holder show that the shape of this pottery is a tube with a lid. Based on the results of exploration and supporting theory, the shape of this money box does have a tube shape, it's just that one end is not covered by a perfect circle.
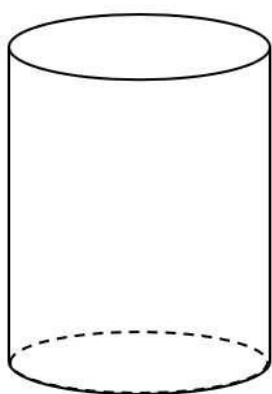

| Figure 18. | Figure 19. | Figure 20. |
| The Shape of a Tube | Height of Money box | Diameter celengan |

Pottery with a diameter of $10\ cm$ and a height of $16\ cm$ has a tubular pottery body, we can also find out the volume of the tube with the formula $V = \pi\ x\ r^2 x\ t$ so we can get $V = 3{,}14\ x\ 52\ x\ 16 = 1.256$ se while the surface area of the money box uses the formula $Lp = 2\ \pi\ x\ r\ x\ t + 2\pi\ x\ r^2$ so that we can get $Lp = (2\ x\ 3{,}14)\ x\ 5\ x\ 16 + (2\ x\ 3{,}14)\ x\ 52 = 502{,}4 + 157 = 629{,}4\ cm$. As for the size when making money boxs using non-standard units, where craftsmen use moulds and are often adjusted to buyer orders. For tubular money box models have large and small sizes. The large size has a diameter of $10\ cm$ and a height of $16\ cm$ while the small size has a diameter of $8\ cm$ and a height of $10\ cm$.

Figure 18. Small size

Figure 19. Large size

There are various forms of money box on Wonorejo Pottery Educational Tourism, which are very unique and interesting, of course, it can be a place to explore children's creativity to decorate money box as they please, it can be seen from the many character shapes that exist on this educational tour. (figure 9.)

Figure 20. Various kinds of money box shapes

CONCLUSIONS

Wonorejo Pottery Educational Tourism is located in Wonorejo village, Wonopringgo sub-district, Pekalongan district, before the establishment of this tour, many native Wonorejo villagers had produced pottery, then began to be inaugurated in the year after covid-19. Based on the results of our exploration, this educational tour produces several types of pottery including jugs, pots, vases,

cups, lemper, cobek, money box, teapots, and others. In making pottery through several stages, namely grinding, forming, drying, burning and colouring pottery. In the observations we have made, there is ethnomathematics in pottery making activities at Wonorejo Pottery Educational Tourism including the concept of counting, the concept of measuring, the concept of designing, and the concept of building space.

The concept of counting appears during the material processing process, pottery craftsmen determine the amount of clay and water in a day can produce approximatel 200 pottery. Other ethnomathematics calculations also appear in the activities of craftsmen when drying and firing pottery. Furthermore, the concept of measuring appears when craftsmen determine the length of the diameter and height of the pottery. In the process of making pottery at Wonorejo Pottery Educational Tourism for sale in stores or for general sale, craftsmen do not use measuring instruments when making pottery but only rely on estimates. However, if there is a special order requesting a certain diameter and height, craftsmen use a ruler measuring tool.

Ethnomathematics appears in the activity of making pottery of different sizes but with the same type, there are mathematical concepts used. Based on the results of the exploration, it can be seen that the sizes of the lemper form a number pattern. When craftsmen make similar pottery that has the same diameter and height, there is a mathematical concept, namely congruence. When craftsmen make pottery of the same type but different sizes of height and diameter with a certain ratio, commonly called small, medium and large sizes, there is a mathematical concept contained, namely the concept of congruence.

The concept of designing appears during the pottery making process when designing the pottery to be produced. Ethnomathematics appears in the form of flower vase designs that can be used as learning materials in mathematics. In addition, carvings on flower vases can also be used as a means of learning the concept of transformation, namely reflection. The last is the concept of space in the shape of a money box, there are various forms of money box in pottery, one of which is the shape of the ka'bah which is the same as the shape of the cube space and the shape of the boba cup money box which is the same as the shape of

the tube space, we can apply the volume and surface area formulas that we have learned.

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