

Ethnomathematics: Cultural Exploration of Bangkalan Madura Regency in Mathematics Learning for Phase D

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ABSTRACT

Culture is a way of life of a group of people that is passed down from generation to generation so it is unavoidable with everyday life. One way to change learners' poor perspective on mathematics is by linking it to local culture. An approach used to explain the relationship between culture and mathematics is called ethnomathematics. Bangkalan Regency deserves to be removed from the 2015-2019 list of disadvantaged regions. This is because Bangkalan Regency has a diverse culture. Some of them are batik and *toron tana*. The purpose of this research is to explore and examine the concept of mathematics in culture in Bangkalan Regency in Learning for phase D. This type of research is qualitative with an ethnographic approach. Data collection methods in the study consisted of observation, interviews, literature study, and documentation. The results of this study indicate that the culture in Bangkalan Regency has mathematical potential which includes ratios, number patterns, geometric transformations, similarity and congruence, curved-sided spaces, and opportunities. Some of these potentials are included in the learning outcomes for phase D of the elements of number, algebra, geometry, and data analysis and probability. These potentials can be implemented in mathematics learning activities such as, in the apperception or motivation section and can also be applied when developing question items.

Keywords: *Ethnomathematics, Bangkalan Regency, Batik, Toron Tana.*

Etnomatematika: Eksplorasi Budaya Kabupaten Bangkalan Madura dalam Pembelajaran Matematika untuk Fase D

ABSTRAK

Budaya merupakan suatu cara hidup sekelompok masyarakat yang diwariskan dari generasi ke generasi sehingga tidak dapat dihindari dengan kehidupan sehari-hari. Salah satu cara untuk mengubah perspektif buruk peserta didik mengenai matematika yaitu dengan mengaitkannya pada budaya setempat. Sebuah pendekatan yang digunakan dalam menjelaskan hubungan antara budaya dan matematika disebut dengan

etnomatematika. Kabupaten Bangkalan pantas terentang dari daftar daerah tertinggal 2015-2019. Hal tersebut dikarenakan Kabupaten Bangkalan memiliki budaya yang beragam. Beberapa di antaranya yaitu batik dan *toron tana*. Tujuan dari penelitian ini yaitu mengeksplorasi dan mengkaji konsep matematika pada budaya di Kabupaten Bangkalan dalam Pembelajaran untuk fase D. Jenis penelitian ini yaitu kualitatif dengan pendekatan etnografi. Metode pengumpulan data dalam penelitian terdiri dari observasi, wawancara, studi literatur, dan dokumentasi. Hasil dari penelitian ini menunjukkan bahwa budaya di Kabupaten Bangkalan memiliki potensi matematika yang meliputi rasio, pola bilangan, transformasi geometri, kesebangunan dan kekongruenan, bangun ruang sisi lengkung, dan peluang. Beberapa potensi tersebut termasuk dalam capaian pembelajaran untuk fase D dari elemen bilangan, aljabar, geometri, serta analisis data dan peluang. Potensi-potensi tersebut dapat diimplementasikan dalam kegiatan pembelajaran matematika seperti pada bagian apersepsi atau motivasi dan bisa juga diterapkan saat mengembangkan butir soal.

Kata Kunci: *Etnomatematika, Kabupaten Bangkalan, Batik, Toron Tana*

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1. Introduction

Educators have a very important role in the learning process. The role of educators in the learning process is to be responsible for planning and implementing the teaching and learning process and motivating the success of students (Sopian, 2016). Educators can also be said to be the main actors in a teaching and learning process. This is in line with the opinion of Wulandari & Nuhamara (2020) which states that an educator is the main actor in learning.

Learning is an effort made by educators intentionally aiming to convey knowledge by organizing and creating an environmental system in various methods so that students can learn optimally (Kiron, 2017). Learning can also be interpreted as an educator's effort in helping students to learn according to their interests and needs (Ubabuddin, 2019). According to Yusuf & Syurgawi (2020), there is interaction between students and their learning environment, including educators, friends, media or other learning resources. So, learning is a conscious effort made by educators to convey knowledge by creating a learning environment system in various methods according to the interests and needs of students so that they can learn optimally.

Creating optimal learning activities for students is not an easy thing, especially in mathematics learning. Some learners have a bad mindset towards math (Aprilia & Fitriana, 2022). This mindset is caused by several factors. One of the factors is educators who still emphasize students to memorize formulas. This is in accordance with the results of observations made by Fauzi et al. (2020) that some educators still emphasize students to memorize mathematical formulas.

Pressing students to memorize formulas is not the right way to teach mathematics. This will cause students to easily forget the formulas that have been memorized (Sukmana & Arhasy, 2019). Therefore, educators are expected to be able to open students' thinking insights so that they can remember longer the mathematical concepts taught by linking them to everyday life. Linking math to everyday life can also introduce students that math is not just about formulas. However, math is also used in everyday life both regarding simple things such as adding or subtracting to applying theorems or formulas to solve a problem (Nada, 2020).

Everyday problems that can be solved using mathematical concepts or ways of thinking are proof that mathematics is so close to everyone's lives. Therefore, educators must explore the surrounding environment in order to find mathematical concepts in everyday life. One of the things that can be explored in everyday life to find mathematical concepts is culture. Culture is a way of life that develops and is owned by a group of people and is passed down from generation to generation (Kusniyati & Sitanggang, 2016). The approach used to explain the reality of the relationship between culture and mathematics is called ethnomathematics (Astutiningtyas et al., 2017).

The application of ethnomathematics in mathematics learning in Indonesia is very possible. Because Indonesia is a country that has a variety of cultures (Sari & Najicha, 2022). One of the islands that must be explored is Madura. Madura Island consists of 4 districts namely Bangkalan, Pamekasan, Sumenep, and Sampang. One of the districts on Madura Island was once included in the list of underdeveloped regions ranked 16th based on Presidential Regulation of the Republic of Indonesia Number 131 of 2015 concerning the Determination of Underdeveloped Regions for 2015-2019, namely Bangkalan.

Based on the Decree of the Director General of the Acceleration of Development of Disadvantaged Regions Number 2021 concerning the Strategic Plan of the Directorate of Acceleration of Development of Facilities and Infrastructure for 2020-2024, Bangkalan Regency was officially eradicated from the list of disadvantaged areas in 2015-2019. Although Bangkalan was once included in the list of disadvantaged areas, the district has a lot of culture that is still preserved by its people. Therefore, researchers want to explore the culture in Bangkalan Regency to find mathematical concepts in it. Some of the cultures in Bangkalan that will be explored in this research are batik and *toron tana*.

In previous studies, no one has explored the relationship between the culture of Bangkalan Regency by looking for mathematical concepts in it. However, there are several previous studies that examine the relationship between Madurese culture at large or culture in districts other than Bangkalan by looking for mathematical concepts in it. One of the studies is entitled Exploration of Ethnomathematics in Madura Batik conducted by Zayyadi (2017). Based on the data analysis and discussion of the study, it was found that there are mathematical concepts in Madura batik motifs consisting of straight lines, curved lines, parallel lines, symmetry, points, angles, rectangles, triangles, circles, parallelogram, and similarity.

Kesebangunan, jajenjang, circle, triangle, rectangle, point, angle, symmetry, straight line, curved line, and parallel line are mathematical concepts that appear in Madura batik motifs in the research of Sari et al. (2021). The research was entitled Exploration of Ethnomathematics in Madura Batik Art in Geometry Learning. Then Fajriyeh & Zayyadi (2023) also conducted research on the exploration of the culture of *rokat tase'* on the beach of Jumiang Pamekasan Madura. The results of the study, mathematical concepts found in the culture of *rokat tase'* are about geometry such as angles, circles, parallel lines, straight lines, curved lines, symmetry, reflection, dilation, translation, rotation, and so on. Apart from the research that has been described, there are several other previous studies that examine Madurese culture, so that in

this study researchers only explore the culture in Bangkalan Regency in learning mathematics for phase D.

Phase D in the independent curriculum consists of grades VII, VIII, and IX. Based on the decision of the Head of the Education Standards, Curriculum and Assessment Agency (2024), there are several content elements in phase D including numbers, algebra, measurement, geometry, data analysis and opportunities. Each content element in phase D has its own learning outcomes. To achieve these learning outcomes can use the concept of mathematics in culture in Bangkalan Regency. From the background that has been described, this study aims to explore and examine the concept of mathematics in culture in Bangkalan Regency in Learning for phase D.

2. Method

The method in this research is descriptive qualitative with an ethnographic approach. Ethnography is a research model related to anthropology, studying cultural events, and presenting the life views of subjects who are the object of research (Siddiq & Salama, 2019). The purpose of ethnography is to document the culture, perspectives, and practices of the people in the setting (Rosaliza et al., 2023). This ethnographic research focuses more on the culture of community life. This is in accordance with the opinion of those who state that the type of ethnographic research focuses more on the culture of community life in it (Usop, 2019).

This research was conducted in Bangkalan Regency, Madura, East Java. The data collection methods in this study consisted of observation, interviews, literature study, and documentation. The purpose of observation is to obtain data on cultures in Bangkalan Regency that have mathematical potential. Interviews were conducted to gather information about cultural objects and observation data. In this study, interviews were conducted with three resource persons consisting of the owner of Naraya Batik in Paseseh Village, a batik seller in Sepulu Village, and one of the people of Sepulu Village who had held *toron tana*.

The data in this research are the results of observations and interviews about cultural objects, photographs from documentation, and theoretical from in-depth literature studies. The literature study was conducted by collecting several references such as journals, conference papers, and books. For data analysis techniques in this study using the stages of Miles & Huberman. There are 4 stages in analyzing data consisting of data collection, data reduction, data presentation, and conclusion drawing. (Saleh, 2017).

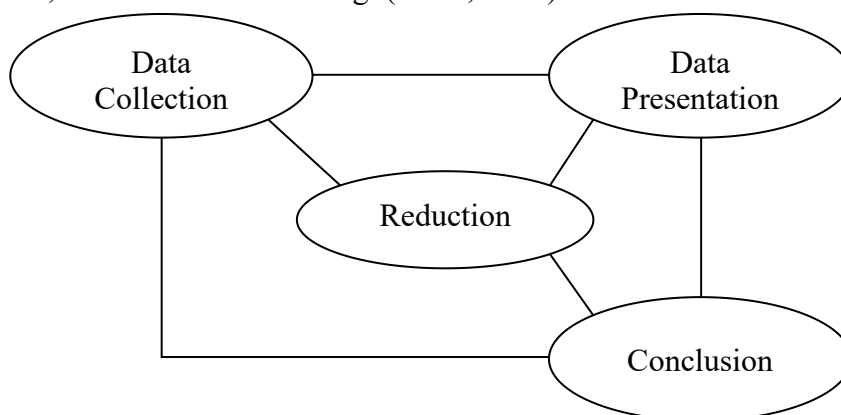


Figure 1. Data Analysis Technique According to Miles and Huberman

3. Result and Discussion

Based on observation, Bangkalan is one of the batik-producing districts. Batik from Bangkalan Regency certainly has its own characteristics. These characteristics consist of a special manufacturing technique called *gentongan*, has bright colors because it is a coastal area, and the name of the motif is related to the image and coloring method spoken in the local language (Suminto, 2015). Apart from producing written batik, Bangkalan also has other unique cultures such as *toron tana*. Based on the results of interviews, *toron tana* is a ceremony performed by babies when they are seven months old.

Ethnomathematics in batik can be explored both from the motif and the process of making batik. Then for ethnomathematics in *toron tana* can be explored from the equipment used during the ceremony. In this research, we will discuss the mathematical potential of batik and *toron tana* in learning for phase D. In phase D, it consists of grades VII, VIII and IX of junior high school / MTs / Package B. The learning outcomes of math subjects in phase D have several elements that must be achieved.

The elements of the learning outcomes in math subjects in phase D include numbers, algebra, measurement, geometry, data analysis and opportunities. Each of these elements has its own learning outcomes that must be achieved by the end of the phase. The various math concepts in batik and *toron tana* for phase D can be seen in table 1 and table 2.

3.1 Mathematical Potential of Batik in Bangkalan Regency

Table 1. Math Potential in Batik

Number	Objects that can be explored	Math Potential	Elements
1	Sokoh bujhel motif	Geometric transformations (reflections) and congruence and similarity	Geometry
2	Pereng bhesa motif	Number pattern	Algebra
3	Bajhid motif	Geometric transformation (translation)	Geometry
4	Manufacturing process	Ratio	Numbers

One of the areas that produces batik is Bangkalan Regency. One of the most prominent characteristics of Bangkalan batik is the coloring process. Based on an interview with the owner of Naraya Batik, which is a batik production house located in Paseseh Village, Tanjung Bumi District, Bangkalan Regency, he stated that the batik coloring process in Bangkalan used to use a barrel as shown in Figure 2 which was buried in the ground. Therefore, batik with this coloring technique is called batik *gentongan*. Batik *gentongan* is actually the same as other written batik, but the difference is in the coloring technique.



Figure 2. Gentong

The owner of Naraya Batik also stated that one barrel can only be filled with 3 fabrics, so currently the coloring process has been changed to the dyeing technique. This is due to market demand that wants to be fast at an affordable price. Even though the coloring process is currently being changed, there are some people who still want the batik *gentongan*. The following is a description of the mathematical potential of each element in phase D.

3.1.1 Element Numbers

Based on the decision of the Head of the Education Standards, Curriculum and Assessment Agency of the Ministry of Education, Culture, Research and Technology Number 032/H/KR/2024 (2024), it is written that there are learning outcomes in the number element which states that at the end of phase D students can use prime factorization and the notion of ratio (scale, proportion, and rate of change) in problem solving. From these learning outcomes, students are asked to learn about several materials, one of which is the ratio. Ratio is the comparison of two quantities in the form of size or number of objects (Susanto et al., 2022).

The mathematical potential in the ratio material can be related to the length of the process of making hand-written batik with a coloring process using a barrel and making hand-written batik with a coloring process as in general, namely using the dyeing technique. Based on the results of interviews with the owner of Naraya Batik, the estimation of making batik *gentongan* is around 6 months to 1 year. Then the estimated time for making written batik with dip dyeing techniques is around 2 months to 3 months. This is in line with the opinion Amirullah et al. (2021) that the time for making written batik made by craftsmen is 2 to 3 months. For example, educators can make questions like in Figure 3 below.

The time to make one batik gentongan is 1 year while batik tulis is 3 months. Determine the ratio of the time to make batik gentongan to batik tulis!

Figure 3. Problem of Ratio Material

3.1.2 Algebraic Elements

Algebraic elements in the decision of the Head of the Education Standards, Curriculum and Assessment Agency of the Ministry of Education, Culture, Research and Technology Number 032/H/KR/2024 (2024) has several learning outcomes. One of the learning outcomes is that at the end of phase D students can recognize, predict and generalize patterns in the form of an arrangement of objects and numbers. One of the batik motifs in Bangkalan Regency that can be associated with these learning outcomes is *pereng bhesa*. According to the results of an

interview with one of the batik sellers in Sepulu Village, Bangkalan Regency, the batik motif in Figure 4 is called *pereng bhesa*.



Figure 4. *Pereng Bhesa* Batik Motif

Pereng bhesa when translated into Indonesian means broken plate. The batik motif in Figure 4 is called *pereng bhesa* because the motif shaped like a parabola is considered like a broken plate. If you pay attention in row 1, there are 2 images of *pereng bhesa*, in row 2 there are 3 images of *pereng bhesa*, row 3 there are 2 images of *pereng bhesa*, until row 6 there are 3 images of *pereng bhesa*. This shows that if in the order of odd rows, the *pereng bhesa* image is 2, while in the order of even rows the *pereng bhesa* image is 3. Therefore, the batik motif of *pereng bhesa* can be associated with one of the learning outcomes in algebraic elements.

In achieving learning outcomes in algebraic elements, educators can create problems included in the LKPD. Like research from Disnawati & Nahak (2019) who developed an LKPD based on the ethnomathematics of timor weaving. The problems in the LKPD in the study raised the potential for color in the timor weaving motif. From this it does not rule out the possibility of making problems from the *pereng bhesa* batik motif. An example of the problem is that batik craftsmen want to make 20 rows of *pereng bhesa* batik motifs with row 1 containing 2 *pereng bhesa* batik motifs, then row 2 contains 3 *pereng bhesa* batik motifs, in row 3 contains 2 *pereng bhesa* batik motifs and so on until row 20 contains 3 *pereng bhesa* batik motifs, in row 15 there are how many *pereng bhesa* batik motifs.

3.1.3 Geometry Elements

The most mathematical potential in batik motifs in Bangkalan Regency is in the field of geometry. One of them is in transformation material. The learning outcomes of the geometry element state that at the end of phase D students can perform a single transformation (reflection, translation, rotation, and dilation) of points, lines, and flat shapes on the Cartesian coordinate plane and use it to solve problems. In order for learners to recognize geometric transformations, especially in translation and reflection, educators can use batik cultural objects such as the *bejhid* motif as in Figure 5 and the *sokoh bujhel* motif as in Figure 6.



Figure 5. Batik *Bejhid* Motif



Figure 6. *Sokoh Bujhel* Batik Motif

At first glance, the two batik motifs only depict beauty. However, if further attention to the two batik can be used for the introduction of the concept of geometric transformation material, especially in translation and reflection. In Figure 7 has shown that the batik *bejhid* motif can be associated with translational material. Translations are also called shifts. This means that translation is a change in the position of an object (point, line, or shape) with a certain distance and direction (Kristanto et al., 2022).

The translation in Figure 7 is a change in the position of a rhombus with a certain radius. This shows that translation is only a change in position not size or shape. If the image of point $A(x, y)$ by translation $\begin{pmatrix} a \\ b \end{pmatrix}$ then the result is $A'(x + a, y + b)$. Translation $\begin{pmatrix} a \\ b \end{pmatrix}$ means that a represents the horizontal component while b represents the vertical component.

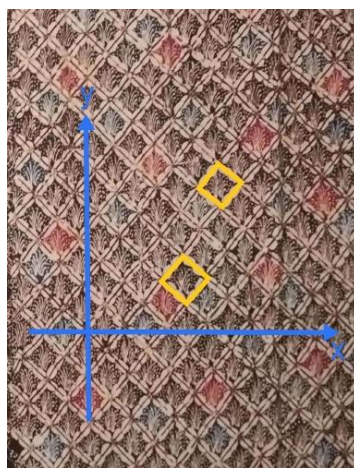


Figure 7. Mathematical Potential of *Bejhid* Batik Motifs

Just like translation, reflection is also only a change in position not size or shape as in Figure 8. Because reflection is a type of transformation that moves each point on a plane by using the properties of a mirror (Subchan et al., 2018a). Figure 8 is an example of reflection on the x -axis with the result that the shadow coordinate point is $(x, -y)$.



Figure 8. Mathematical Potential of *Sokoh Bujhel* Batik Motifs

In addition to geometric transformations, the mathematical potential in the *sokoh bujhel* batik motif is Similarity and congruence. For learning outcomes that are in accordance with this potential, students can explain the properties of similarity and congruence in triangles and quadrilaterals, and use them to solve problems. Similarity between two flat shapes are two flat shapes that have the same shape, the corresponding sides have the same ratio, and the corresponding angles are equal (Subchan et al., 2018b). If Figure 9 is seen at a glance, the two shapes have the same shape. The shape in Figure 9 is a triangle. The corresponding sides between the two triangles have the same ratio and the corresponding angles must also be equal.



Figure 9. Mathematical Potential of Similarity in *Sokoh Bujhel* Batik Motifs

The concept of congruence is different from that of equality. Congruence between two figures is two figures that have the same shape, the corresponding sides are the same length, and the corresponding angles are equal. From Figure 10, it can be seen that the two triangles have the same sides and the corresponding angles are equal in length. Therefore, educators can use this potential to introduce learners to the properties of congruence.



Figure 10. Mathematical Potential of Congruence in *Sokoh Bujhel* Batik Motifs

3.2 Math Potential of *Toron Tana* in Bangkalan Regency

Table 2. Math Potential on *Toron Tana*

Number	Objects that can be explored	Math Potential	Elements
1	A tray of items	Probability	Data analysis and probability
2	Lasor	Build a cone	Geometry

In addition to batik, a culture that is still preserved by the community in Bangkalan Regency is *toron tana*. Based on the results of an interview with one of the communities in Sepulu Village, Bangkalan Regency, *toron tana* is a ceremony performed by a 7-month-old baby to touch the ground for the first time. This ceremony signifies that the baby is allowed to touch the ground. There are several processions when carrying out the *toron tana* ceremony.

The opening event is to pray for the baby first. Usually the one who prays is Kiai with some food provided such as lasor (cone-shaped rice), side dishes, and snacks. After that the baby is placed on a tettel as shown in Figure 11. Then the baby is asked to take three items on the tray. According to one of the people of Sepulu Village, Bangkalan Regency, who was the source of this research, each village has a different *toron tana* procession. However, in Sepulu Village, Bangkalan Regency, the *toron tana* procession is like that.



Figure 11. Baby sitting on the tettel

According to one of the people of Sepulu Village, Bangkalan Regency, who became a resource person in this study, each village in Bangkalan Regency has a different *toron tana* procession. However, in Sepulu Village, Bangkalan Regency, the *toron tana* procession is

like that. The following is an explanation of the mathematical potential of each element in phase D.

3.2.1 Measurement and Geometry Elements

In the geometry element in phase D, there is one of the learning outcomes regarding the cone. The learning outcome is that at the end of phase D, students can make the nets of spatial shapes (prisms, tubes, pyramids and cones) and make the spatial shapes from the nets. In addition, the learning outcomes regarding the cone shape are also in the measurement element. The learning outcomes in this element are that learners can explain how to determine the surface area and volume of a spacecraft (prism, tube, ball, pyramid and cone) and solve related problems.

In exploring this *toron tana* culture, researchers experience limitations, namely documentation. This is because no one has held a *toron tana* ceremony. Therefore, the documentation in this section is not very clear.

One of the *toron tana* equipment that has the potential for mathematics is the *lasor*. *Lasor* here is a cone-shaped white rice. In Figure 12, the shape is not clearly visible. However, based on the results of an interview with one of the people of Sepulu Village, Bangkalan Regency, it is stated that usually the shape of the *lasor* resembles a cone. In this case, educators can introduce the concept of cones from the *lasor*.



Figure 12. *Lasor*

3.2.2 Data and Opportunity Analysis Elements

In *toron tana* there is a procession of taking items carried out by babies. This can have mathematical potential in the element of data analysis and probability. Because in this element there are learning outcomes that at the end of phase D students can explain and use the notion of chance and relative frequency to determine the expected frequency of one event in a simple experiment (all experimental results can appear evenly). However, the procession only has the potential for chance material.

Based on the results of an interview with one of the people of Sepulu Village, Bangkalan Regency, the items taken by the baby in this procession will describe future work or ideals. The items in the tray as shown in Figure 13 consist of the Qur'an, rice, corn, powder, glass, ballpoint pen, and comb. Actually, these items are not always provided, sometimes they are also replaced.

When the baby takes rice or corn, it is believed that one day it will become a successful farmer. If the baby takes a ballpoint pen, it will be good at writing. Then if the baby takes a comb, powder, or glass it will be good at makeup and always look neat. Then when the baby takes the Qur'an it is believed that one day it will become a hafidz.



Figure 13. Items on the Tray

The procession of the baby taking three items on the tray, there is mathematical potential contained in the procession. In this case, the educator can make a problem about the probability of an event regarding the possibility of a baby taking three items at random. For example, the problem is as in Figure 14.

Toron tana is one of the cultures that is still preserved by the Madurese community. Usually toron tana is done when the baby is 7 months old which indicates that a child is allowed to touch the ground to learn to walk. In the toron tana ceremony there is a procession of a child being asked to take three items that have been provided on a tray. According to the belief of the Madurese people, the items taken by the child will describe future work or ideals. The items in the tray in the picture of the toron tana ceremony above are the Qur'an, rice, corn, powder, glass, ballpoint pen, and comb. Find the probability that three items are randomly drawn from the tray?

Figure 14. Problem about probability

From the problem in Figure 14, learners can determine the probability of an event regarding the possibility of a baby taking three items at random. Based on the interview results, the contents of the tray can also be replaced with other items that can describe a profession. Therefore, educators can customize the problem by replacing the items in the tray.

4. Conclusion

Based on the results of cultural exploration in Bangkalan Regency, it can be concluded that there is mathematical potential found in batik and *toron tana*. The mathematical potential found by researchers is only limited to learning mathematics for phase D. This limitation is because when conducting this research no one held a *toron tana* event and batik *gentongan* typical of Bangkalan Regency was rarely produced so that researchers could not explore too deeply about the culture. In addition to these limitations, researchers found several mathematical potentials consisting of ratios, number patterns, geometric transformations, congruence, curved-sided spaces, and opportunities. All of these potentials are included in the learning outcomes in phase D.

The learning outcomes in phase D consist of 5 elements. In this study, learning outcomes that can be associated with culture in Bangkalan Regency consist of elements of number, algebra, measurement, geometry, and data analysis and opportunities. The discovery of mathematical potential in culture in Bangkalan Regency can be applied in learning such as

when making apperceptions and motivating students at the beginning of teaching and learning activities, as well as developing ethnomathematics-based question items.

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