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EXPLORATION OF MATHEMATICAL CONCEPTS IN BATIK TRUNTUM SURAKARTA

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ABSTRACT

This research investigates the mathematical concepts embedded within Batik Truntum motifs, including geometry, analysis, arithmetic, and algebra. Employing a qualitative methodology with an ethnographic approach, the study addresses four critical questions: "Where should I begin the search?", "How do I locate the concepts?", "How do I identify significant findings?", and "How do I comprehend these findings?". Through addressing these questions, the researcher successfully analyzed the mathematical concepts inherent in Batik Truntum. Of the four primary mathematical concepts, only geometry was substantiated by experts, encompassing sub-concepts such as geometric transformations, line relationships, and planar geometry. Specifically, transformation geometry includes translation and reflection, while the study of line relationships involves line alignment, and planar geometry covers the topic of circles. This research aims to ensure that the millennial generation remains connected to batik as a vital part of Indonesia's cultural heritage, preventing cultural erosion amidst technological advancements through the intricate and exploratory study of mathematics.

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1. INTRODUCTION

Batik is a craft with high artistic value. Batik as part of Indonesian culture inherited by the ancestors of the Indonesian nation since ancient times. The origin of the development of batik in Indonesia is related to the existence of the kingdoms of Majapahit, Surakarta, and Yogyakarta so that in the Javanese tribe itself (Trixie, 2020). Batik making activities grow and develop very fertile and produce two types of various batik patterns, namely Solo batik patterns and Yogyakarta batik patterns (Rizali & Sudardi, 2019). Furthermore, Rizali and Sudardi (2019) said that the determination of the variety of the two batiks occurred based on culture and the environment. So that both types of batik have their own peculiarities.

Batik technique is an original skill possessed by the Indonesian people since centuries ago. In its development, various types of batik were also born based on the local environment so that the interest of the Indonesian people in batik is also increasing (Rizali & Sudardi, 2019). This can be seen from the increasing use of batik in daily clothing both formal and non-formal (Widiyono & Mawarti, 2020). In addition to the type of clothing, various ornaments and decorations also use many batik elements. Therefore, preservation efforts need to be carried out continuously so that they are maintained. One of them is Batik Truntum.

1.1. Batik Truntum

According to the author's interview with Asti Suryo Astuti, SH, KN as the manager and curator at the Danar Hadi Batik Museum Surakarta on December 11, 2022, the Batik Truntum motif is one of the batik motifs that grows and comes from the Surakarta Palace environment. The Batik Truntum motif can be recognized by the variety of ornamental flowers that are neatly arranged geometrically (See Figure 1). In his historical perspective, K.P.T. Hardjonagoro told in the forum of the Roundtable on Museum Textile in Washington D.C. in 1979, the Batik Truntum motif was created by Kanjeng Ratu Beruk. She is a consort of Sri Susuhan Paku Buwono III entitled Ratu Kencono. On a clear night studded with stars and fragrant Tanjung flowers, Kanjeng Ratu Beruk offered a prayer accompanied by a request for mercy to the Creator so that His Majesty would love her again. In the midst of her sadness, the queen created batik with a truntum motif which means sincere, eternal and unconditional love (Doellah, 2002).

While in the perspective of its use, Batik Truntum is widely used in marriage ceremonies worn by the parents of the bride and groom (Widodo et al., 2021). This means a message and hope that one day the bride and groom can run their home life harmoniously and lastingly. Furthermore, Widodo et al. (2021) said the truntum motif comes from the word tumarumtum which means guide, meaning parents are obliged to guide and set an example for the bride and groom in entering their new life.

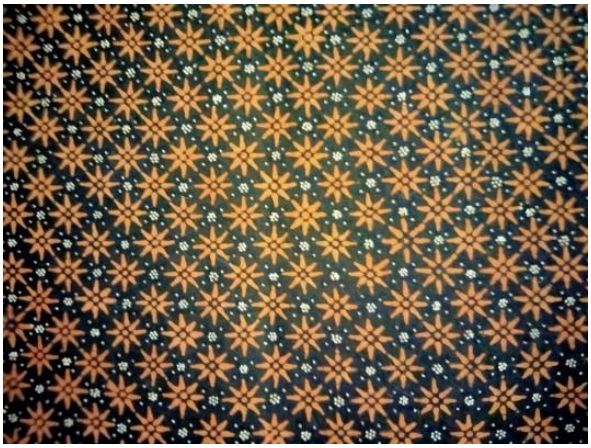


Figure 1. Batik Truntum motif's

Batik truntum has a smooth and simple motif, Batik Truntum with abstract motifs such as sprinkling cape flowers with twinkling star sprinkling decorations one night. Although the truntum motif looks abstract, the floral motif is neatly arranged and geometric as shown in Figure 1.

Figure 2. Truntum Gurdo and Truntum Sri Kuncoro batik motif's

Basically, Batik Truntum motifs are batik that grows and comes from the Kasunanan Surakarta Palace so that Batik Truntum motif is included in the type of palace batik motifs. However, in its development there are many requests for batik as clothing. Therefore, many batik merchants have developed the batik into several Batik Truntum with additional motifs such as garuda bird wings (see Figure 2 on the left), puffers or flower arrangements that are dironce (see Figure 2 on the right), and so on.

1.2. Batik Truntum Preservation Efforts

In the perspective of its use, Batik Truntum is usually used in wedding ceremonies, especially traditional wedding parties, especially in several regions in Yogyakarta and Surakarta (Widodo et al., 2021). The use of Batik Truntum in wedding ceremonies is usually worn by the parents of the bride and groom which means that parents are obliged to guide and set an example for the bride and groom in entering a new life. However, based on the results of the author's interview with Asti Suryo Astuti, SH, KN as the manager and curator at the Danar Hadi Batik Museum Surakarta on December 11, 2022, currently many people do not know the Batik Truntum motif and do not even know it. This is very concerning because Batik Truntum as the national heritage of Indonesia, especially in Surakarta is less recognized. Therefore, an effort is needed to preserve Truntum Batik where one way is through the education sector at the school level.

In the context of education, there are several subjects that can be contextually related to batik, one of which is mathematics. Although until now there has been no expert agreement on the definition of mathematics, but in principle and agreed by many mathematicians that mathematics is a study about abstract objects (Mitchelmore & White, 2004). Hence, a mathematics teacher needs to use realistic context to explain the mathematics objects such as geometry shapes, numbers, patterns, and so on. There have been many previous research results that have found mathematical concepts in batik (Mulyani & Natalliasari, 2020). Therefore, the exploration of mathematical concepts in Truntum Batik can be an alternative way to preserve and introduce Truntum Batik through the education sector at the school level.

1.3. Ethnomathematics

Ethnomathematics is "applied mathematics" that develops in identifiable cultural groups such as ethnic societies, labor groups, children of certain age groups, and professional classes. In short, ethnomathematics is a form of mathematics that has been integrated into culture. Ubiratan D'Ambrosio, a Brazilian educator and mathematician, introduced the term in 1977 in a presentation for the American Association for the Advancement of Science. The goal of ethnomathematics is to contribute to an understanding of culture and mathematics, as well as appreciate the relationship between the two.

Based on previous research, there are several studies that examine mathematical concepts in batik. Some of them are research conducted by Safira et al. (2021) which examines the philosophical value and mathematical concepts in Banten batik. Next, the research conducted by Afifah et al. (2020) which explores mathematical concepts in Gajah Mada Batik with Sekar Jagad Tulungagung motif, another one is is research conducted by Wati et al. (2021) which examines the application of mathematical concepts and how mathematical concepts in Gedog batik. A study conducted by Ishartono and Ningtyas (2021) which examines mathematical concepts and also philosophical values in Sidoluhur Solo batik. Lastly the research conducted by Faiziyah et al. (2021) which examines related mathematical elements found in batik in Surakarta. However, from those studies, there has not been found in-depth research related to the exploration of mathematical concepts in Batik Truntum. Therefore, this study is considered to be important due to the findings of this study may contribute to promote the existance of Batik Truntum toward Indonesian students through mathematics learning process. The exploration of mathematical concept may help mathematics teachers to deliver mathematics concepts to more contextual and realistic.

Based on this description, researchers want to explore the mathematical concepts contained in Batik Truntum, therefore this study aims to describe the process of exploring mathematical concepts in Batik Truntum and describe the mathematical concepts contained in Batik Truntum. The results of this research can later be used by teachers as a medium for learning mathematics and become a context for mathematics learning so that it is expected that mathematics learning will be more realistic and contextual. In addition, contextual mathematics learning will make students more familiar with Batik Truntum, especially in Surakarta and surrounding areas.

2. METHOD

This type of method in exploring mathematical concepts in Batik Truntum uses ethnomathematical studies with an ethnographic approach. This study used a design that refers to ethnography, according to Sutama (2019), Ethnographic method is a method that is often used for research in the field of cultural anthropology (Pratiwi & Nurcahyo, 2022). Ethnographic studies in this study focused on one main component, namely the knowledge system, in this case researchers must dive into the knowledge system and art of Surakarta Batik Truntum to find a knowledge base. Ethnographic studies begin with the answers to four general questions that are the core of ethnographic research, namely “where to start looking?”, “how to look?”, “how to recognize that you have found something significant?”, “how to understand what it is?” (Prahmana & D'Ambrosio, 2020). Based on these four general questions, the research design can be compiled in Table 1.

Table 1. Research design

Frequently Asked Questions	Initial Answer	Specific Point	Specific Activities
Where do I start looking?	The initial observation began by analyzing the place where there was Batik Truntum	Culture	Conduct interviews with people who know Batik Truntum and people who make Surakarta batik motifs
How to find it?	Investigate Batik Truntum motifs directly	Alternative thinking	- Analyzing truntum motifs in Surakarta batik - Determine whether there are mathematical concepts in Surakarta Batik Truntum
How do you recognize that something important has been found?	Evidence (the result of alternative thinking from the previous process)	Philosophy of mathematics	- Identify whether in the Batik Truntum motif there are mathematical concepts - Discovering mathematical concepts in Surakarta Batik Truntum motifs
How to understand that?	It's important for culture, and it's important for mathematicsa	Anthropological methods	- Explain the relationship between the two knowledge systems, namely culture and mathematics - Describe the mathematical concept of Surakarta Batik Truntum motif

The data collection process is carried out from October 2022 to January 2023 in various places such as the Danar Hadi Batik Museum, universities, to one of the batik making centers. The object of the study to be studied is mathematical concepts on the Batik Truntum motif. The mathematical concepts studied are based on four branches of mathematical science, which are in line with opinions James (1976) which says that mathematics is divided into four parts namely arithmetic, algebra, geometry and analysis. While the subject in this study is Batik Truntum.

The type of data used is qualitative data with observational data collection techniques, interviews, and documentation using two research instruments, namely observation sheets and interview sheets. Furthermore, both instruments were validated to two experts including mathematicians with master's degrees from private universities in Indonesia and also cultural experts who are managers of one of the museums in Indonesia. After validation, both instruments were tested for validity using the Aiken's Value validity test by involving two experts to assess the draft (Retnawati, 2016). The content validity index (CVI) obtained the average value of all items is 0.83 or classified as high validity in this study.

Data analysis in this study refers to Miles and Huberman, namely through three stages, namely data reduction, data presentation, and conclusion drawing (Sutama, 2022).

The data is then analyzed by researchers and their knowledge to see the existence of mathematical concepts in Batik Truntum and continued with experts who confirm the results of the analysis or triangulate data sources.

3. RESULT AND DISCUSSION

3.1. Results

In this study, it began with researchers finding out where Batik Truntum can be found. Finally, Batik Truntum can be found in one of the shops that are also making batik in Pilang Village, Masaran District, Sragen Regency, Central Java named "Sekar Melati". However, the place only sells and makes Surakarta batik, so researchers only conduct interviews to see batik samples with Truntum motifs which will later be used as study material in this study.

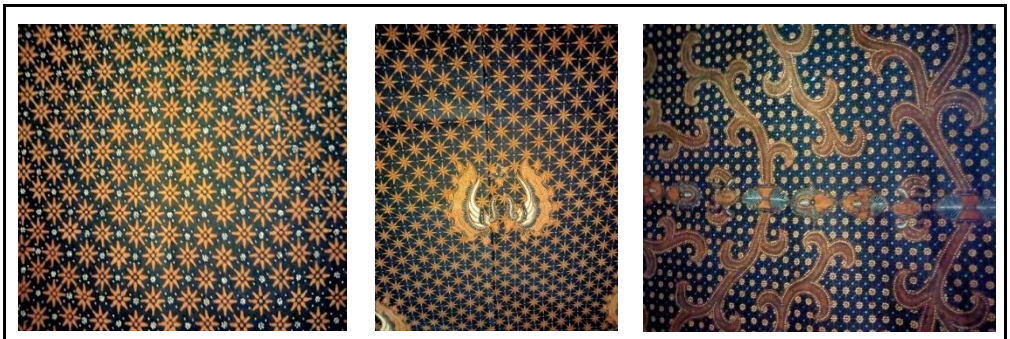
Researchers then searched again for information related to Batik Truntum at the Danar Hadi Batik Museum located on Jl. Slamet Riyadi No. 261, Sriwedari, Surakarta City, Central Java 57141, Indonesia (see Figure 3). Then the researcher conducted an interview with Mrs. Asti Suryo Astuti as the manager of the Danar Hadi Batik Museum. An interview with Ibu Asti was conducted to identify the meaning and philosophy of the Batik Truntum motif, as well as the mathematical values of the batik motif. So that the results are obtained as in the introduction previously described.

Figure 3. Interview process with manager of the Danar Hadi Batik Museum

Based on interviews with samples from Batik Truntum, which will be further examined in this project, it was found that Batik Truntum originated from the Surakarta Palace. This type of batik is characterized by its floral motifs, which are meticulously arranged in geometric patterns. The design typically features a black background with motifs in yellow, sogan (a shade of brown), or brown and can be recognized by the floral motifs in

it which are neatly arranged geometrically. Batik Truntum uses black in its base color, yellow and sogan or brown in its motif (Widodo et al., 2021).

There are three Batik Truntum motifs that will be followed up for this study, namely truntum byur motifs (without a variety of supporting ornaments), Truntum Gurdo (truntum motif with a variety of ornamental supports for garuda bird wings), and Truntum Sri Kuncoro (truntum motif with a variety of ornamental supporting puffer motifs or flower arrangements that are reconciled). The three motifs are shown in Figure 4.



Truntum byur Batik (without supporting ornamental variety) | Batik Truntum with garuda bird motif (Gurdo) | Batik Truntum with puffer motifs or flower arrangements that are dironce (Sri Kuncoro)

Figure 4. Batik Truntum motif's, Truntum Gurdo and Truntum Sri Kuncoro

3.2. Discussion

Based on the results of the analysis, in the sub-concept of transformation geometry there is a topic of reflection or reflection on Truntum Gurdo batik or Batik Truntum with a combination of garuda bird wings and Truntum Sri Kuncoro Batik or Batik Truntum with a combination of puffers or flower arrangements that are trumpeted. According to Roebyanto (2014), reflection is moving geometric shapes or objects with the same distance between the transfer point with the mirror and the starting point with the mirror Hada et al. (2021) while in principle Martin (1982) say, reflection is one form of geometric transformation where the mapping of Euclidean space is isometric with the hyperplane as a fixed set of points or what is called the plane of the reflection axis (Ishartono & Ningtyas, 2021). In the Truntum Gurdo Batik motif, if an imaginary line is drawn as in Figure 5, from the middle of the pair of garuda bird wings, it can be seen that the line becomes a symmetrical line that divides the pair of wings into two equals. The illustration can be seen in Figure 5.

Figure 5. Reflection analysis on Truntum Gurdo motifs

The concept of reflection on Batik Truntum motifs is not only found in Batik Truntum with Gurdo motifs but also in Sri Kuncoro Batik Truntum, namely in puffer motifs. An illustration of reflection analysis on the puffer motif is in Figure 6.

Figure 6. Puffer motif reflection analysis

The topic of reflection on batik is also in previous research, namely on Sidoluhur Batik (Ishartono & Ningtyas, 2021), Batik Kawung (Faiziyah et al., 2021), Batik Yogyakarta (Prahmana & D'Ambrosio, 2020), Batik Trusmi Cirebon (Arwanto, 2017), and Batik Indramayu (Sudirman et al., 2017).

In addition to the topic of reflection, the findings on the sub-concept of geometric transformations are found on the topic of translation or shift. Basically, according to Jamil (2019) everything can be said to be translational, that is, when there is a transformation of the displacement of a certain point along a straight line with a certain direction and distance. In addition, shifts that only change position at points that do not change their size and shape are called translational. While in principle, translation is a transformation produced congruently with a transformed form including direct isometric transformations (Hada et al., 2021). In the Batik Truntum motif, the shift or displacement occurs in the batik motif in it. The shift or displacement of batik motifs clearly proves that the translation concept has been applied in making the batik motif.

The results of the analysis related to the sub-concept of geometric transformation, there is a translational concept on the basic motif of Truntum. Translational analysis has been found in Batik Truntum as shown in Figure 7.

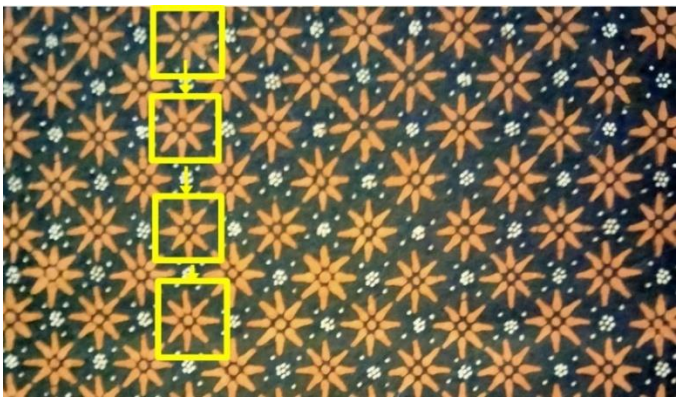


Figure 7. Translational analysis of Truntum motifs

The topic of translation in batik is also in previous research, namely on Bantul Krebet Wood Batik (Abdullah & Rahmawati, 2021), Batik Parang (Faiziyah et al., 2021), Batik Indramayu (Sudirman et al., 2017), Batik Banten (Safira et al., 2021), and Batik Kawung (Sa'id et al., 2021). In addition to previous research, the topic of geometric transformation which includes translation and reflection has also been applied to mathematics learning and the development of student worksheets, as in research Akmalia (2020) which uses the mathematical concept of Batik Sekar Jagad Blambangan as an ethnomathematics and research-based student worksheet by Sintiya et al. (2021) which uses mathematical concepts on Adi Purwo Batik motifs as electronic modules (E-modul) which is base ethnomathematics.

Another sub-concept of geometry found is the science of flat plane measurement, where in the Truntum Gurdo batik motif has been found a shape that resembles a flat circle on a pair of eagle eyes. By definition, Nasryah and Rahman (2020) in the book "Ethnomathematics, Mathematics in Cultural Perspective" states, a circle is the set of all points in a flat plane that are equidistant from a fixed point in that plane. In addition, a circle can also be defined as the set of points that are equidistant to a certain point.

The research results also show that the topic of flat areas that fit the definition is one type of Batik Truntum motif. An illustration of the results of circle analysis on Truntum Gurdo Batik is in Figure 8.

Figure 8. Circle analysis on Truntum Gurdo motif's

In Figure 8 related to circle analysis in Truntum Gurdo Batik, you can see the topic of plane geometry which is given a yellow line, in the line there is an eagle eye motif that resembles one of the flat shapes, namely circles. The topic of flat circle has also been found in previous batik motif studies such as Banten Batik (Safira et al., 2021), Batik Sukapura (Mulyani & Natalliasari, 2020), Batik Kawung (Faiziyah et al., 2021), Batik Kayu Krebet Bantul (Abdullah & Rahmawati, 2021), Batik Sidoluhur (Ishartono & Ningtyas, 2021), Batik Jlamprang (Muttaqin et al., 2018), and Batik Medan (Harahap & Mujib, 2022).

In addition to previous research, the topic of building flat circles has also been applied to learning and some development of student worksheets, such as in research Wulandari (2019) which uses the mathematical concept of Tanjung Bumi Madura Batik as an ethnomathematics-based student worksheet and also research Humaeroh and Rahayu (2022) which applies the ethnomathematics of batik kawung to the development of mathematics teaching materials.

In addition to containing sub-concepts of flat plane geometry and geometric transformations, the sub-concept of the relationship between lines was also found in the Batik Truntum motif. By definition, a parallel line is a position of two lines on a flat plane

that has no intersection even though both lines are extended (Aflah & Andhany, 2022). This shows that the sub-concept of the relationship between lines is found in the Batik Truntum motif.

Based on the results of an exploratory study of mathematical concepts on Batik Truntum motifs, a line alignment topic has been found that corresponds to this definition in one type of Batik Truntum motif. An illustration of the parallel line analysis is in Figure 9.

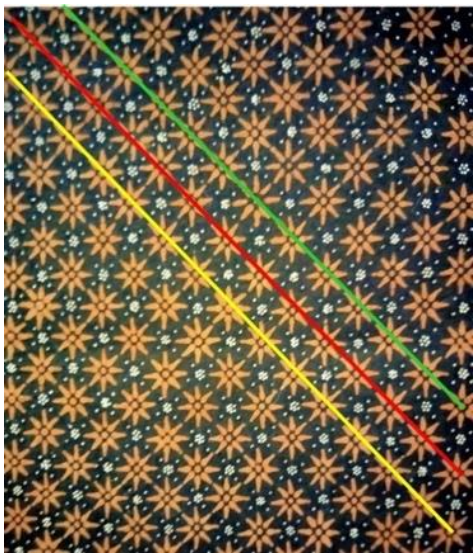


Figure 9. Analysis of the Relationship Between Lines on the Truntum Motif

In Figure 9 related to the results of the analysis of the relationship between the lines, if an imaginary line is drawn on the twinkling pattern from end to end, a slash pattern will be obtained as in the red line. Furthermore, if the twinkling pattern below the red imaginary line is made an imaginary line as well, it will look like a yellow line in Figure 9. And if an imaginary line is drawn following the twinkling pattern above the red imaginary line, it will also get a slash like the green line in Figure 9. The three lines have no intersection points and if extended, the imaginary lines that follow the batik pattern will not be found intersection points. This also applies to other flickering patterns, which are certainly in the Batik Truntum motif. The topic of line alignment has been found that corresponds to the definition of line alignment. According to the manager of one of the batik museums in Surakarta revealed, for the manufacture of Batik Truntum in the present using printing techniques that use precision calculations so that the concept of alignment can be found in the batik motif.

The topic of line alignment has also been found in previous batik research studies, such as the Gajah Mada Batik motif (Afifah et al., 2020), Batik Pasedahan Suropati (Ulum, 2018), Batik Paoman (Sudirman et al., 2018), Batik Mojokerto (Islam & Mariana, 2021), and Batik Solo (Faiziyah et al., 2021). In addition to previous research, the topic of relationships between lines has also been applied to learning and developing student worksheets, such as in research Hasanah et al. (2019) which uses mathematical concepts in Madura Batik as ethnomathematics-based student worksheets.

Number pattern is an arrangement of numbers that have a regular shape or a number composed of several other numbers that form a pattern and number patterns also have many types (Dewi et al., 2020; Oktaviyani et al., 2023). The topic in the number pattern sub-concept is arithmetic rows.

Arithmetic row is one of the rows of numbers that is one of the main subjects in the school mathematics curriculum, especially in secondary schools. The main characteristic of

this line is that each successive term has the same difference or difference (Ismail, 2014). Furthermore, Ismail said the main study of the substance of this material is to determine the difference, determine the nth term and calculate the number of n consecutive terms. If the scope of the substance of this sequence material is only limited to the three things above, then it is often felt that it is not enough to develop mathematical reasoning skills in solving related problems. This is in line with the student's book at the secondary level, which concludes that an arithmetic sequence is a series of numbers whose differences are fixed (Syamsuddin, 2004).

Based on the results of the research conducted, there is a mathematical element in Batik Truntum which has a core motif in the form of twinkling and small cape flowers which both core motifs form a pattern of rows and arithmetic series. Batik Truntum motifs form arithmetic row patterns when viewed from the direction of the motif. Figure 10 presented an example of the Batik Truntum motif.

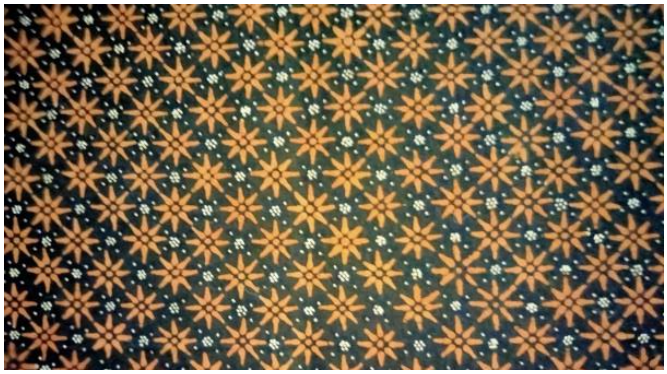


Figure 10. Batik Truntum motif's

Batik Truntum motif was re-identified related to its core motif. The results of the identification of Batik Truntum motifs are presented in Table 2.

Table 2. Truntum motif details

No	Motive Name	Picture
1	Flicker Motif	
2	Small Flower Motif	

Both motifs have a pattern that can be determined in order. For details, consider the following Figure 11.

Figure 11. Batik Truntum motifs in detail

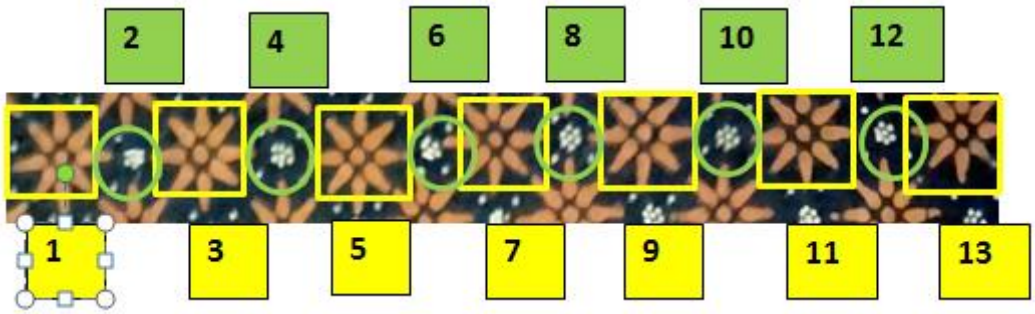


Figure 12. Arithmetic line analysis on Truntum motifs

Referring to Figures 11 and 12 related to the results of arithmetic sequence analysis on the truntum motif, we observe that the twinkle motif has patterns 1, 3, 5, 7, 9, 11, 13 and so on. This means that each tribe of the pattern has a difference of 2 with the next tribe. Then we can find out the next term after 13 plus 2 which is 15. If adjusted to the arithmetic sequence pattern with a difference of 2, then for the nth term the formula is obtained: U_n = 2n-1.

Furthermore, if we observe the cape floral motif has patterns 2, 4, 6, 8, 10, 12. This means that each tribe of the pattern has a difference of 2 tribes with the next tribe. Therefore, we can know the next term after 12 which is 14 because plus 2. If adjusted to the arithmetic sequence pattern with a difference of 2, then for the nth term the formula is obtained: U_n=2n. The topic of arithmetic rows has also been found in previous research studies found in the Yogyakarta Kawung batik motif (Safitri et al., 2022) and Batik Adipurwo (Astuti et al., 2019).

Based on the results of the initial analysis related to the existence of mathematical concepts in the Batik Truntum motif, the final result was obtained that among the four parts of mathematics according to James (1976) which include arithmetic, algebra, geometry, and analysis there are only concepts of geometry, arithmetic, and algebra contained in the Batik Truntum motif (Rahmah, 2018). The observational conclusions are arranged in Table 3.

Table 3. Analysis of mathematical concepts

Concept	Researchers' Arguments	Sub-Concepts	Topic	Expert Argumentation	Appropriateness of Arguments
Geometry	Exist	Geometry Transformation	Mirroring (reflection) Shift (translation)	Exist	√
		Relationship Between Lines	Line Alignment		
		Flat Plane Measuring Science	Circle		
Arithmetic	Exist	Number	Calculations on the area and circumference of a circle	Exist	√
		Number Patterns	Arithmetic row		

Concept	Researchers' Arguments	Sub-Concepts	Topic	Expert Argumentation	Appropriateness of Arguments
Algebra	Exist	Algebra Tribe	Number patterns that use algebraic terms such as (2n and 2n+1)	Exist	√
Analysis	None	-	-	None	√

Table 3 shows that among the four mathematical concepts studied, there are only the concepts of geometry, arithmetic, and algebra contained in the Batik Truntum motif. As for the geometry concept, the groups into two sub-concepts, namely geometric transformations and relationships between lines. In the sub-concept of geometric transformation, it consists of two topics, namely translation (shifting) and reflection (mirroring). While in the sub-concept of the relationship between lines, the found the concept of parallel lines in the batik motif. In addition to the concept of geometry, the concept of arithmetic is also divided into two sub-concepts including numbers and number patterns and in the concept of algebra found one sub-concept, namely algebraic terms obtained in the use of algebraic terms in number patterns.

As an effort to test the validity of the data. Data validity testing is carried out by the process of source triangulation. According to Sutama (2019), Source triangulation is used to test data credibility by checking data that has been obtained through several sources. The source triangulation process is carried out by comparing the related mathematical concepts contained in the Batik Truntum motif in Table 2 with expert points of view in the fields of geometry, arithmetic, algebra, and analysis. There are two fundamental questions that must be asked of experts related (1) their views on mathematical concepts in batik, and (2) whether the context of Batik Truntum can be used in mathematics learning. The first point was used to confirm whether they found the same mathematical concepts as the authors' findings. The process is carried out by interviews and if the results are consistent, it can be said to be valid.

The first concept that the author discovered was geometry which included sub-concepts of transformation geometry, relationships between lines, and the science of flat plane measurement. In response to this, the expert found a sub-concept similar to what the author found. In addition, experts also revealed that the concept can be used in contextual mathematics learning. In the sub-concept of transformation geometry, teachers can visualize one of the objects in the Batik Truntum motif using geogebra as a medium for learning mathematics. The use of geogebra in this case is in line with the opinion Hohenwarter and Fuchs (2004) Related to one of the benefits of using Geogebra in learning is as a medium to demonstrate and visualize mathematical concepts. As in research Ramadhani and Narpila (2018) and Darmawan and Suparman (2019) concluded that Geogebra-assisted mathematics learning through local cultural problems is proven to help students understand new science from real problem solving.

During the geogebra-based geometry transformation learning, the teacher sketches one of the objects contained in Batik Truntum then students can transform the object geometrically, such as reflection and translation using the media. While responding to the findings related to the second concept, namely arithmetic, the expert stated that he agreed with the author's findings regarding the existence of sub-concepts of numbers and number patterns in Batik Truntum, so that the Batik Truntum motif can be used in mathematics learning, especially on the topic of calculating the area and circumference of a circle and on the topic of arithmetic rows.

The third concept confirmed by experts is the concept of algebra. Experts respond that in Batik Truntum motifs can be used in algebra learning. The algebraic sub-concept here

referred to is on the topic of algebraic terms found in arithmetic sequence calculations. Then the fourth concept confirmed by the expert is the concept of analysis, the expert stated that he did not find the concept of analysis on the Batik Truntum motif, so he was not sure that the Batik Truntum motif could be used in mathematics learning, especially in the concept of analysis. In addition, experts in the field of analysis also revealed that if a batik motif is limited in a concept, it cannot be forced. This opinion is in line with the opinion D'Ambrosio's (1985) that is, if in a culture there is no mathematical concept, then it does not need to be forced to exist (D'Ambrosio, 1985).

The topic of reflection on batik is also in previous research, namely on Sidoluhur Batik (Ishartono & Ningtyas, 2021), Batik Kawung (Faiziyah et al., 2021), Batik Yogyakarta (Prahmana & D'Ambrosio, 2020), Batik Trusmi Cirebon (Arwanto, 2017), and Batik Indramayu (Sudirman et al., 2017). The topic of translation in batik is also found in previous research, namely on Batik Kayu Krebet Bantul (Abdullah & Rahmawati, 2021), Batik Parang (Faiziyah et al., 2021), Batik Indramayu (Sudirman et al., 2017), Batik Banten (Safira et al., 2021), and Batik Kawung (Sa'id et al., 2021). In addition to previous research, the topic of geometric transformation which includes translation and reflection has also been applied to mathematics learning and the development of student worksheets, as in research Akmalia (2020) that uses mathematical concepts Batik Sekar Jagad Blambangan as ethnomathematics and research-based student worksheets by Sintiya et al. (2021) which uses mathematical concepts on Adi Purwo Batik motifs as electronic modules (E-modul) ethnomathematics-based.

In addition to translational topics, the topic of flat circle fields has also been found in previous batik motif studies such as Batik Banten (Safira et al., 2021), Batik Sukapura (Mulyani & Natalliasari, 2020), Batik Kawung (Faiziyah et al., 2021), Batik Kayu Krebet Bantul (Abdullah & Rahmawati, 2021), Batik Sidoluhur (Ishartono & Ningtyas, 2021), Batik Jlamprang (Muttaqin et al., 2018), and Batik Medan (Harahap & Mujib, 2022). In addition to previous research, the topic of building flat circles has also been applied to learning and some development of student worksheets, such as in research Wulandari (2019) which uses the mathematical concept of Tanjung Bumi Madura Batik as an ethnomathematics-based student worksheet and also research Humaeroh and Rahayu (2022) which applies the ethnomathematics of batik kawung to the development of mathematics teaching materials. The topic of line alignment has also been found in previous batik research studies, such as motifs Batik Gajah Mada (Afifah et al., 2020), Batik Pasedahan Suropati (Ulum, 2018), Batik Paoman (Sudirman et al., 2018), Batik Mojokerto (Islam & Mariana, 2021), and Batik Solo (Faiziyah et al., 2021). which applies the ethnomathematics of Batik Kawung to the development of mathematics teaching materials. The topic of line alignment has also been found in previous batik research studies, such as motifs (Hasanah et al., 2019) which uses mathematical concepts in Madura Batik as ethnomathematics-based student worksheets.

The results of this research can later be used by teachers as a medium for learning mathematics and become a context for mathematics learning so that it is expected that mathematics learning will be more realistic and contextual. In addition, contextual mathematics learning will make students more familiar with Batik Truntum, especially in Surakarta and surrounding areas. However, this study still has some limitations, namely on the time of research and geometry concepts alone for the researchers' findings. Based on some of the findings and results of the study, of course, there are still many things that can be studied from this research such as the effectiveness of Batik Truntum-based learning and how it is applied in mathematics learning. So that the benefits obtained will be wider and more complex.

4. CONCLUSION

Based on the purpose of this study, two things were concluded, namely from ethnomathematical exploration obtained this research using ethnographic methods that answer four ethnographic questions which include "where to start looking?", "how to look?", "how to recognize that you have found something significant?", "how to understand what it is?", the concept obtained in the exploration is the concept of geometry, arithmetic, and algebra. The concept of geometry which includes sub-concepts of geometric transformations, the science of measuring flat planes, and relationships between lines. The geometry transformation sub-concept includes the topic of translation and reflection while the flat plane measurement sub-concept includes the topic of circles, and for the concept of relationships between lines includes the topic of line alignment. Arithmetic concepts obtained include the topic of numbers and number patterns as well as algebraic concepts obtained from the topic of algebraic terms. Based on these conclusions, the next research can further explore the mathematical concepts found in this study and utilized in mathematics learning resources and media in schools.

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