Symmetry | Pasundan Journal of Research in Mathematics Learning and Education
Volume 10 Nomor 1, Juni 2025
e-ISSN: 2548-2297 • p-ISSN: 2548-2297

ETHNOMATHEMATICS AND BATIK CULTURAL CONVERSATION: A QUALITATIVE-ETHNOGRAPHIC STUDY OF MATHEMATICAL CONCEPTS IN BATIK CEPLOK KASATRIAN

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ABSTRAK

Batik Ceplok Kasatrian merupakan warisan budaya Indonesia yang sarat akan makna filosofis, namun kurang dikenal oleh generasi muda. Oleh karena itu, integrasi batik dalam pembelajaran matematika dapat menjadi salah satu strategi untuk melestarikan tradisi budaya batik. Penelitian ini bertujuan untuk mengeksplorasi konsep-konsep matematika seperti geometri, aljabar, aritmetika, dan statistika dalam motif Batik Ceplok Kasatrian. Penelitian ini menggunakan pendekatan kualitatif-etnografi. Subjek penelitian ini adalah motif Batik Ceplok Kasatrian. Keabsahan data diperoleh melalui triangulasi sumber, sedangkan analisis data mencakup reduksi data, penyajian data, dan penarikan kesimpulan. Proses eksplorasi dilakukan dengan menjawab empat pertanyaan utama: "*"Where do I begin exploring?", "How can I discover it?", "How will I know if it has discovered something important?*", dan "*How can I make sense of it?*". Hasil penelitian menunjukkan bahwa dari keempat konsep matematika, hanya ditemukan dua konsep matematika dalam batik ini, yaitu geometri dan aritmetika. Subkonsep geometri meliputi transformasi (refleksi, translasi, dilatasi) dan geometri bidang (ruas garis, simetri, kekongruenan). Subkonsep aritmetika mencakup bilangan bulat (bilangan ganjil-genap). Temuan ini dapat diintegrasikan dalam pembelajaran matematika melalui pengembangan asesmen berbasis etnomatematika yang berorientasi pada High Order Thinking Skills (HOTS).

Received 20 Juni 2025 • **Accepted** 30 Juni 2025 • **Article DOI:** 10.23969/symmetry.v10i1.28298

ABSTRACT

Batik Ceplok Kasatrian is an Indonesian cultural heritage that is full of philosophical meaning but is less known by the younger generation. Therefore, the integration of batik in mathematics learning can be one of the strategies to preserve tradition of batik culture. This research aims to explore mathematical concepts, such as geometry, algebra, arithmetic, and statistics, in Batik Ceplok Kasatrian motifs. This research uses qualitative-ethnographic. The subject of this study is the Batik Ceplok Kasatrian motif. Data validity is obtained through source triangulation, while data analysis includes reduction, presentation, and conclusion. The exploration process is carried out by answering four main questions: "Where do I begin exploring?", "How can I discover it?", "How will I know if it has discovered something important?", and "How can I make sense of it?". The results show that of the four mathematical concepts, only two mathematical concepts are found in this batik, namely geometry and arithmetic. Geometry subconcepts include transformation (reflection, translation, dilation) and plane geometry (line segments, symmetry, congruence). Arithmetic subconcept includes integers (odd-even numbers). These findings can be integrated into mathematics learning through the development of ethnomathematics-based assessments oriented towards High Order Thinking Skills.

Kata Kunci: batik, ceplok kasatrian, conservation, ethnomathematics, mathematical concepts

Cara mengutip artikel ini:

Santosa, Y. T., dkk. (2025). Ethnomathematics and Batik Cultural Conversation: A Qualitative-Ethnographic Study of Mathematical Concepts in Batik Ceplok Kasatrian. *Symmetry: Pasundan Journal of Research in Mathemetics Learning and Education.* 10(1), hlm. 1-20

INTRODUCTION

Indonesia has a diverse cultural richness, one of which is batik, a traditional textile art that reflects the ancestral heritage and national identity (Febriani et al., 2023; Hakim, 2018; Luthfia & Dewi, 2021; Munir, 2021). Batik is a traditional Indonesian textile art made through colour-blocking techniques using paraffin and has an important function in national and traditional official events (Musman & Arini, 2011; Setiyanto & Fuad, 2024; Susanto,

2018). In the international arena, batik has been recognized by UNESCO as an Intangible Cultural Heritage since October 2, 2009, which has made batik increasingly known in diplomacy and world fashion shows because of its beauty, symbolic meaning, philosophical value, and diversity of motifs (Hastangka, 2013; Irwan, 2024). The diversity of batik motifs in each region of Indonesia enriches the peculiarities of local culture, one of which is the Ceplok motif, some of which are Sriwedari (see Figure 1), Kawung (see Figure 2), and Kasatrian (see Figure 3), which are differentiated based on flower motifs (Noverma, 2023). According to the results of an interview with Mrs Nita, a batik expert at Kampoeng Batik Kauman Surakarta, among the various Ceplok motifs that exist, Ceplok Kasatrian is the only motif that also features modern designs. Modern design lies in its complex floral motifs and rich detail, resembling a stacked flower or a more layered and ornamental flower crown, thus giving it a luxurious and elegant impression typical of contemporary styles. Because of its uniqueness, this research only focuses on Ceplok batik with Kasatrian motifs.

Figure 1. Ceplok Sriwedari

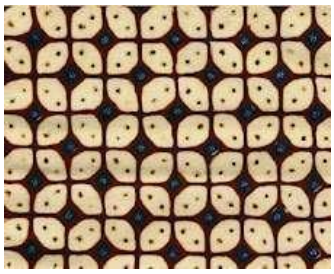


Figure 2. Ceplok Kawung

Figure 3. Ceplok Kasatrian

Batik Ceplok Kasatrian

Batik Ceplok Kasatrian is a typical batik of Surakarta, Central Java, which originally originated from the Yogyakarta Sultanate and developed in the Surakarta Sultanate (Musman & Arini, 2011). Hindu-Buddhist temple ornaments inspire the motif and have a close relationship with the palace environment, especially the character of the courtiers (Susanto, 2018). According to the results of an interview with Mrs Nita on March 10, 2025 (a batik expert in Kampoeng Batik Kauman Surakarta), this batik has characteristics in the form of floral motifs, gordo (garuda birds), and stars, which can be seen in Figure 4. It is dominated by soga, white, and blackish-blue brown colours that use natural dyes. These colours symbolize patience and courage (Rahayu et al., 2013). Philosophically, Batik Ceplok Kasatrian symbolizes courage, strength, devotion, and Sufism values and is worn by the people of the palace so that the wearer looks dashing and brave (Cendana, 2016; Susantio, 2012). In the general public, the groom-to-be often uses this batik before the wedding ceremony to symbolize chivalry and authority (Astriandini & Kristanto, 2021). Thus, Batik Ceplok Kasatrian batik is not only a traditional fabric but also a cultural heritage full of meaning, reflecting noble values of leadership and courage in people's lives.

Figure 4. Batik Ceplok Kasatrian Surakarta

Batik Ceplok Kasatrian Conservation Efforts

Currently, the Batik Ceplok Kasatrian motif is not only worn by the courtiers of the Surakarta Palace in traditional and religious events but has also been used by the general public because of its unique geometric patterns, distinctive motif details, and deep meaning that is believed to exude authority and charisma (Musman & Arini, 2011). Thus, Batik Ceplok Kasatrian has a significant role in the life of the Javanese people, especially in Surakarta. Therefore, it is appropriate for today's young generation to understand this motif's meaning and help preserve it.

In line with the opinion of Aini et al. (2024), the study of local culture plays a pivotal role in shaping national identity, preserving ancestral heritage, and fostering a sense of pride among younger generations. Furthermore, in the context of education, integrating local culture into learning helps students connect academic content with their own cultural environment, making the learning process more meaningful (Antara, 2023). Specifically, the exploration of Batik Ceplok—particularly the Kasatrian motif—serves not only as a means of cultural preservation but also as a bridge to understanding the philosophical values, symbolism, and aesthetic principles embedded in traditional Indonesian art. By studying Batik Ceplok Kasatrian, students are encouraged to appreciate the richness of their cultural heritage, recognize the significance of traditional symbols, and develop a deeper respect for local wisdom that is often overlooked in formal education.

Although the study of Batik Ceplok Kasatrian holds significant educational and cultural value, the reality shows that many students remain unfamiliar with its meaning and symbolism. This is accordance by several studies that highlight the low level of knowledge about local traditions and cultural symbols among Indonesian youth (Gadeng et al., 2024; Manurung et al., 2022). Specifically, in the case of traditional batik motifs, a study by Sidharta (2023) revealed that more than 60% of students in Surakarta could not distinguish between different types of batik patterns, and only a small fraction recognized the Ceplok motif. This is also supported by the opinion of Mrs. Nita (a batik expert at Kampoeng Batik Kauman Surakarta), who stated that many young people or students still do not know the Kasatrian batik and tend to wear it without understanding its meaning.

These issues indicate the need for conservation efforts through early introduction, one of which is through the education sector. In school, Batik Ceplok Kasatrian motif can be integrated into learning, especially mathematics, by exploring concepts such as geometry, algebra, arithmetic, statistics, and others. Teachers can use the results of these explorations as contextual learning media to help students understand abstract concepts through a culture-based approach (Dahoklory et al., 2023; Nurhasanah et al., 2022). This kind of approach is

known as ethnomathematics, which is the association of mathematical concepts with traditional cultures and practices of society, thus allowing for more meaningful and contextual learning in students' lives (Castro, 2024; Sabon & Telussa, 2024).

Ethnomathematics

Ethnomathematics was first introduced by Ubiratan D'Ambrosio in 1985 as an innovative approach that examines how mathematical concepts can emerge, develop, and be applied in the context of varied cultures and social practices (D'Ambrosio, 1985). Furthermore, Ishartono & Ningtyas (2021) describe ethnomathematics as a field that examines how cultural practices are connected to mathematical concepts and the teaching of mathematics. Through ethnomathematical approaches, mathematical concepts such as geometry, algebra, numbers, patterns, and other mathematical concepts can be better understood when placed in a specific cultural context known to the local community (Putra & Prasetyo, 2022). In this study, ethnomathematics is used to explore mathematical concepts contained in Batik Ceplok with Kasatrian motifs. The concepts may later be utilized to highlight Batik Ceplok Kasatrian as a representation of cultural heritage at the local and national levels. In addition, mathematics learning will be more contextual and meaningful and can increase students' appreciation of batik.

Previous Studies

Previous studies involving the exploration of mathematical concepts in batik have been conducted. Some of them were carried out by Risdiyanti & Prahmana (2017) explored Batik Yogyakarta, Andriani & Indri (2020) focused on Batik Ceplokan Yogyakarta, Faiziyah et al. (2021) regarding the exploration of Batik Surakarta, Ishartono & Ningtyas (2021) studying Batik Sidoluhur Surakarta, Permita et al. (2022) regarding the exploration of Batik Gringsing motif, Uula et al. (2024) related to the exploration of Batik Sidomulyo in Surakarta, and Nurcahyo et al. (2024) regarding Batik Tuntrum Surakarta. However, from these studies, no studies have been found that specifically explore the concept of mathematics in the type of Batik Ceplok Surakarta, especially the Kasatrian motif. Therefore, an in-depth study is needed to identify and analyze the mathematical concepts contained in the Batik Ceplok Surakarta with a Kasatrian motif. This research can promote the existence of Batik Ceplok Kasatrian to students at the elementary to high school levels through the mathematics learning process. The results of this exploration of mathematical concepts can also help mathematics teachers to convey mathematical concepts to be more contextual and realistic.

Based on the description, the formulation of the research problem that arises is how the process of analyzing mathematical concepts in Batik Ceplok Kasatrian and what are the mathematical concepts embedded in Batik Ceplok Kasatrian. Thus, the objective of this study is to explain the process of exploring mathematical concepts in Batik Ceplok Kasatrian and explore the mathematical concepts embedded in Batik Ceplok Kasatrian.

METHODS

This study uses a qualitative approach with ethnography design. The ethnography design was chosen because it aims to explore and interpret mathematical concepts embedded in cultural artifacts, specifically the Batik Ceplok Kasatrian. Ethnography is a qualitative research design that involves an in-depth study of cultural contexts to produce insights that can inform, reform, and transform society (Qutoshi, 2024). Furthermore, Prahmana & D'Ambrosio (2020) said that ethnographic studies begin with answers to four common

questions that are at the core of ethnographic research, namely "Where do I begin exploring?", "How can I discover it?", "How will I know if it has discovered something important?", and "How can I make sense of it?". Based on these four general questions, the ethnographic design in this study is presented in Table 1.

Table 1. Research Design

Questions	Preliminary Answer	Detailed Point	Focused Activity
Where do I begin exploring?	The observation process begins with examining the location, in this case, Batik Ceplok Kasatrian in Surakarta	Culture	Collecting information through interviews with individuals who have insights into Batik Ceplok Kasatrian in Surakarta
How can I discover it?	Observing and studying the motif of Batik Ceplok Kasatrian Surakarta directly	Alternative Thinking	1. Exploring the distinctive patterns and elements found in the Batik Ceplok Kasatrian motif 2. Exploring the mathematical elements represented in the Batik Ceplok Kasatrian Surakarta
How will I know if it has discovered something important?	Formulating conclusions based on previously processed alternative ideas	Involving philosophical perspectives in mathematics	1. Analyzing what mathematical concepts are contained in Batik Ceplok Kasatrian Surakarta motif. 2. Mathematical concepts can be discovered within the structure of the Batik Ceplok Kasatrian motifs.
How can I make sense of it?	This has significance both in terms of cultural preservation and mathematical understanding	Applying an anthropological methodological approach	1. Explaining the interconnection between cultural knowledge and mathematical concepts 2. Identifying mathematical concepts in Batik Ceplok Kasatrian motif

The subject of this study is Batik Ceplok, with a Kasatrian motif from the city of Surakarta. Meanwhile, the object of research to be studied is the concepts of mathematics in the Batik Ceplok Kasatrian. The mathematical concepts studied are based on four branches of mathematical science, which are in line with the opinion of Rubenstein & Schwartz (1999), namely geometry, algebra, arithmetic, and statistics.

The data in this study is qualitative. Data collection was carried out by observation, interview, and documentation techniques. Observations were carried out to identify the shapes and mathematical concepts contained in the Batik Ceplok Kasatrian Surakarta motif. The interviews used in this study were semi-structured to reinforce the findings of the observations. Interviews were conducted with four experts in the field of mathematics from a private university in Indonesia, consisting of one geometry, one algebraist, one arithmetician and one statistician. In addition, documentation techniques were used to record the interview process and document the observed Batik Ceplok Kasatrian motif.

Specifically in the interview technique, the researchers used the help of semi-structured interview instruments. The instrument consists of two components, namely 1) the occurrence of mathematical concepts in Batik Ceplok Kasatrian and (2) the potential of using Batik Ceplok Kasatrian as a context for teaching mathematics. (geometry, algebra, arithmetic, and statistics). Then, the instrument has been validated by two experts in the field of mathematics and mathematics education and declared valid.
The validity of the data is carried out using source triangulation. In this study, the researcher compared the researchers' assumptions related to the concept of mathematics in Batik Ceplok Kasatrian with the viewpoints of experts in the fields of geometry, algebra, arithmetic, and statistics. This triangulation aims to ensure the consistency of findings and increase the credibility of research results. Then, the data analysis used Miles and Huberman's qualitative data analysis, which included reduction, presentation, and drawing of data conclusions (Miles et al., 2014).

RESULTS AND DISCUSSION

Where do I Begin Exploring?

This research started with tracing the location of the existence of Batik Ceplok Kasatrian. Then, the researchers finally found that the batik could be found in Kampung Batik Kauman Surakarta, which is located at Trisula III Street, No.1, Kauman, Pasar Kliwon District, Surakarta in Central Java. Furthermore, the researchers carried out interviews with batik experts at the location to obtain in-depth information about the philosophy of Batik Ceplok Kasatrian, which includes the history, motif, philosophical characteristics, and uses of batik. The results of the interview have been explained earlier in the introduction. Morever, the researchers also gathered documentation to review samples of Batik Ceplok Kasatrian, which were then further analyzed in this research.

Figure 5. Interview Process with Batik Experts in Kampoeng Batik Kauman Surakarta

Based on the results of interviews and documentation, the Ceplok Kasatrian motif studied in this study is typical of Surakarta's Ceplok batik. However, the coloring technique adopts the Yogyakarta model coloring, which is characterized by a white or light background. Based on the batik expert's explanation, the main motifs contained in Ceplok Kasatrian consist of three main elements (see Figure 6), namely flower motifs (bold red), stars (circled in green), and gordho or garuda or Javanese eagle (circled in blue). Meanwhile, the fish and river motifs are only complementary motifs to fill the void in the batik.

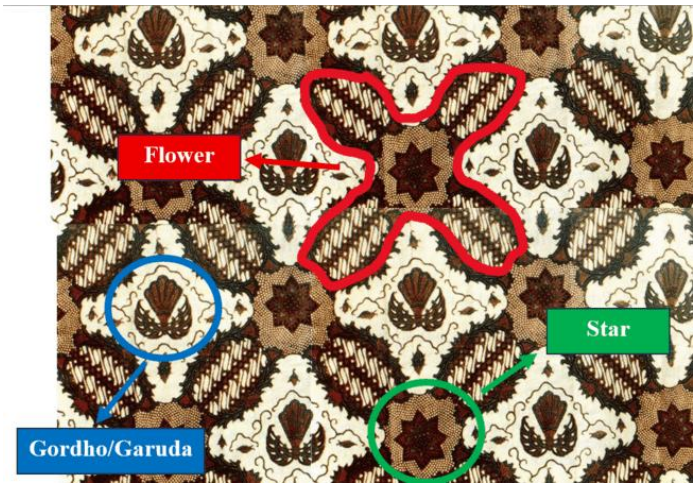


Figure 6. Primary Motif of Batik Ceplok Kasatrian

How Can I Discover it?

Based on the selected Batik Ceplok Kasatrian motif, the researchers then made observations to identify the mathematical concepts embedded in the batik. Researchers consisting of a team of four analyzed the relationship between the Batik Ceplok Kasatrian motif and the predetermined mathematical concept. A summary of the researchers' observations is presented in Table 2.

Table 2. Identification of Mathematical Concepts by Researchers

Concepts	Existence of Concept	Sub-Concepts	Topics
Geometry	Yes	Geometry Transformation	Reflection Rotation Translation Dilation
		Plane Geometry	Line Segment Line of Symmetry Congruence
Algebra	No	-	-
Arithmetic	Yes	Sequences and Series	Arithmetic Sequence
Statistics	No	-	-

How Will I Know if tt has Discovered Something Important?

Based on the results of the initial identification of mathematical concepts contained in Batik Ceplok Kasatrian, as shown in Table 2, only two mathematical concepts were found, namely geometry and arithmetic. In the concept of geometry, there are two sub-concepts, namely transformation geometry and plane geometry. Transformation geometry includes the topics of reflection, rotation, translation, and dilation. In comparison, plane geometry includes the topics of straight-line segments, symmetry, and congruence. Meanwhile, in the concept of arithmetic, one sub-concept is found, namely sequences and series, with the topic of arithmetic sequences.

Reflection

According to the results of the researcher's analysis, the sub-concept of transformation geometry on the topic of reflection can be seen in Figures 7 and 8. In transformation geometry, reflection is the displacement of geometric objects with equal distances between the point of the result of the reflection with the mirror and the starting point with the mirror (Akarsu, 2022). In Figure 7, if the star motif (circled in blue) is considered as the meeting point of each flower motif (bold red and yellow), then each point can be connected with a straight line (green), which will function as a reflection line, with the object of reflection in the form of a flower motif (red) and the result of the shadow is a flower motif (yellow) which is the same shape, size. Meanwhile, in Figure 8, the green straight line is the flower petal bone as the reflection line. At the same time, the garuda motif (circled in red) is reflected against the green line so that it produces a shadow in the garuda motif (circled in blue), or vice versa. These findings are in line with previous research that found the concept of geometric reflection in Batik Trusmi (Arwanto, 2017), Batik Indramayu (Sudirman et al., 2017), Batik Bali (Irawan et al., 2019), Batik Sidoluhur Solo (Ishartono & Ningtyas, 2021), and Batik Tuntrum (Nurcahyo et al., 2024).

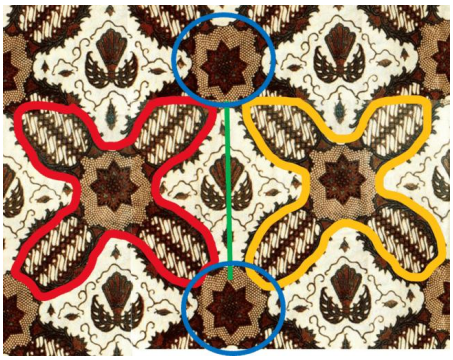


Figure 7. Reflection 1

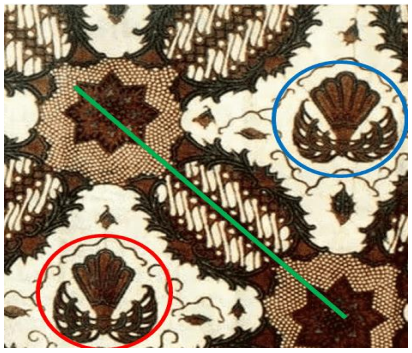


Figure 8. Reflection 2

Rotation

The topic of rotation in Batik Ceplok Kasatrian can be seen in Figure 9, especially in the180-degree rotation. A 180-degree rotation is a transformation that rotates a point or a flat 180 degrees around a certain point (Villiers, 2004). In Figure 9, the star motif (circled green) can be thought of as a central point of rotation. Then, the garuda motif (circled in blue) is rotated to the star motif so that the result of the shadow is the garuda motif (circled in red). This is also the case the other way around. This finding is in line with previous research that found the concept of 180-degree rotation geometry in Batik Gajah Oling (Hariastuti, 2016).

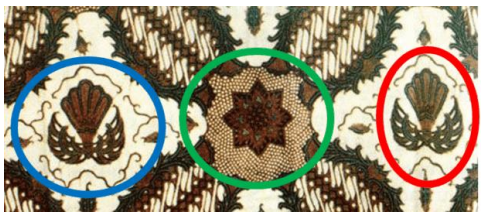


Figure 9. 180-degree Rotation

Translation

Another topic of transformational geometry is translation, which can be seen in Figures 10 and 11. Translation is transformation of geometry that shifts each point in a plane or space at the same distance in a certain direction (Biran, 2019). In Figure 10, each star

motif can be translated with a specific vector $V = \binom{a}{b}$, so that the same star motif shadow is produced without changing the orientation, shape, and size. For example, the star motif (circled in red) is translated by the vector $U = \binom{x}{y}$, so that the shadow is in the position of the yellow circled star motif, and so on. In Figure 11, the river motif (circled in red) can be translated with a certain vector so that it produces a shadow in the river motif (circled in green), and vice versa. These findings are in line with previous research that found the concept of geometric translation in Batik Tulis Sidoarjo (Lestariningsih, 2017), Batik Cikadu (Widyaningrum et al., 2022), and Batik Kawung Solo (Toha et al., 2023).

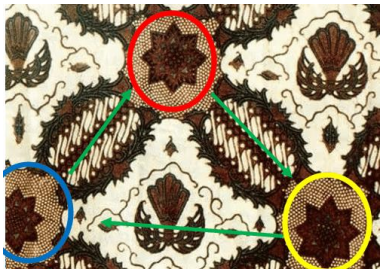


Figure 10. Translation 1

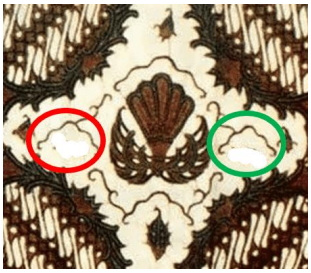


Figure 11. Translation 2

Dilation

The next topic of transformation geometry found is dilation can be seen in Figure 12. In transformation geometry, dilation is a transformation that changes the size of an object but does not change its shape (Martin, 1982). In Figure 12, the fish motif (circled in red) can be dilatated to the centre of the yellow garuda motif (as the centre of dilatation), with a factor k, so the fish motif (circled in green) is the result of the shadow of the dilation. Then, the river motif (circled in red) can also be dilated so as to produce a shadow in the river motif circled in green. These findings are in line with previous research that found the concept of geometric dilation in Batik Ceplok Sriwedari (Andriani & Indri, 2020), Batik Lontara (Mirdayanti et al., 2024), and Batik Tanggerang (Utomo et al., 2020).

Figure 12. Dilation

Line Segment and Line of Symmetry

The subconcept of plane geometry on the topic of line segment and line of symmetry can be seen in Figures 13 and 14, respectively. According to Nurhayati et al. (2019), a line segment is part of a straight line that has a base point and an endpoint. As for the line of symmetry, Conway et al. (2008) define it as the property of a flat body that allows the shape to be folded on a line in such a way that the two parts formed are perfectly close to each other. In Figure 13, it can be noted that the flower motif on the Ceplak Kasatrian batik has petal bones (coloured red and green) in the form of straight-line segments. Figure 14 shows that the two sides of the flower petals (checked blue and red) have axes or symmetrical lines

in the form of flower petal bones (given green colour). The petal bone divides the two sides of the flower (checked blue and red) into equal parts so that both sides can cover each other perfectly when folded. These findings are in line with previous research that found the concept of line segment and line of symmetry in Batik Paoman (Sudirman et al., 2018) and Batik Madura (Sari et al., 2021).

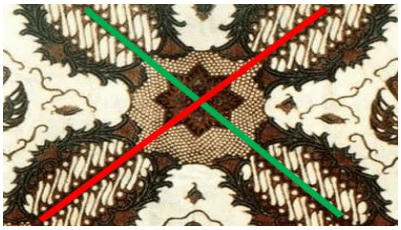


Figure 13. Line Segment

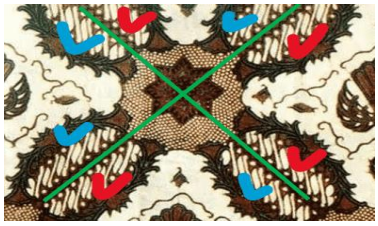


Figure 14. Line of Symmetry

Congruence

The topic of congruence in Batik Ceplok Kasatrian can be seen in all the motifs, ranging from flowers, garuda, stars, fish, and rivers. The flower motifs have the same size, angles, and shapes. Likewise, one garuda motif and the other garuda have the same shape, size, and so on. This is relevant to the concept of congruence that two objects are said to be congruent if they have corresponding sides and angles of equal length and size respectively (Cummins et al., 2005).

Arithmetic Sequence

The subconcept of sequences and series on the topic of arithmetic sequence can be seen in Figure 15. In each petal motif, there are dots in the form of holes that form an arithmetic sequence with the first term = 3, common difference = 1, and a number of terms = 4. Thus, the sequence formed are 3, 4, 5, and 6. This is in accordance with the concept of an arithmetic sequence, which is a row of numbers in which each number is obtained by adding or subtracting a fixed difference from the previous number (Sá & Louro, 2024).

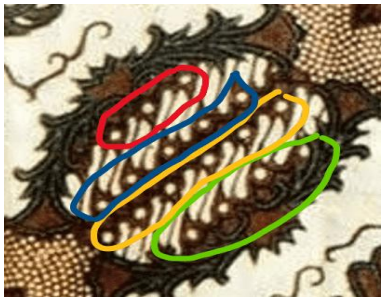


Figure 15. Arithmetic Sequence

How can I Make Sense of It?

The researchers have triangulated the data sources by comparing the researchers' assumptions regarding mathematical concepts in the Ceplok Kasatrian motif (found in Table 2) with the perspectives of experts in mathematics in the fields of geometry, algebra, arithmetic, and statistics. This triangulation is a step to test the validity of the data. The triangulation process was carried out by the walkthrough interview method, where the author communicated directly with the experts to compare the author's findings with the opinions of experts (Fitri & Prahmana, 2020). The researchers asked two basic questions, namely the

expert's point of view regarding the mathematical concept in the Batik Ceplok Kasatrian and whether the batik context can be used in mathematics learning.

Expert's Point of View Regarding the Mathematical Concept

Confirmation of the mathematical concept in the Batik Kasatrian Ceplok starts from the concept of geometry, which is consulted directly with the geometry expert. The expert expressed an understanding with the researchers regarding the concept of transformation geometry, especially on the topics of reflection (Figure 7), translation (Figures 10 and 11), and dilatation (Figure 12), as well as plane geometry such as line segment (Figure 13), line of symmetry (Figure 14), and congruence. However, there are differences of view in Figure 8 and Figure 9. According to the geometry expert, Figure 8 does not include reflection because it does not meet the characteristics of geometric reflection, namely, objects and shadows must form folding symmetry with a mirror line as the axis of symmetry (Rasmedi & Darhim, 2014). Meanwhile, the pattern in Figure 8 is more appropriately categorized as translation because it corresponds to the definition of translation that shifts each point in plane or space by the same distance and direction (Biran, 2019). In addition, the geometry expert also stated that Figure 9 does not include 180-degree rotation because if it is true that it is a 180-degree rotation, then the garuda motif should have undergone a change in orientation that shows the direction of the head downwards (Rasmedi & Darhim, 2014). On the contrary, the expert states that Figure 9 represents reflection by the principle of reflection in geometry (Akarsu, 2022).

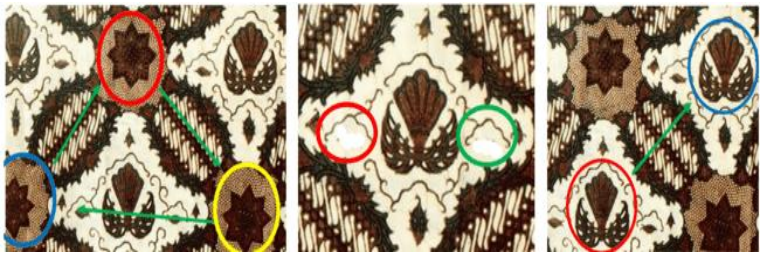
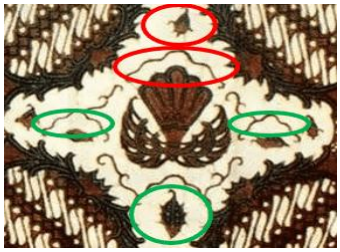
The second concept that was confirmed was algebra, which was directly asked to the algebra expert. In response to the first question, the expert has a point of view that is in line with the researchers that there is no algebraic concept found in the Batik Ceplok Kasatrian. This is also the same when the fourth concept, namely statistics, has been confirmed to the statistics expert that there is no statistical concept in the batik.

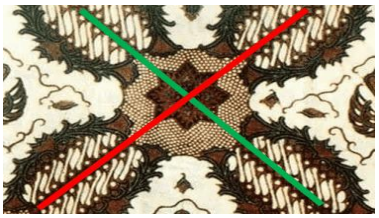
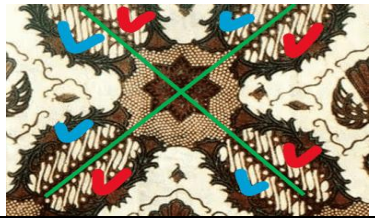
Then, the third confirmed concept is arithmetic, which is directly asked to the arithmetic expert. In response to the first question, the arithmetic has a different view than the researchers. According to the expert, if Figure 15 is included in the topic of arithmetic rows, then this is too forceful. The reason is that although the number of points formed is 3, 4, 5, and 6, the arrangement does not follow the pattern of arithmetic rows because they are not located sequentially. For example, the dots with numbers 3 and 5 are located on the left side of the petal bones, while the dots with numbers 4 and 6 are located on the right side of the petal bones. In the concept of arithmetic rows, each quarter in a row must be arranged in a certain order with fixed differences (Bourchtein & Bourchtein, 2022). However, in the dot pattern in Figure 15, the sequence of numbers does not correspond to the arithmetic sequence pattern because they are located in a systematic order. Furthermore, the expert added that Figure 15 makes more sense if it is categorized into the concept of odd and even numbers. The pattern that forms shows that the dots on the left side of the flower petal bones (3 and 5) are odd numbers, while the dots on the right side of the flower petal bones (4 and 6) are even numbers. Furthermore, Walle et al. (2017) explained that odd-even numbers are one of the topics in arithmetic.

Based on the exploration of mathematical concepts and the results of confirmation from experts, the Batik Ceplok Kasatrian motif contains two main subconcepts in geometry, namely transformation geometry and plane geometry. In the geometry of transformations, three main topics are found, namely reflection, translation, and dilation. Meanwhile, in plane geometry, the topics identified include straight-line segments, symmetry, and congruence. In addition, the concept of arithmetic is also found in this batik motif, especially in the

subconcept of integers with a focus on odd and even numbers. However, in the exploration carried out, no connection between the Batik Ceplok Kasatrian and the concept of algebra or statistics was found. Table 3 shows the mathematical concepts contained in the Batik Ceplok Kasatrian after data validation. Specifically, the topic of congruence can be seen in Figure 4 because all the object motifs contained in the Batik Ceplok Kasatrian contain the concept of congruence.

Table 3. The Final Mathematical Concepts Embedded in Batik Ceplok Kasatrian

No	Batik Motif	Mathematical Concepts
1		Reflection
2		Translation
3		Dilation
4		Odd and Even Numbers

5		Line Segment
6		Line of Symmetry

The Use of Batik Ceplok Kasatrian as a Context in Mathematics Learning

In response to the second question, geometry and arithmetic experts argue that the subconcepts of transformation geometry, plane geometry, odd and even numbers contained in the Batik Ceplok Kasatrian can be used in contextual mathematics learning. In transformation geometry, the geometry expert argues that teachers can visualize one of the objects of the Batik Ceplok Kasatrian using GeoGebra learning media. This is in line with research by Tamam & Dasari (2021), Hermawan et al. (2023) and Santosa et al. (2025), which shows that one of the benefits of using GeoGebra in mathematics learning is as a medium to demonstrate and visualize mathematical concepts so that students can understand transformations more concretely. Then, in plane geometry, the geometry expert argues that teachers can use the Batik Ceplok Kasatrian motif to introduce the concepts of straight line segments, symmetry, and congruence, for example, by inviting students to identify symmetrical lines on the batik motif.

Meanwhile, on the topic of odd and even numbers, the arithmetic expert argues that the motif of dots in Batik Ceplok Kasatrian can be used as a concrete representation to understand number patterns. The teacher can ask students to group the dots by number and then classify them as odd or even numbers. This is relevant to the opinion of Rif'at et al. (2024) and Suhendar & Rosita (2023), who stated that visual representations in mathematics learning can help students understand patterns and properties of numbers more intuitively.

Then, because there are no mathematical concepts relevant to algebra and statistics materials in the Ceplok Kasatrian motif, experts in the field conclude that these motifs cannot be used as a context in mathematics learning. This is in line with D'Ambrosio (1985) view that the concept of mathematics in a culture should not be artificially introduced. In other words, if indeed a mathematical concept is not present in a cultural product, then the cultural product cannot be imposed to be used as a context in teaching mathematical concepts that are not in it.

The Implementation of the Research Findings in Mathematics Instruction

The exploration of mathematical concepts in Batik Ceplok Kasatrian has revealed various geometric and arithmetic concepts that can be effectively integrated into mathematics learning. These findings can be used to develop ethnomathematical-oriented assessment tools, especially in designing Higher-Order Thinking Skills (HOTS) questions that are aligned with the cognitive levels of C4 (analyzing), C5 (evaluating), and C6 (creating) (Shalikhah et al., 2021). By incorporating batik patterns into mathematical

problem-solving, students can engage with real-world contexts that enhance their conceptual understanding. Given the complexity of the mathematical concepts involved, such as geometric transformations, the following example is designed specifically for junior or senior high school students (grades 8–10) who have learned about coordinate geometry and transformation. The following is an example of HOTS questions that can be presented to students.

The flower motif in Batik Ceplok Kasatrian not only depicts beauty but also balance and harmony of life. Suppose the flower motif is depicted in the coordinate plane, with the center of the petals at the coordinate points O(6, 5.5), and the four ends of the petals at the coordinate points A(2,1), B(10,1), C(10,10), and D(2,10).

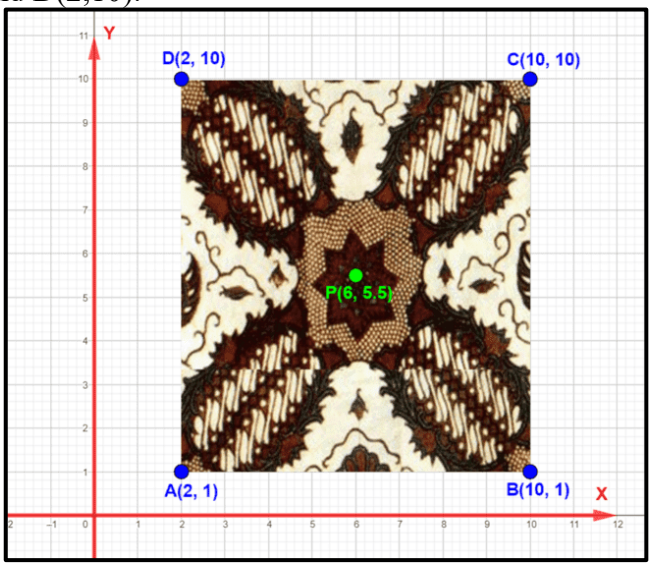


Figure 16. Coordinates of Flower Motif

To obtain a similar floral motif, this motif is reflected in such a way that the center of the flower moves to the coordinate point O'(6,-7.5). Determine the shadow coordinates of the four tips of the petals after they have been reflected (A′, B′, C′, and D′)! Explain how this transformation reflects the philosophy of balance in Ceplok Kasatrian batik!

The question is included in the HOTS category because students are not only asked to apply the reflection formula directly but also have to analyze the coordinate changes to determine the reflection line and then apply the line to another point. In addition, this question requires students to evaluate and relate the concept of reflection in mathematics to the philosophical context of Kasatrian batik, especially the idea of "balance and harmony of life." Thus, this question tests students' high-order thinking skills in analyzing, evaluating, and relating mathematical concepts to cultural values.

Research Limitation

This study has several limitations that need to be considered. First, it focuses exclusively on the Ceplok Kasatrian Batik motif, so the findings may not be generalizable to other batik patterns with different philosophical and structural characteristics. Second, the study is exploratory in nature, and it is possible that there are other mathematical concepts embedded in the motif that were not identified or captured in the current analysis.

Additionally, this study has not yet been implemented in actual classroom settings, so the practical impact of integrating this motif into mathematics learning remains to be examined. Given these limitations, further studies involving a wider variety of batik motifs and direct applications in educational contexts are necessary to better assess the effectiveness and broader implications of this approach.

CONSLUSION

As one of the efforts to preserve Batik Ceplok Kasatrian through mathematics learning, it is important to explore mathematical concepts that can be explored from the batik motif through an ethnomathematical approach. The exploration of these mathematical concepts uses ethnographic design, which is based on four main questions, namely, "Where do I begin exploring?", "How can I discover it?", "How will I know if it has discovered something important?", and " How can I make sense of it?". This process began with a visit to Kampoeng Batik Kauman Surakarta to take samples of Batik Ceplok Kasatrian and explore its philosophical meaning with batik expert. Furthermore, the researcher analyzed the mathematical aspects contained in the batik motif. The results of the analysis were then confirmed to mathematical expert as a form of triangulation and an effort to deepen understanding of the mathematical concepts contained in it. Based on the results of the exploration of the four mathematical concepts studied (geometry, arithmetic, algebra, and statistics), only two were found, namely geometry and arithmetic. Subconcepts of geometry include tranformation geometry (reflection, translation, and dilation) and plane geometry (straight line segments, symmetry, and consonance). Meanwhile, the subconcept of arithmetic covers integers with a focus on odd and even numbers. These findings have the potential to be used in mathematics learning, especially in the preparation of HOTS-based mathematics assessments that are integrated with the local culture of Batik Ceplok Kasatrian.

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