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Research Article

Systematics Literature Review: The Application of Ethnomathematics in Batik Art for Understanding Geometric Concepts

Yuli Bangun Nursanti* and Irene Chelsyana Febrianti

Sebelas Maret University, Indonesia

ORCID:
Yuli Bangun Nursanti: https://orcid.org/0000-0002-2386-8625

Abstract.
Ethnomathematics, which studies the application of mathematical concepts in a cultural context, can enrich understanding and enhance meaningful learning. This study aims to explore ethnomathematics in batik art as a foundation for developing a relevant and engaging mathematics curriculum. It employs a systematic literature review (SLR) approach to identify, review, and evaluate studies related to ethnomathematics in batik motifs that are published between 2017-2024. The findings indicate that various batik motifs contain geometric concepts such as transformations (translation, rotation, reflection), plane figures (square, rectangle, circle, triangle, rhombus, trapezoid), congruence, similarity, and graph theory. Batik motifs incorporate these concepts, making them an effective medium for teaching mathematics in a local cultural context. The integration of batik motifs into the mathematics curriculum is expected to make learning more relevant and engaging while enhancing students' appreciation of local cultural heritage.

Keywords: ethnomathematics, mathematics, geometric concepts, batik motif

Corresponding Author: Yuli Bangun Nursanti; email: yulibangununs@staff.uns.ac.id

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1. INTRODUCTION

Culture is the entire system of ideas, actions, and human creations in society through the process of learning. Culture encompasses all aspects of human life, from language, art, customs, and social systems to the values and norms upheld by society. In every culture, there are significant concepts of knowledge that can be interpreted, such as mathematical concepts (1). Mathematical objects have a socio-cultural-historical nature, making them part of community life and closely related to the culture and habits of society (2).

Mathematics in a cultural context is known as ethnomathematics, which studies how communities apply mathematical concepts in everyday life. Ethnomathematics is an approach that can be used to explain the reality of the relationship between

environmental culture and mathematics as a branch of knowledge (3). By applying ethnomathematics, people can enrich their understanding of mathematics as a universal and dynamic discipline, influenced by culture and ways of thinking.

Meaningful learning is key to achieving students' understanding of applying abstract and complex concepts. Through learning activities using the ethnomathematics approach, mathematics becomes more tangible, making it easier for students to understand mathematical material (4). For example, students can grasp concepts like reflection, translation, and rotation in geometry by applying them to batik patterns. This has been demonstrated in the study by Rizqi & Lukito (5), titled Exploration of Ethnomathematics in Batik Motifs in Kampoeng Batik Jetis Sidoarjo.

Batik is one of Indonesia's traditional textile arts recognized worldwide. Batik motifs not only have high aesthetic value but also contain many mathematical concepts, particularly in geometry. Batik motifs depict geometric shapes such as squares, parallelograms, rhombuses, triangles, rectangles, and circle. Furthermore, batik can help students understand geometric concepts such as straight lines, curved lines, parallel lines, symmetry, angles, and similarity (6).

The integration of ethnomathematics in batik art can be an innovative teaching strategy for understanding geometric concepts. By incorporating batik art into geometry instruction, students can more easily grasp geometric concepts in a real-world and culturally relevant context. Additionally, this approach can increase students' appreciation of local cultural heritage and provide a more enjoyable and meaningful learning experience. It can create more enjoyable and meaningful learning experiences while strengthening cultural identity and local wisdom through (7).

The ethnomathematics approach in batik art also has the potential to address several challenges in mathematics education. One such challenge is the gap between theory and practice. Students often find it difficult to connect abstract mathematical concepts with the real world. Research by Soebagyo et al. (8) shows that ethnomathematics can make mathematics learning more effective and enjoyable, as well as improve students' mathematical abilities. View that ethnomathematics-based mathematics instruction is effective in enhancing students' understanding in identifying, translating, interpreting the meaning of symbols, comprehending and applying mathematical ideas, and exploring (9).

Therefore, this study aims to explore ethnomathematics in batik art as a foundation for developing a mathematics curriculum that is not only engaging but also relevant to

everyday activities. This is expected to create a more interactive and enjoyable learning environment, as well as provide a deeper and more significant educational experience while integrating cultural values that contribute to shaping students' character in the learning process.

2. METHOD

The approach used in this study is the Systematic Literature Review (SLR). This method aims to identify, review, and evaluate all relevant research to answer the established research questions. The study was conducted from May to June 2024 in Surakarta. The stages of this research include formulating the research problem, conducting a literature search, establishing inclusion and exclusion criteria, selecting the literature, presenting the data, processing the data, and drawing conclusions (10).

In this research, two questions were formulated: 'What batik motifs have been studied in ethnomathematics research?' and 'What mathematical concepts are found in batik motifs?' The literature search was conducted using Google Scholar with keywords such as Ethnomathematics, Mathematics, Geometric Concepts, and Batik Motifs. The selected literature was limited to articles published between 2017 and 2024.

The inclusion criteria used for the literature search include studies related to mathematical concepts in batik motifs, with research findings published in journals or national seminar proceedings. The next step involved selecting and analyzing the obtained literature based on inclusion and exclusion criteria. A total of 147 articles related to the keywords were found, and the articles were further filtered based on the criteria, resulting in 20 articles.

Subsequently, the researchers will organize the articles into a table for detailed review and analysis, particularly focusing on the research findings. Finally, the researchers will compare the findings and draw conclusions.

3. RESULTS AND DISCUSSIONS

After conducting the literature search, 20 articles on ethnomathematics in batik motifs were obtained, as presented in Table 1:

Table 1: Description of Literature Related to Ethnomathematics in Batik Motifs.

No	Researcher	Journal Title	Research Findings
1	Fachrunnisa & Sari (2023)	Ethnomatematics: Exploration of Geometric Transformation Concepts in Melati Batik from Kebon Village, Bayat	Melati Batik applies geometric transformation concepts in the making of traditional batik from Kebon Village, Bayat. The Melati Batik features translation concepts in the garuda and leaf motifs, rotation concepts in the garuda and leaf motifs, and reflection concepts in the jasmine flower and leaf motifs. (11)
2	Maulida, Faiza, & Zuliana (2023)	Exploration of Ethnomathematics in Kudus Batik Motifs, Central Java	Kudus Batik motifs incorporate various aspects of mathematics that reflect cultural meanings and specific uses, such as Islamic culture and the distinctive flora of the Kudus region. The motifs display geometric concepts like congruence and harmony related to ethnomathematics. Kudus Batik can be used as a reference in mathematics teaching, as it contains mathematical cultural elements that can be studied by researchers and subjects, such as square and rectangle shape. (12)
3	Aini, Wulandari, & Zuliana (2023)	Exploration of Ethnomathematics in Mlatiharjan Batik, Demak, Related to Elementary School Geometric Concepts	Mlatiharjan Batik from Demak contains ethnomathematical elements related to plane geometry, such as circles, squares, rectangles, triangles, rhombuses, and trapezoids. This batik has philosophical meanings tied to the life of the Demak community, as well as mathematical plane geometry concepts. (13)
4	Subekhi, Nindiasari, & Sukirwan (2021)	Ethnomathematics: A Review of Geometric Aspects in Lebak Batik, Banten Province	Lebak Batik from Banten contains mathematical geometric aspects such as plane shapes and graph theory. The batik represents plane shapes like rhombuses, rectangles, circles, and triangles. Additionally, the graph theory found in this batik is the star graph. (14)
5	Suciaty, Dewi, Nurfadilah & Santoso (2019)	Application of Ethnomathematics in Majalengka Batik Motifs Using Geometric Transformation Concepts	Majalengka Batik motifs are linked to geometric concepts such as reflection, rotation, translation, and plane shapes like rectangles, triangles, semicircles, and rectangles. (15)
6	Yudianto, Susanto, & Priciliya (2020)	Ethnomathematics in Cassava Leaf Painted Batik at Daweea Batik Production House, Bondowoso	Ethnomathematics in Cassava Leaf Painted Batik includes geometric elements such as points, lines, angles, plane shapes (rectangles, squares), similarity, congruence, equations, and geometric transformations (dilation). (16)

Table 1: Continued.

No	Researcher	Journal Title	Research Findings
7	Afifah, Putri, & Listiawan (2020)	Exploration of Ethnomathematics in Gajah Mada Batik Motif Sekar Jagad, Tulungagung	Gajah Mada Batik with Sekar Jagad motif from Tulungagung is closely related to mathematical concepts such as plane shapes (parallelograms, ellipses, and rhombuses), geometric transformations (reflection), and angles (obtuse angles, parallel lines, opposite angles, corresponding angles, alternate interior angles, alternate exterior angles, same-side exterior angles, and same-side interior angles). (17)
8	Syam & Pujiastuti (2023)	Exploration of Ethnomathematics in Cilegon Batik Motifs from a Geometric Perspective	Geometric concepts found in Cilegon Batik motifs include points, lines, parallel lines, curved lines, angles, blocks, triangles, squares, rectangles, rhombuses, ovals, congruence, similarity, reflection, rotation, and translation. (18)
9	Karimah, Kusuma, & Noto (2021)	Ethnomathematics: Analysis of Geometric Systems in Trusmi Batik Motifs, Cirebon	There is a correlation between Trusmi Batik motifs and geometric transformation concepts. (19)
10	Khalisah & Nalim (2022)	Study of Ethnomathematics and Geometric Concepts in the Local Cultural Wisdom of Pekalongan Batik	Ethnomathematics in Pekalongan Batik integrates analytic geometry concepts (equations of straight lines, similarity of plane shapes, circles, and triangles) and geometric transformations (reflection, translation, rotation, and dilation). (20)
11	Prahmana & D'Ambrosio (2020)	Learning Geometry And Values From Patterns: Ethnomathematics On The Batik Patterns Of Yogyakarta, Indonesia	This study's results indicate that in Yogyakarta batik, it uses the concept of geometry transformation in the making of Yogyakarta's unique Batik motif. Besides that, each motif or pattern also contains local values. These, namely moral, historical, and philosophical values, can be felt, reflected, and applied in daily life, such as values that teach leadership, good deeds, and so on. (21)
12	Faiziyah et al. (2021)	Ethnomathematics: Mathematics in Batik Solo	Some Batik Solo motifs contain mathematical elements, especially geometric material, namely the principles of translation and reflection. Besides, that there are vertical and horizontal lines as well as perpendicular and parallel lines included. The mathematical concept, especially the geometry used in the making of Batik, is the use of the tessellation or tiling principle. The tessellation principle is the basis for the development of the Solo batik motifs. (22)
13	Risdiyanti & Prahmana (2017)	Ethnomathematics: Exploration in Javanese Culture	The result is exploration ethnomathematics in the several motifs of Yogyakarta batik that contains philosophy, deep cultural value, and mathematics concept, especially geometry transform subject. (23)

Table 1: Continued.

No	Researcher	Journal Title	Research Findings
14	Pramudita & Rosnawati (2019)	Exploration of Javanese Culture Ethnomathematics based on Geometry Perspective	Batik motifs (Lereng, ceplok, and Jlamprang) are ethnomatematics related to lines and angles, triangles and quadrilaterals, circles. Ethnomatematics in Joglo homes can be associated with line and angle material, triangles and quadrilaterals, constructing flat side spaces, building curved, congruent and Pythagorean theorems. Ethnomatematics in horse-drawn carriages can be associated with constructing curved side spaces. (24)
15	Noerhasmalina & Khasanah (2023)	The Geometric Contents And The Values Of Local Batik In Indonesia	The outcomes of this observation imply that the human beings of Lampung utilize the idea of geometric transformation in making batik motifs, which include theSigermotif,pohon hayat motif, andkapalmotif. The idea of geometric transformation used is reflection, dilation, and translation. (25)
16	Lestari, Irawan, Rahayu, & Parwati (2018)	Ethnomathematics Elements In Batik Bali Using Backpropagation Method	Etnomatematics in Batik Bali is more to geometrical concept in line of strong Balinese culture element. The identification process is use backpropagation method. Steps of backpropagation methods are image processing (including scalling and tresholding image process). Next step is insert the processed image to an artificial neural network. This study resulted an accuracy of identification of batik Bali that has Etnomatematics elements on it. (26)
17	Kumala & Tsabitah (2022)	Ethnomatematics: Learning Geometry From Banyumas Batik Patterns	The mathematical concepts identified in Batik Banyumas are the concept of points, line segments, flat constructs (isosceles triangles, parallelograms, rectangles, rhombuses, and circles), congruence and similarity, as well as geometric transformations (translation, reflection, dilatation, and rotation). The results of this study can be used as a reference for teachers in the application of contextual learning related to learning resources that come from the environment around students and as an explanation to students that mathematics learning can connect to the culture around students, namely the batik Banyumas. (27)

Table 1: Continued.

No	Researcher	Journal Title	Research Findings
18	Septiadi et al. (2023)	The Exploration of Geometrical Concept in Batik Pamekasan	Mathematical motifs in Batik Pamekasan, such as points representing rice or maize seeds, hold philosophical significance. Reflection symbolizes the balance needed in human life. Each mathematical object within the pattern has its own meaning. Geometrical objects in Batik Pamekasan include two-dimensional shapes like circles, rectangles, squares, lines, points, angles, and curves. Additionally, transformative geometry, such as rotation, reflection, and translation, is also present. (28)
19	Meifiani (2022)	The Ethnomathematics of Batik Pace In Geometry Transformation Subject	The findings of this research are in a piece of Kupu Tarung motive of Batik Pace contained the concepts of Reflection, Translation, Rotation, and Dilation. (29)
20	Nurcahyo, Ishartono, Pratiwi, & Waluyo (2024)	Exploration on Mathematical Concepts in Barik Truntum Surakarta	The findings confirm geometry as the primary concept, including transformations (translation and reflection), line relationships (alignment), and planar geometry (circles). The study aims to connect the millennial generation to batik as an essential part of Indonesia's cultural heritage, helping to prevent cultural erosion amid technological advancements by highlighting the mathematical elements in batik. (30)

After reading the title, abstract, and overall content of the literature, a description of the ethnomathematics of batik in geometric concepts that meets the inclusion and exclusion criteria was obtained. In general, the number of published literature in 2017 was 1 article, in 2018 was 1 article, in 2019 were 2 articles, in 2020 there were 3 articles, in 2021 there were 3 articles, in 2022 there were 3 article, in 2023 there were 6 articles, and in 2024 there was 1 articles.

3.1. Batik Motis Explored in Ethnomathematics Research

Based on the description of the results above, information was gathered regarding the batik motifs explored in ethnomathematics research. Refer to **Table 2** below, which presents the description of the batik motifs that were explored.

Table 2: Analysis of Batik Motifs in Ethnomathematics Exploration.

Researcher	Explored Batik Motifs
Fachrunnisa & Sari (2023)	Motif Garuda, Motif Daun, and Motif Bunga Melati.
Maulida, Faiza, & Zuliana (2023)	Motif Batik Kaligrafi, Motif Batik Tambal Isen, Motif Batik Ciplokan Prijoto, and Motif Batik Kawung Kretek.
Aini, Wulandari, & Zuliana (2023)	Motif Bunga Jambu, Bledeg Masjid Sidomukti, Piring Champa, Masjid Agung Demak, Jambu Merah, Pohon Jambu, Jambu Belimbing, Karang Ikan, Mahkota Demak, and Motif Sidomukti Jambu Bulus
Subekhi, Nindiasari, & Sukirwan (2021)	Motif Gula Sakojor, Motif Pare Sapocong, Motif Caruluk Saruntuy, Motif Kahirupan Baduy, and Modif Sadulur.
Suciaty, Dewi, Nurfadilah & Santoso (2019)	Motif Batik Ngusep, motif Nyi Rambut Kasih, dan Motif Gapura.
Yudianto, Susanto, & Priciliya (2020)	Motif Batik lukis Daun Singkong
Afifah, Putri, & Listiawan (2020)	Motif Batik Sekar Jagad Tulungagung.
Syam & Pujiastuti (2023)	Motif Ani-Ani, Motif Kue Engkak, and Motif Ilir.
Karimah, Kusuma, & Noto (2021)	Motif Batik Tusmi, Motif Mega Mendung, Motif Parean Keris, Motif Rajeg Wesi, Motif Supit Urang, Motif Wadasan Lenggang Kangkung, Motif Kipas, and Motif Angkin.
Khalisah & Nalim (2022)	Motif Batik Jlamprang, Motif Semen Babaran Kanjengan, and Motif Kawung.
Prahmana & D'Ambrosio (2020)	Motif Babon Angrem, Motif Parang Barong, Motif Parang Klitik, Motif Sidomukti, Motig Semen Bodhat, Motif Sidoluhur, Motif Soblog, and Motif Sidowirasat.
Faiziyah et al. (2021)	Motif Parang, Motif Kawung, and Motif Sidomukti.
Risdiyanti & Prahmana (2017)	Motif Semen Rama, Motif Kawung, Motif Sido Asih, Motif Wahyu Temurun, and Motif Parang Pamor.
Pramudita & Rosnawati (2019)	Motif Lereng, Motif Ceplok, and Motif Jlamprang.
Noerhasmalina & Khasanah (2023)	Motif Siger, Motif Pohon Hayat, and Motif Kapal.
Lestari, Irawan, Rahayu, & Parwati (2018)	Motif Abyorhokokai, Motif Buketan, Motif Jagatan Pisang, Motif Singa Barong, and Motif UlamSari Mas.
Kumala & Tsabitah (2022)	Motif Serayu, Motif Lumbon, Motif Bumbon, Motif Rajang and Pring.
Septiadi et al. (2023)	Motif Batik Pamekasan.
Meifiani (2022)	Motif Kupu Tarung.
Nurcahyo, Ishartono, Pratiwi, & Waluyo (2024)	Motif Truntum, Motif Truntum Gurdo, and Motif Truntum Sri Kuncoro.

3.2. Geometric Concepts in Batik Motifs

Based on the description of the results above, information was obtained regarding the geometric concepts present in batik motifs. Refer to **Table 3** below, which presents the application of geometric concepts in batik motifs.

Table 3: Analysis of Geometric Concepts in Batik Motifs.

Researcher	Geometry Concepts
Fachrunnisa & Sari (2023)	The concepts of geometric transformation include translation, rotation, and reflection.
Maulida, Faiza, & Zuliana (2023)	The concept of plane figures includes squares and rectangles.
Aini, Wulandari, & Zuliana (2023)	The concept of plane figures encompasses circles, squares, rectangles, triangles, rhombuses, and trapezoids.
Subekhi, Nindiasari, & Sukirwan (2021)	The concept of plane figures includes rhombuses, rectangles, circles, and triangles. The graph theory concept includes star graphs.
Suciaty, Dewi, Nurfadilah & Santoso (2019)	The concepts of geometric transformation include reflection, rotation, and translation. The concept of plane figures includes rectangles, triangles, semicircles, and rectangles.
Yudianto, Susanto, & Priciliya (2020)	The concepts and elements of geometry include points, lines, angles, plane shapes (rectangles, squares), similarity, congruence, equations, and geometric transformations (dilation).
Afifah, Putri, & Listiawan (2020)	The concept of plane figures includes parallelograms, ellipses, and rhombuses. The geometric transformation concept is reflection. The concepts of angles and lines include obtuse angles, parallel lines, opposite angles, adjacent angles, interior opposite angles, exterior opposite angles, exterior adjacent angles, and interior adjacent angles.
Syam & Pujiastuti (2023)	The concepts of points, lines, parallel lines, curved lines, angles, and solids. The concept of plane figures includes triangles, squares, rectangles, rhombuses, and ovals. Concepts of congruence and similarity. The concepts of geometric transformation include reflection, rotation, and translation.
Karimah, Kusuma, & Noto (2021)	The concepts of geometric transformation include translation, rotation, dilation, and reflection.
Khalisah & Nalim (2022)	The concept of linear equations and similarity of plane figures includes circles and triangles. The concepts of geometric transformation include reflection, translation, rotation, and dilation
Prahmana & D'Ambrosio (2020)	The concepts of geometric transformation include translation and reflection.
Faiziyah et al. (2021)	The concepts of geometric transformation include translation and reflection.
Risdiyanti & Prahmana (2017)	The concepts of geometric transformation include translation and reflection.
Pramudita & Rosnawati (2019)	The concepts of geometric include line, angle, and square.
Noerhasmalina & Khasanah (2023)	The concepts of geometric transformation include translation, reflection, and dilatation.
Lestari, Irawan, Rahayu, & Parwati (2018)	The concepts of backpropagation method include scalling and tresholding.
Kumala & Tsabitah (2022)	The concept of points, line segments, flat constructs (isosceles triangles, parallelograms, rectangles, rhombuses, and circles), congruence and similarity, as well as geometric transformations (translation, reflection, dilatation, and rotation)

Table 3: Continued.

Researcher	Geometry Concepts
Septiadi et al. (2023)	The concept geometrical objects are two-dimensional figures such as circles, rectangles, squares, lines, points, angles, and curves. The transformative geometry like as rotation, reflection, and translation
Meifiani (2022)	The concepts of Reflection, Translation, Rotation, and Dilation.
Nurcahyo, Ishartono, Pratiwi, & Waluyo (2024)	The concept of transformation geometry includes translation and reflection, while the study of line relationships involves line alignment, and planar geometry covers the topic of circles.

Based on the literature review, there are 20 articles related to ethnomathematics in batik motifs, which depict various geometric concepts found in traditional Indonesian batik patterns. The results of this review show that ethnomathematics has been widely applied in batik motifs, linking cultural heritage with mathematical concepts.

Several batik motifs that were studied include Garuda, Melati, Kudus, Demak, Lebak, Majalengka, and others. These motifs reflect various geometric concepts, such as plane shapes, including triangles, circles, rectangles, rhombuses, and trapezoids, which are fundamental in geometry. Additionally, these motifs also demonstrate the application of geometric transformations such as translation, rotation, reflection, and dilation. This shows that batik is rich in mathematical concepts that can be explored and utilized in mathematics education. Exploration of ethnomathematics in batik motifs has a positive impact on improving students' learning effectiveness, increasing motivation, self-confidence in learning, as well as their conceptual understanding skills Yolanda & Putra (31).

Many batik motifs reviewed apply geometric transformations. For example, the Melati Batik motif from Kebon Village contains the concepts of translation, rotation, and reflection in its pattern. Similarly, Kudus Batik employs geometric congruence and harmony, while the Mlatiharjan Batik from Demak includes flat geometric concepts such as circles, rectangles, and rhombuses. This research shows that transformations like reflection and rotation are commonly found in various batik designs, demonstrating how traditional art incorporates mathematical concepts. This aligns with the opinion of (32), who stated that mathematical concepts can serve as a source for learning mathematics and can be applied in mathematics education, particularly in the teaching of geometric transformations.

In addition to the application of geometry, batik motifs also carry philosophical and cultural meanings. For instance, the Kudus Batik motif reflects Islamic culture and local

flora, while Lebak Batik from Banten Province symbolizes the philosophical values of the Baduy tribe. These values are often related to balance, harmony, and togetherness, providing a rich cultural context that makes the study of ethnomathematics in batik highly meaningful.

These findings indicate that batik motifs can be a valuable teaching resource in mathematics education. By incorporating these traditional motifs into the curriculum, teachers can create contextual learning experiences that are relevant to students' cultural heritage. Through ethnomathematics, students can understand that mathematics is not only found in textbooks but also in the cultural heritage they encounter in their daily lives (33). This can make mathematics more engaging and relevant, bridging the gap between abstract concepts and real-world applications. For example, batik patterns can be used to teach geometry, transformations, and even graph theory, such as the star graph found in Lebak Batik.

These geometric concepts are integrated into school mathematics learning, allowing students to realize that mathematics is close to them and they can directly observe its applications in everyday life (34). By using contexts familiar to students in mathematics learning, it is hoped that students will better appreciate the beauty of mathematics while also learning about cultural heritage (35).

4. CONCLUSION

The application of ethnomathematics in batik motifs offers a rich pathway for both cultural preservation and mathematical education. The reviewed articles present various batik designs from different regions, each with unique geometric characteristics that highlight the connection between art and mathematics. Each batik motif has its own uniqueness in integrating geometric concepts. The dominance of geometric concepts in batik lies in the topic of geometric transformations. These concepts provide structure and symmetry to batik designs, which not only have aesthetic value but also carry mathematical meaning. In addition to geometric transformations, concepts such as plane figures, congruence, similarity, and graph theory are also frequently found in batik motifs. This demonstrates that various geometric elements can be found and analyzed in the art of batik.

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