EXPLORATION OF THE CONCEPT OF GEOMETRIC TRANSFORMATION IN BATIK NITIK YOGYAKARTA

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ABSTRAK

Etnomatematika merupakan hubungan timbal balik antara matematika dan budaya. Pembelajaran matematika yang dikaitkan dengan budaya masih minim adanya, bahkan guru saja masih kesulitan dalam implementasinya. Di sisi lain penerapan ethnomatematika dapat memudahkan pemahaman dan peningkatan pembelajaran siswa karena budaya sendiri sudah erat dengan lingkungan sekitar. Tujuan penelitian ini adalah untuk mengetahui konsep transformasi geometri pada Batik Nitik Yogyakart. Metode yang digunakan dalam penelitian adalah metode etnografi yang digunakan untuk mengamati dan mendeskripsikan Batik Nitik Yogyakarta. Hasil penelitian menunjukkah bahwa Eksplorasi Geometri Batik Nitik Yogyakarta dengan konsep etnomatematika ditemukan konsep-konsep matematika yang dapat dijadikan suber belajar khususnya pada materi geometri transformasi seperti, simetri lipat, refleksi, rotasi, dilatasi.

Kata kunci: Batik, batik nitik, batik Yogyakarta, etnomatematika, transformasi geometri

ABSTRACT

Ethnomathematics is a reciprocal relationship between mathematics and culture. Mathematics learning that is linked to culture is still minimal, and even teachers still have difficulty implementing it. However, on the other hand, the application of ethnomathematics can make it easier for students to understand and improve learning because culture itself is closely related to everyday life. The aim of this research is to examine the concepts of Geometric Transformation in Batik Nitik Yoyakarta. The method used is an ethnographic method used to observe and describe Batik Nitik Yogyakarta. The results of the research show that the Yogyakarta Nitik Batik Geometry Exploration using ethnomathematics concepts found mathematical concepts that can be used as learning resources, especially in transformation geometry material such as folding symmetry, reflection, rotation, dilation.

***Keywords** : Batik, batik nitik, ethomathematics, geometrics transformation*

INTRODUCTION

Education and culture cannot be separated, like two sides of a coin, they support and strengthen each other. Culture is the basis of educational philosophy, while education is the main guardian of culture, because the role of education is to shape people to be cultured. Education and culture are a complete, comprehensive and applicable unity in society, apart from that, education is also a basic need for every individual in society, so that both cannot be avoided in everyday life (Bahrul Ulum et.al, 2018)

In school learning, almost all material is related to the culture in this country, one of which is mathematics. Mathematics is a branch of science that is used to solve everyday problems, including cultural ones (Feni, Aan, 2022). Culture-based learning in mathematics is an innovation that eliminates the fact that mathematics learning tends to be rigid, mathematics is linked to culture and becomes something interesting and more flexible. Ethnomodoling is one of the right methods to help mathematical innovation in culture.

One culture that stands out is batik. Batik is one of Indonesia's cultural heritages which has been recognized by UNESCO since October 2 2009. Apart from language, flag colors, national songs, customs, regional clothes and national symbols, batik has also become one of the identities and identity of the Indonesian nation, through world batik the outside will know where we come from (Asih Retno, 2022).

Some definitions of batik from experts, practitioners and observers of batik are as follows:

1. According to Murdijati - Gardjito, et.all stated that batik can be said to be a cultural symbol that creates identity for the Indonesian nation through various symbolic meanings written or depicted on a piece of cloth.
2. According to Komarudin Kudiya, batik is a form of traditional artistic expression of a region which shows traces of meaningfulness in the Indonesian cultural treasures and batik is also a cultural expression of the

crystallization of human experience so that it ultimately becomes the personality identity of a group of people or personally.

3. According to GBRAY. Murywati S. Darmokusumo, batik is a track record of history's journey from time to time related to power, extraordinary events or natural events - volcanic eruptions - wars and so on, the natural richness of a region's decoration, flora and fauna, history of environmental conditions which is applied as illustrative evidence on a piece of cloth.
4. According to Afif Syakur, batik behind the long and detailed manufacturing process in forming motifs that have symbols of noble philosophy also has a symbolic meaning for the wearer to become a noble person from birth until the end of his life.

From the four definitions above, we can conclude that batik can be said to be the identity of the Indonesian nation and the personality of a group of people or personally, as a trace of meaningfulness in Indonesia's cultural treasures and historical track record. Apart from that, the motifs formed have symbols of noble philosophy and are cultural expressions or extraordinary events.

This research examines the concept of geometric transformation in the Yogyakarta Nitik Batik motif. Teachers can use batik in mathematics learning to introduce mathematical concepts such as geometric transformations of plane shapes, fold symmetry, rotational symmetry, translation, dilitation, reflection, rotation, and many more. Based on the description above, the researcher considers it necessary to study the concept of geometric transformation in batik motifs, as a special view of mathematics that is owned and practiced by the general public regarding batik patterns. It is hoped that the results of this research can be used in the world of education, especially mathematics learning.

This research is a qualitative study using ethnographic methods, ethnographic methods are often used in the field of culture and emphasize the big picture of what happens in surgery or certain situations. Ethnographic research is used to observe and describe culture related to Batik Nitik Yogyakarta, overall the subject of this research is information, Batik Nitik cloth. The research stages used were fielding,

selecting information, interviews, analyzing data and providing an explanation of the research results.

This research was conducted at the Griya Slendang Batik Production House, Buaran Village, South Pekalongan District, Pekalongan City. Data collected through observation, documentation, interviews and literature techniques. The observation used is an unstructured observation which aims to describe Yogyakarta nitik batik through geometric transformation. The next step is conducting interviews with informants, namely craftsmen and batik observers. The data obtained was then processed and the data was checked against the data source using the triangulation technique. Apart from that, this technique was also carried out by mathematics education experts to validate the results of the analysis, that the results of the research on the concept of geometric transformation in Batik Nitik Yogyakarta were in accordance with mathematical concepts.

DISCUSSION

One of the batiks that has high value and is spread throughout the world is Batik Nitik. According to Barokah, Nitik batik has its own characteristics, namely the edges of the motif on Nitik Batik must have a speckled motif, apart from that, the canting process is not like the canting process in general but looks more like it is dotted. According to him, Batik Nitik also only exists in the Yogyakarta area, but if you look at it at first glance, it is similar to Batik Jlamprang Pekalongan, only Batik Nitik is simpler in coloring, namely only using one or two colors and tends to use dark colors (black, white, soga/brown). , different from Jlamprang Batik which uses more than two colors and uses bright colors.

Figure 1. Yogyakarta Nitik Batik Motif belonging to Afif Syakur

1. Sekar Rambutan	43. Sekar Pijetan
2. Mountain Claw	44. Nitik Rumpuk
3. Sekar Menur	45. Nitik Grumpul

4. Cube
5. Sekar Cendul
6. Sekar Sadeh
7. Broken Twig
8. Puddle
9. Truntum Brackets
10. Sekar Munduh
11. Sekar Keben
12. Sekar Cendul
13. Ceprettruntum
14. Sekar Duren
15. Nitik Rumpuk
16. Sekar Blimbing
17. Keket
18. Kartiko
19. Sarimulat
20. Cross
21.Sekar Ketongkeng
22. Sekar keniker
23. Sekar Boyfriend
24. Sekar kenongo
25. Sekar Uring
26. Sekar Miati
27. Dindhe Willis
28. Sekar Kepel
29. Corn Husk
30. Sekar Jali
31. Rengganis
32. Sritamat
33. Kawun Nitik
34. Sekar Mindhi
35. Manggaran
36. Sekar Soku
37. Sekar Untang
38. Sekar Menur
39. Krambyah
40. Sekar Gudhe
41. Sekar Gayam
42.SekarKemuning
46. Jonggrong
47. Dara Degree
48. Sekar Gambir
49. Chicken Claws
50. Jaya Kosumo
51. Sekar Sawo
52.SekarArum Dalu
53. Grass
54. Dopo Bolong
55. Dragon Sari
56. Sekar Banga
57.Kawung Brandy
58. Potato Sekar
59. Mount Dopo
60. Clove Sekar
61. Bribilant
62. Joyo Kirono
63. Fragrant Panda
64. Sekar Jambe
65. Dopo Kurung
66. Mlinjo
67. Nuju Prono
68. Sekar Pace
69. Oneng
70. Orange Juice
71. Potato Sekar
72. Sekar Lombok
73. Karawitan
74. Sekar Kenanga
75. Mtik Kres
76. Sekar Mawar
77. Cucumber
78. Crack
79. Sekar Randu
80. Dopo Tanjung
81. Srengengeh
82. Sekar Lombok
83. Krempel
84. Dopo

In this research we examined fabric containing 84 Nitik Yogyakarta motifs. Apart from that, we also found the same journal and only discussed 60 Nitik Yogyakarta motifs. From this statement we can conclude that Nitik Yogyakarta batik has experienced development. If we look in detail at the Nitik Batik motif, there are mathematical concepts such as geometric transformations, namely mirror rotation, dilation, etc. as explained below.

1. Symmetry Concept in Nitik Batik Motif

The concept of symmetry used in this batik motif is folded symmetry. This can be done by first outlining the subject, usually drawing the outline first on paper. The Nitik batik motif which contains the mathematical concept of symmetry is as follows

1.1 Sekar Arum Dalu Motif

Figure 1.1.1 The concept of symmetry in the Sekar Arum Dalu motif

Figure 1.1.1 shows a symmetrical batik motif, with the thick line above showing the symmetrical axis of Sekar Arum Dalu. The symmetrical concept is found in many motifs other than this motif.

1.2 Sekar Pace motif

Figure 1.2.1 Symmetry concept in the Sekar Pace motif

Figure 1.2.1 Shows a symmetrical batik motif, with the thick line above showing the symmetrical axis of the Sekar Pace motif. The symmetrical concept can be found in many motifs other than this motif.

1.3 Cepretruntum Motif

Figure 1.3.1 The concept of symmetry in theCapretruntum motif

Figure 1.3.1 Shows a symmetrical batik motif, with the thick line above showing the axis of symmetry in the Cepretruntum motif. The symmetrical concept can be found in many motifs other than this motif.

1.4 Sekar Blimbing Motif

Figure 1.4.1 The concept of symmetry in the Sekar Blimbing motif

Figure 1.4.1 Shows a symmetrical batik motif, with the thick line above showing the axis of symmetry in the Sekar Blimbing motif. The symmetrical concept can be found in many motifs other than this motif.

2. Transformation Concept in Nitik Batik Motif

The Nitik batik theme also contains transformative concepts such as reflection, translation, rotation and dilation. Batik Nitik's research regarding the main concepts of batik is described as follows.

2.1 Reflections on the Nitik Grompol motif

Reflection is a type of geometric transformation where all points in a plane are moved geometrically to run in the same direction as a line (mirror) which is the same distance and twice the distance from the point to the mirror. In this motif, the left and right sides are drawn on a plane so that the concept of mirroring or reflection arises. Based on the results of this research analysis, the nitik grampol motif has a reflection concept.xy

Figure 2.1.1 Nitik Batik Motif

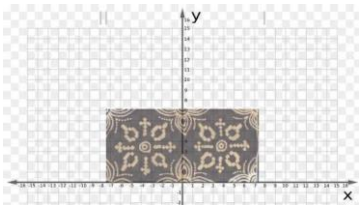


Figure 2.1.2 Reflections on the Nitik Grompol Motif

The theme of the Nitik Grompol motif reflects on the axis or . If the motif is located at A($yx = hx, y$)reflected from the axis or then the shadow completes the subject into a perfect theme. If point A is reflected on the axis , then the coordinates of the image are A'. If point A$yx = h(x, y)y(-x, y)(x, y)$reflected on the axis, then the coordinates of the image are $x = h$A').$(2h - x, y$When notated in mathematics then:

PointA(x, y) reflected by the axis, then the image coordinates are written as$y$A' is written with.$(-x, y)$

$$\text{A}(x, y)\text{A}' \xrightarrow{sumbu\ y} (-x, y)$$

QThe duck A(x,y) is reflected by the x = h axis, then the image coordinates are written asA') is written with.$(2h - x, y$

$$\text{A}(x, y)\text{A}') \xrightarrow{sumbu\ x=y} (2h - x, y$$

2.2 Dilation of the Cepretruntum Batik Motif

One type of transformation that appears in the Nitik Cepretuntrum motif is the concept of dilation like the motif below. The concept of dilation arises because the

size of the parts of an object increases or decreases. There are pictures that can clarify the concept of dilation in the Nitik Cempretuntrum motif, such as the picture.

Figure 2.2.1 Cepretrunrum motif

Figure 2.2.2 Dilation of the Cepretruntum motif

Based on the illustration above, it can be seen that in Figure 1, as the main object, the scale is reduced with shadows as in Figure 2, so we can conclude that the Dilation concept occurs because the main object (Figure 1), which is presented in the form of a flower, experiences a scale reduction so that the shadow object (Figure 2) is visible. smaller than the main object.

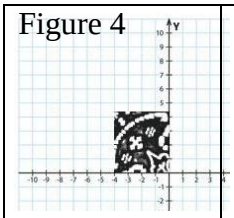
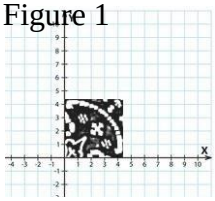
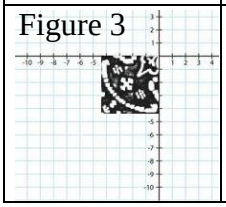
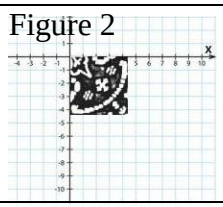
2.3 Rotation of the Nitik Sekar Blimbing Batik motif

In the sekar Blimbing motif we can find the concept of geometric transformation in the form of a rotation concept. Rotation is a transformation that moves a shape by rotating the point about its center point (Setyo & Ba'da, 2021). A rotation can be described as a positive rotation if it is done counterclockwise, while a rotation is said to be a negative rotation if it is done clockwise.

The concept of rotation in the Sekar Blimbing model is found in the rotation of each motif. If we illustrate the Sekar Blimbing motif by dividing it into planes xy, we can see that the motif rotates at a certain central point.

Figure 1 	Main object
Figure 2 	Shadow object

Figure 2.3.1 Sekar Blimbing Motif Figure

Figure 4 	Figure 1 
Figure 3 	Figure 2 

2.3.2 Rotation of the NitikSekar Blimbing Motif

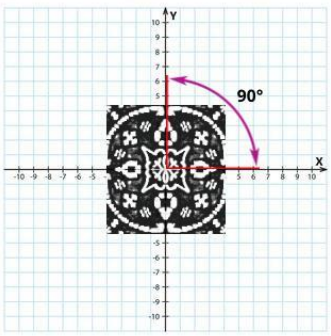


Figure 2.3.3 Rotation of the Nitik Sekar Blimbing Motif

Based on the concept of rotation, the displacement in the motif above is 90°. If the motif is located at the point$A(x, y)$and rotated about the point, the position of the next motif can be determined using the concept of rotation. If the concept is written in mathematical concepts then:$B(p, q)$

The point is rotated parallel to the center point and a point image is obtained and written as, the coordinates are:$(x, y)\alpha(p, q)A'(x', y')A'$

$A(x, y)A' \xrightarrow{D[A(a,b),a]} (x', y')$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \cos\alpha & -\sin\alpha \\ \sin\alpha & \cos\alpha \end{pmatrix} \begin{pmatrix} x-a \\ y-b \end{pmatrix} + \begin{pmatrix} a \\ b \end{pmatrix}$$

3. The concept of elliptical transformation in Nitik batik with Sekar Pace and Sekar Arum Dalu motifs

In arranging the Sekar Pace and Sekar Arum Dalu motifs, they form a cavity that looks like an Elliptical transformation concept. According to Rosa and Orey, Ethnomodeling is a pedagogical approach that connects cultural aspects of mathematics with dynamic aspects. Bassanezi and D'Ambrosio state that ethnomodeling is a process of elaborating problems and questions that grow from real situations that form a picture of meaning or a radicalized version of mathematics.

Figure 3.1 Sekar Pace motif

Figure 3.2 Sekar Dalu motif

If you approach the Sekar Pace and Sekar Arum Dalu motifs mathematically, they have the same concept as an ellipse. In the general formula, an ellipse has coordinate points. In this article, an Ellipse equation is used. From this equation, it is obtained that the vertex of the Ellipse S rotates about the center of rotation with a central angle of 45° with the major axis parallel to the axis as shown in the f

$x^2 + y^2 + ax + by + c =$
$0(0,0) S = x^2 + 4y^2 - 6x - 8y +$
$9 =$
$0(5,1), (1,1), (3,0)\ dan\ (3,2). P(a,b)\ x$

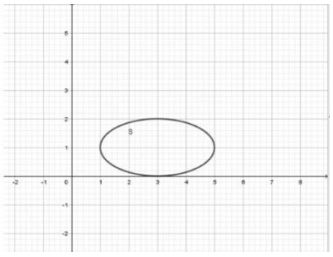


Figure 3.3 Illustration of an Ellipse

From the discussion above, it states that to arrange the motif by using a rotational transformation towards the center point with a rotation angle of 45°. Point rotation steps regarding the center of rotation and a rotation angle of 45° $P(1,1)(x,y)P(a,b)$

$$\begin{pmatrix} x'-a \\ y'-b \end{pmatrix} = \begin{pmatrix} \cos 45° & -\sin 45° \\ \sin 45° & \cos 45° \end{pmatrix} \begin{pmatrix} x-a \\ y-b \end{pmatrix}$$

$$\begin{pmatrix} x'-a \\ y'-b \end{pmatrix} = \begin{pmatrix} \frac{1}{2}\sqrt{2} & -\frac{1}{2}\sqrt{2} \\ \frac{1}{2}\sqrt{2} & \frac{1}{2}\sqrt{2} \end{pmatrix} \begin{pmatrix} x-a \\ y-a \end{pmatrix}$$

$$\begin{pmatrix} x'-a \\ y'-b \end{pmatrix} = \begin{pmatrix} \frac{1}{2}\sqrt{2}(x-a) - \frac{1}{2}\sqrt{2}(y-b) \\ \frac{1}{2}\sqrt{2}(x-a) + \frac{1}{2}\sqrt{2}(y-b) \end{pmatrix}$$

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \frac{1}{2}\sqrt{2}(x-a) - \frac{1}{2}\sqrt{2}(y-b) + a \\ \frac{1}{2}\sqrt{2}(x-a) + \frac{1}{2}\sqrt{2}(y-b) + b \end{pmatrix}$$

where the point is the result of rotation of the point$(x', y')(x, y)$. The rotation of the vertex of the ellipse S about the center and the rotation angle of 45° is as follows:$P(1,1)$

The result of rotation of the peak point (1.5) is

$$\begin{pmatrix} x_1' \\ y_1' \end{pmatrix} = \begin{pmatrix} \frac{1}{2}\sqrt{2}(5-1) + 1 \\ \frac{1}{2}\sqrt{2}(5-1) + 1 \end{pmatrix} = \begin{pmatrix} 2\sqrt{2} + 1 \\ 2\sqrt{2} + 1 \end{pmatrix}$$

The result of rotation of the vertex (1,1) is

Then the resulting elliptical rotation at a 45° angle can be continued with a rotation at an angle of 90°, 180°, 270°, thus forming one side of the cavity of the Sekar Pace and SekarArum Dalu motifs.

$$\begin{pmatrix} x_2' \\ y_2' \end{pmatrix} = \begin{pmatrix} \frac{1}{2}\sqrt{2}(1-1)+1 \\ \frac{1}{2}\sqrt{2}(1-1)+1 \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$$

The result of rotation of the vertex (3,2) is

$$\begin{pmatrix} x_3' \\ y_3' \end{pmatrix} = \begin{pmatrix} \frac{1}{2}\sqrt{2}(3-1)-\frac{1}{2}\sqrt{2}.1+1 \\ \frac{1}{2}\sqrt{2}(3-1)+\frac{1}{2}\sqrt{2}.1+1 \end{pmatrix} = \begin{pmatrix} \frac{1}{2}\sqrt{2}+1 \\ \frac{3}{2}\sqrt{2}+1 \end{pmatrix}$$

The result of rotation of the vertex (3,0) is

$$\begin{pmatrix} x_4' \\ y_4' \end{pmatrix} = \begin{pmatrix} \frac{1}{2}\sqrt{2}(3-1)+\frac{1}{2}\sqrt{2}.1+1 \\ \frac{1}{2}\sqrt{2}(3-1)-\frac{1}{2}\sqrt{2}.1+1 \end{pmatrix} = \begin{pmatrix} \frac{3}{2}\sqrt{2}+1 \\ \frac{1}{2}\sqrt{2}+1 \end{pmatrix}$$

So we get the rotation results from the top point of the ellipse S towards the center point and a rotation angle of 45°, namely the ellipse S passing through$P(1,1)$

$$\begin{pmatrix} x_1' \\ y_1' \end{pmatrix} = \begin{pmatrix} 2\sqrt{2}+1 \\ 2\sqrt{2}+1 \end{pmatrix}, \begin{pmatrix} x_2' \\ y_2' \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}, \begin{pmatrix} x_3' \\ y_3' \end{pmatrix} = \begin{pmatrix} \frac{1}{2}\sqrt{2}+1 \\ \frac{3}{2}\sqrt{2}+1 \end{pmatrix}, \begin{pmatrix} x_4' \\ y_4' \end{pmatrix} = \begin{pmatrix} \frac{3}{2}\sqrt{2}+1 \\ \frac{1}{2}\sqrt{2}+1 \end{pmatrix}.$$

From the results of this rotation, an ellipse equation and a graphic sketch are obtained after rotating it about the center point and a rotation angle of 45° as shown in the picture.$P(1,1)$

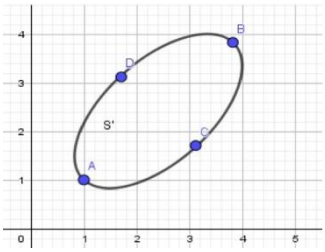


Figure 3.3 Illustration of Elliptical Rotation

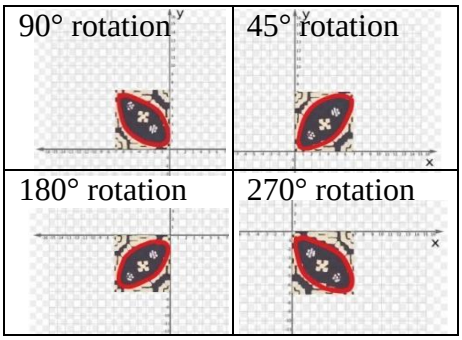


Figure 3.4 Illustration of Elliptical Rotation

CONCLUSION

Based on the results of the research that has been carried out, it can be concluded that in the Yogyakarta Nitik Batik Geometry Exploration with the concept of Ethnomathematics there is a reciprocal relationship between the cultural elements of Yogyakarta Nitik Batik and mathematical concepts. The results of this research can be used as learning material in class by teachers, especially in material on geometric transformations such as reflection, dilation, rotation, symmetry and ellipses. Through the ethnomathematics approach, it is hoped that it can foster a love of culture character in students. Researchers are aware that there are still many shortcomings in this research, starting from the lack of supporting data sources and limited sources, for this reason this research needs to be refined in order to get maximum results. The researcher suggests several things that need to be considered in further research, developing topics adapted to existing references, adding more related references and sources.

REFERENCES

Afifah, Dian Septi Nur, Ika Mariana Putri, and Tomi Listiawan. "Ethnomathematical exploration of Gajah Mada batik with the Sekar Jagad Tulungagung motif." *BAREKENG: Journal of Mathematical and Applied Sciences* 14.1 (2020): 101-112.

Arimah, NI, DA Kusuma, and MS Noto. "Ethnomathematics: Geometry System Analysis of Cirebon Trusmi Batik Motifs. Euclid, 8 (1), 16–40." (2021).

Arsa, Nur Thabitah. EXPLORATION OF BANYUMAS BATIK AS A SOURCE OF MATHEMATICS LEARNING (ETHNOMATHEMATICS STUDY

AT ANTO DJAMIL SOKARAJA BATIK HOUSE, BANYUMAS DISTRICT). Diss. UIN Prof. KH Saifuddin Zuhri Purwokerto, 2022.

Bustan, Ariestha Widyastuty, Munazat Salmin, and Taufan Talib. "Ethnomathematical Exploration of Geometric Transformations in Malefo Batik." *Journal of Mathematics Education (JUPITEK)* 4.2 (2021): 87-94.

Christanti, Angela Dewi Ika, and Fransisca Yuanita Sari. "Ethnomathematics in Yogyakarta Kawung Batik in Geometric Transformation." *ProSANDIKA UNIKAL (Proceedings of the National Seminar on Mathematics Education, Pekalongan University).* Vol. 1. 2020.

Dewanti, Asih Retno. "Application of Batik Nitik in Alternative Media ." *Journal of Fine Arts and Design Dimensions* 18.2 (2022): 205-216.

Fachrunnisa, Yusticia Nurrohmah, and Christina Kartika Sari. "ETHNOMATHEMATICS: EXPLORATION OF THE CONCEPT OF GEOMETRIC TRANSFORMATION IN MELATI BATIK IN KEBON VILLAGE, BAYAT." AKSIOMA: *Journal of the Mathematics Education Study Program* 12.1 (2023).

Lumbantoruan, Jitu Halomoan. "Geometry Module II (Analytical and Transformational Geometry)." (2018).

Mardiaz, Lucky, Tito Haripradianto, and Ali Soekirno. Transformation of the Parang Batik Motif in the Design of the Batik Museum in Yogyakarta. Diss. Brawijaya University, 2016.

Minarno, Agus Eko, Indah Soesanti, and Hanung Adi Nugroho. “Batik Nitik 960 Dataset for Classification, Retrieval, and Generator.” Data 8.4 (2023): 63.

Pajrin, Nur Fathaillah, Emi Pujiastuti, and Sugiman Sugiman. "Ethnomathematics: Exploration of Transformed Geometry through Doyo Ulap Crafts and Badong Tencep Kutai Kartanegara." Theorems: Mathematical Theory and Research 8.2 (2023): 211-222.

Rahman, Sidiq Aulia, Rachma Sundhari, and Ramanda Ramanda. "Exploration of Umbrella Geulis Tasikmalaya Using Ethnomathematics Concepts Assisted by the Geogebra Application." *Scholar's Journal: Journal of Mathematics Education* 7.1 (2023): 889-904.

Ratiwi, Jhenny Windya, and Heni Pujiastuti. "Ethnomathematical exploration of the traditional game of marbles." *Rafflesia Journal of Mathematics Education* 5.2 (2020): 1-12.

Susanti, Iin Rani, and Bambang Sumarno HM. "Augmented reality: 3D visualization of geometric decorative batik." Proceedings. National Seminar on Mathematics and Mathematics Education, Yogyakarta State University. 2015.

Wati, Lia Listiana, Afdiyatul Mutamainah, and Lilis Setianingsih. "Ethnomathematical Exploration of Gedog Batik." *Journal of Mathematics Learning Research* 3.1 (2021): 27-34.

Zuhro, Aida Roihana, I. Ketut Sunarya, and Wiga Nugraheni. "Batik Nitik's Existence in the Postmodern Era." *3rd International Conference on Arts and Arts Education (ICAAE 2019).* Atlantis Press, 2020.