

# Ethnomathematics on the *Gringsing* batik motifs in Javanese culture

Adinda Indah Permita <sup>1</sup>, Tien-Trung Nguyen <sup>2</sup>, Rully Charitas Indra Prahmana <sup>1\*</sup>

<sup>1</sup> Universitas Ahmad Dahlan, Yogyakarta, Indonesia

<sup>2</sup> Vietnam National University, Hanoi, Vietnam

\* Correspondence: [rully.indra@mpmat.uad.ac.id](mailto:rully.indra@mpmat.uad.ac.id)

Received: 13 April 2022 | Revised: 3 June 2022 | Accepted: 10 June 2022 | Published: 11 June 2022

© The Author(s) 2022

## Abstract

Mathematics cannot be separated from human life. However, mathematics is often taught directly through formulas and abstract mathematical forms at school and is less associated with students' daily lives. Hence, it makes it difficult for students to understand mathematics and often find it difficult to understand how mathematics can be useful in dealing with various problems in real life. Therefore, school mathematics needs to be reconnected with the reality of human life so that students can easily understand mathematics and use it to solve various daily life problems. This study explores ethnomathematics in Javanese culture, especially in the *Gringsing* batik motif. The ethnographic method was employed in this study, and the data was collected through literature review, observation, and interviews. The data was then analyzed before and according to the conditions in the field. The results showed that the *Gringsing* batik motif contains philosophical meanings, cultural values, and mathematical elements of plane shapes and geometric transformations. This research contributes to the context of learning mathematics. In addition, it also increases the knowledge of mathematics and culture and can be used as a reference in learning or similar research.

**Keywords:** 2D Shapes, Ethnography, Ethnomathematics, Geometric Transformation, *Gringsing* Batik

## Introduction

Mathematics is inherent in human life (Nurhasanah, Kusumah & Sabandar, 2017). Many human activities are unconsciously part of mathematics (Sembiring, 2010). So, it can be said that mathematics has been very close to culture in human behavior and habits since ancient times in responding to real-life phenomena and problems (Muhtadi et al., 2017). Mathematics is often taught directly through formulas and abstract mathematical forms at schools and is less

associated with students' daily lives (Alangui, 2010). In turn, students find it challenging to understand mathematics and its usefulness in dealing with real-life problems (Risdiyanti & Prahmana, 2020). Therefore, mathematics in schools needs to be reconnected with real-life to help students understand mathematics and use mathematics to solve various daily life problems.

D'Ambrosio, a mathematician from Brazil, initiated Ethnomathematics as a solution to bridge formal mathematics and the realities of daily human life (Rosa & Orey, 2016). Ethnomathematics reconstructs mathematics to be rooted in mathematical knowledge built by the ideas, ways, and techniques of a cultural group in dealing with daily life problems so that mathematics is close to students and easily understood (D'Ambrosio, 1985). Using Ethnomathematics as a context in learning mathematics can trigger the process of mathematization in students' minds so that there is no leap in students' thinking processes in understanding mathematics (Risdiyanti, 2022). This mathematization process does not occur in mathematics learning which directly teaches abstract mathematical formulas and forms to students, resulting in students finding it difficult to understand the concepts and the benefit of mathematics to deal with real-life problems (Risdiyanti & Prahmana, 2021).

Mathematics educators see Ethnomathematics as a way to connect aspects of culture to the mathematics their students are learning (Meaney et al., 2021), and Ethnomathematics has been integrated into school mathematics and contributes to helping indigenous students improve their Math performance (Gerdes, 1986; Meaney et al., 2021). For example, teachers can help students build mathematical knowledge in artefacts and practices, contribute to valuing local cultures (Tereshkina et al., 2015), and assess problem-solving abilities on topics related to the local cultural context in the northern mountainous region of Vietnam (Nguyen et al., 2019). Therefore, images of history and culture also need to be studied and installed in textbooks or teaching and learning materials for Mathematics (Nguyen et al., 2019; Nguyen et al., 2020). At the same time, mathematics education, in addition to developing mathematical and general competencies, also has a goal of fostering traditional cultural values for students.

Indonesia has abundant cultures that can be used as contexts for learning mathematics (Risdiyanti & Prahmana, 2020). One of them is batik motifs in Javanese culture, including Yogyakarta. However, research on ethnomathematics exploration in batik is limited. Whereas in the daily life of the people of Yogyakarta, batik is a familiar and common clothing, such as for school uniforms, office services, celebrations or weddings, traditional events, or casual clothes (Didik, 2017; Dian, 2017). One of the famous batik motifs in Yogyakarta is the *Gringsing*, the oldest ancient batik motif native to the archipelago but is preserved and widely used today. In ancient times, the cloth with the *Gringsing* batik motif was believed to be a lucky cloth that could heal sick people (Kusrianto, 2021). The *Gringsing* batik motif is in the form of *isen-isen mata deruk* eyes (a circle with a diameter touching each other) (Sulistiyobudi, 2017). This motif can be used as a context in learning mathematics because it is close and familiar to students, especially students on Java islands. However, there has been no research exploring Ethnomathematics in the *Gringsing* batik motif.

Therefore, this study aims to explore the Ethnomathematics of the *Gringsing* batik motif. The exploration results can be used as a context for learning mathematics and ease students to

understand the concepts and use mathematics to deal with real-life problems. In addition, the results of this study also contribute to enriching the knowledge of mathematics and culture so that it can be used as a reference in mathematics learning or similar research.

## Methods

The method used in this research is an ethnographic method. This method has the purpose to describes the culture of a community (Spardley & McCurdy, 1989). This method is chosen in this research because the method is in line with the aims of the ethnomathematics ideas (Shirley & Palhares, 2016). The ethnographic method involve study about cultures that found and developed by certain cultural community (Spardley & McCurdy, 1989). It means, the researcher does not only study the culture but also learns the mathematics ideas that which is found and developed by the cultural community. So, the ethnographic method was used in this research to explore ethnomathematics in the Gringsing batik motif.

## Data Collection

Data collection is done by observation, interviews, photo documentation, and a literature study about the Gringsing batik motif. The observation was done by looking at the Grising batik motif at Yogyakarta Barik Museum. Then, interviews were done with two key informants, they are Mr. Prayogo the curator of Yogyakarta Batik Museum, and Mr. Utut the staff of Yogyakarta Batik Crafts Center. The interviews were done to obtain information about the history and cultural value of the Gringsing batik motif.

## Data Analysis

Data in this research were analyzed using two techniques, that is pre-field analysis and field data analysis (Spardley & McCurdy, 1989). The pre-field analysis was done by analyzing the preliminary study results or secondary data to determine the research focus. Then, the field data analysis was done with three processes, such as data reduction, data presentation, and conclusion. The data reduction process was done by selecting important data. Furthermore, the data presentation process was done by presenting the data which is relevant to this research. Then the last process is the conclusion which is done by withdrawing the conclusion from the observation, interviews, and literature study. After that, all data that has been analyzed is then written in the field notes.

## Results and Discussion

The exploration results showed that the *Gringsing* batik motif contains philosophical meanings, cultural values, and mathematical elements. It is one of the well-known classic Javanese batik motifs in Indonesia. Before independence, Indonesia consisted of kingdoms, including the Majapahit kingdom (Prayogo, 2021). Rouffaer (1928), a researcher and librarian from the

Netherlands, in his writing entitled "De Batik-kunst in Nederlandsch Indie" explained that the *Gringsing* batik motif has been found since the era of the Majapahit kingdom in the XIII century. Paraton book mentions that Raden Wijaya, the first king of the Majapahit kingdom, distributed the cloth with the *Gringsing* motif to his soldiers before the war (Utut, 2021).

The *Gringsing* batik motif is dominated by isen-isen ornaments, dragon scales of small circles with a dot in the center (Prayogo, 2021). In Javanese culture, it is believed that the dragon is the guardian for balancing the earth and the universe. The dragon scales on the *Gringsing* motif are interpreted as a symbol of balance, prosperity, and fertility. The dragon symbol is an essential symbol of countries in the East Asian historical and cultural contexts, including China, Japan, and Vietnam (Nguyen, 2015). The symbol of the dragon is often used to denote mysterious strength (Pham & Lee, 2008). Of course, the symbol of the dragon can also be used in fashion and can also be printed on household items (Nguyen, 2015; Pham & Lee, 2008). In the Javanese culture, the dragon is often used as to symbol in the many Javanese artifacts including in the motif batik, the dragon is interpreted as a symbol of strength and fertility (Hidajat, 2004).

The giving of *Gringsing* motif cloth by Raden Wijaya to his soldiers is a symbol of Raden Wijaya's hope that his soldiers can always live in prosperity (Utut, 2021). The Majapahit kingdom applied very strict cultures with philosophical, moral, ethical, and other values believed to be passed from generation to generation. Thus, the people tried to pass on their culture through various media, one of which was the *Gringsing* Batik motif (Prayogo, 2021). *Gringsing* batik motifs are usually equipped with various ornaments, such as *cemplokan* (circles), stars, flowers, and others. Besides, the *Gringsing* batik motif contains mathematical elements of plane shapes and geometric transformations.

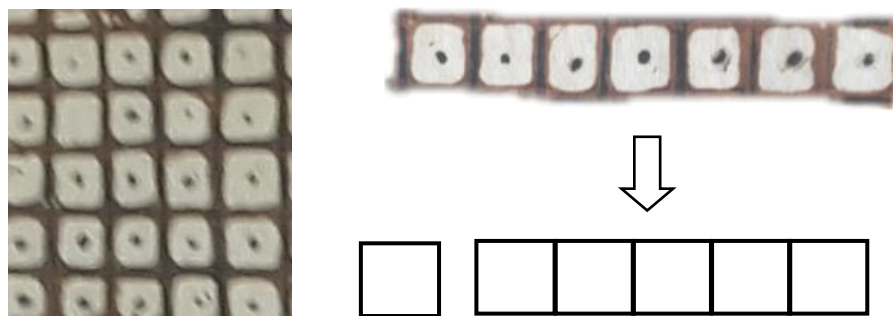
The philosophy behind one sheet of *Gringsing* batik cloth is that it symbolizes a prayer to avoid danger or pain. *Gringsing* comes from the word "*gering*", which means pain, and "*sumingkir*", which means lost, so it is a prayer for the pain to disappear (Prayogo, 2021). Ancient people wore or gave *Gringsing* batik cloth to others as a symbol of worship to avoid calamities and illnesses, such as physical illness, mental illness, economic illness, and others (Utut, 2021). Besides, the *Gringsing* batik motif contains mathematical elements of plane shapes and geometric transformations.

In its development, *Gringsing* batik motif is not only used by people in the kingdom but was already popularly used by the general public (Sulistiyobudi, 2017). Besides that, *Gringsing* batik motif is currently often used in performances (Prayogo, 2021). In Javanese culture, *Gringsing* batik motif is still preserved and widely used by the community, especially Javanese society (Utut, 2021).

## **Philosophical Meaning, Cultural Values, and Elements of Plane Shapes in *Isen-Isen* Ornaments of *Gringsing* Batik Motifs**

*Isen-isen* is one of the basic ornaments of the *Gringsing* batik motif. It is an image of dragon scales with a black dot in the middle, like an eye. In ancient times, people in the Singosari kingdom interpreted it as a symbol of prosperity (Prayogo, 2021). Thus, anyone using

*Gringsing* batik is expected to have a prosperous life. Dragon scales symbolize prosperity and wealth both in tangible and intangible terms, such as the wealth of the soul, the wealth of brothers and sisters, and others. Illustrated as dragon scales, it is because there are so many dragon scales, but they cannot be counted. Therefore, the prayer of this motif is that someone wearing the batik with this *Gringsing* motif can live prosperously so that the wealth, both material and non-material owned, is priceless or cannot be counted anymore. In addition, *isen-isen* ornaments also contain mathematical elements of plane shapes square and rectangle, as shown in Figure 1.



**Figure 1.** Square Elements in *Isen-Isen* Ornaments of *Gringsing* Batik Motifs

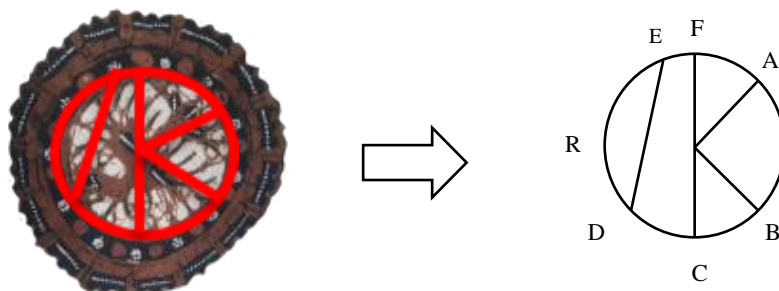
Figure 1 shows that the *isen-isen* ornaments of the *Gringsing* batik motif are a square making a rectangle when arranged in a row. In batik, the shape of the *isen-isen* is sometimes not a perfect square because it is often handmade, not printed, making it difficult to create a perfect square.

### **Philosophical Meanings, Cultural Values, and Elements of Plane Shapes and Rhombus on the *Ceplok* (circle) Ornaments of *Gringsing* Batik Motifs**

There are two colors in the *Ceplok* ornament, blue and brown. Blue is a symbol of eternity, meaning that every human being will return to their God, an eternal place (Prayogo, 2021). At the same time, brown is a symbol of the land. In addition, the *Ceplok* ornament also consists of dots symbolizing the *Sedulur Papat Limo Pancer*. *Sedulur Papat* was a symbol of the four cardinal directions, with East as the source of life, North as the abode of God, West as a source of luck, and South as the center of everything (Prayogo, 2021). The center of *Sedulur Papat* is the center of life, defined as the human surrounded by the four cardinal directions.

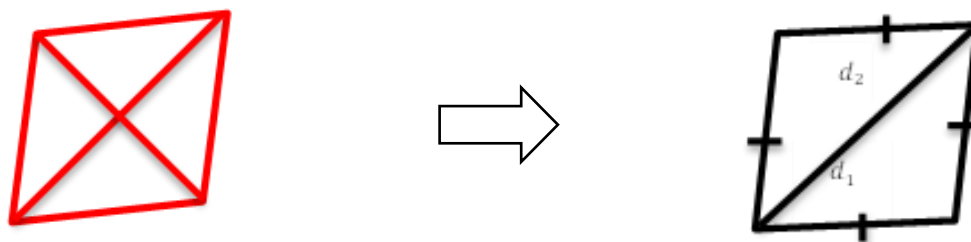
Then, in the *Ceplok* ornament, there is also a tiny crab shape, meaning there will be many obstacles in life, so we must be agile like small crabs surrounded by five *Pancers* or four pillars of life (Prayogo, 2021). The *Ceplok* image has an eternal philosophy of life and will be saved if it is filled with *Sedulur Papat Limo Pancer* dots (Utut, 2021). In life, everyone will face the dark blue, or transverse obstacles; therefore, you must be agile in seeking fortune and living life but have limits, *Sedulur Papat Limo Pancer*, so that it can run smoothly and

according to the manners of life (Utut, 2021). In addition, this batik contains mathematical elements of plane shapes of a circle, as shown in Figure 2.



**Figure 2.** The Circle Elements in *Ceplokan* Ornaments of *Gringsing* Batik Motifs

Figure 2 depicts the *Ceplokan* ornament with mathematical elements of a circle. It has a radius (OA), a chord (ED), diameter (FC), central angle (FOA), arc (DE), and segment (R). In batik, the *Ceplokan* is often not a perfect circle due to its making. *Gringsing* batik is mostly handmade, not printed, making it hard to create a perfect circle. In addition to mathematical elements of circles, this *Ceplokan* ornament also contains the mathematical element of rhombus, as seen in Figure 3.



**Figure 3.** The Rhombus Element in the *Ceplokan* Ornament of *Gringsing* Batik Motifs

Figure 3 shows the mathematical element of a rhombus when several *Ceplokan* ornaments are connected. When connected, the distance between the ornaments is equal and forms a diagonal intersecting perpendicularly.

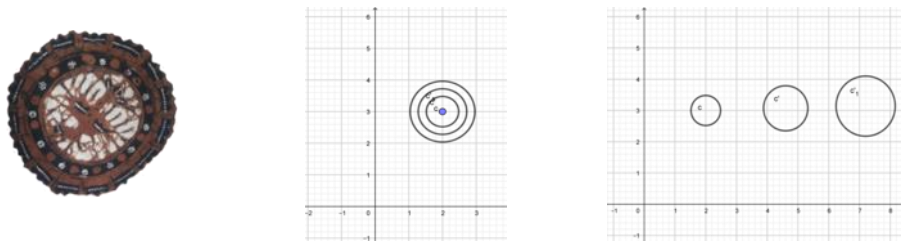
### The Elements of Geometry Transformation in Various *Gringsing* Batik Motif Ornaments

Some ornaments of *Gringsing* batik motifs consist of the elements of geometric transformation, such as dilation, reflection, translation, and rotation. The details are as follows.

a. Dilation on *Ceplokan* Ornaments

The *Ceplokan* ornaments of the *Gringsing* batik motif are made using the concept of dilation, as seen in Figure 4.

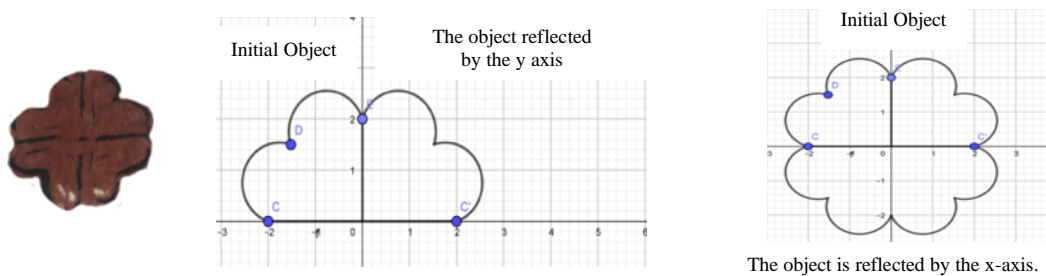




**Figure 4.** Dilation Concept in *Ceplokan* Ornaments of the *Gringsing* Batik Motif

b. Reflection on Flower Ornaments

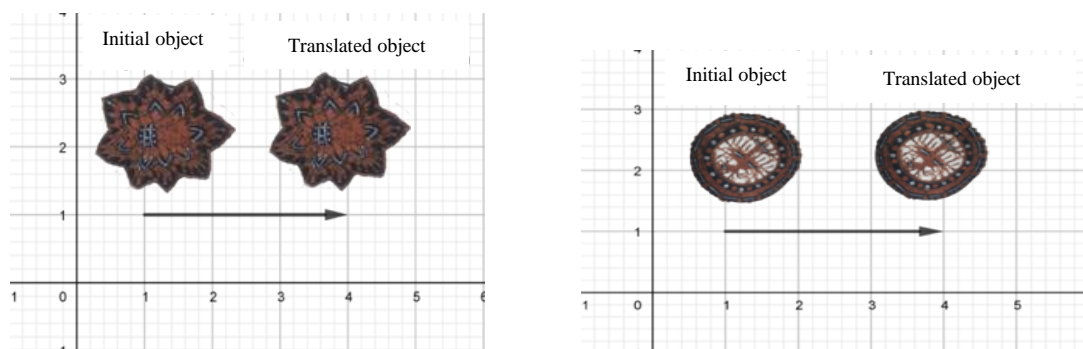
The floral ornament on the *Gringsing* batik motif is created using the concept of reflection, as seen in [Figure 5](#).



**Figure 5.** Reflection Concept in *Ceplokan* Ornaments of the *Gringsing* Batik Motif

c. The Translation of Star Ornaments and *Ceplokan*

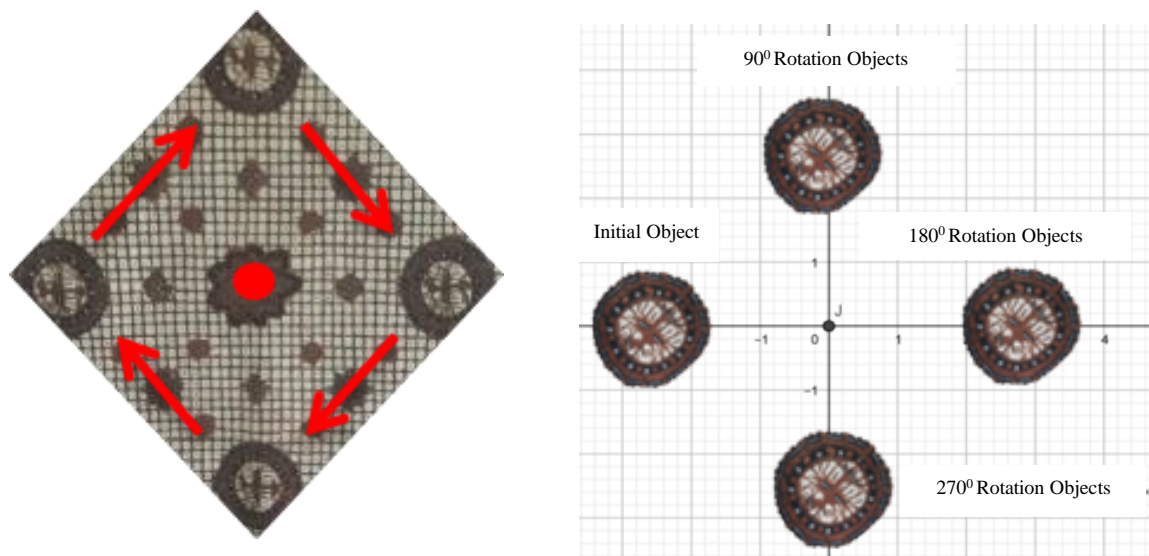
The *Gringsing* batik motif has a star ornament created using the concept of translation, as seen in [Figure 6](#).



**Figure 6.** Translation Concept in *Ceplokan* Ornaments of the *Gringsing* Batik Motif

d. Rotation on the *Ceplokan* Ornament

Besides the concept of translation, the *Ceplokan* ornament can also be made using the concept of rotation, as seen in [Figure 7](#).



**Figure 7.** Rotation Concept in *Ceplokan* Ornaments of the *Gringsing* Batik Motif

The exploration results of the Ethnomathematics of the *Gringsing* batik motif show that in making *Gringsing* Batik Motif used mathematics concepts that are found and developed by people in Javanese culture since the Majapahit Kingdom era. Furthermore, Javanese people have used the concept of plane shapes and geometric transformations by self-taught, and these creative ideas emerged from their experience in drawing the *Gringsing* batik motif (Prayogo, 2021). In addition, the *Gringsing* batik motif also contains philosophical and cultural values that are passed down from generation to generation. The ethnomathematics findings on *Gringsing* batik complement some previous findings regarding the exploration of Ethnomathematics in Indonesian culture (Utut, 2021). The previous findings include research on Ethnomathematics in traditional Balinese houses (Suharta, Sudiarta, & Astawa, 2017), Ethnomathematics on rat repellent devices in Baduy culture (Arisetyawan, Suryadi, Herman, & Rahmat, 2014), mathematical calculations on the pranatamangsa system and predictions of the anniversary of death and birth in Javanese culture (Prahmana, Yuniyanto, Rosa, & Orey, 2021), Ethnomathematics on the architecture of the mosque of the Sasak people in Lombok (Supiyati & Hanum, 2019), Ethnomathematics on the Fort Rotterdam building in Makasar (Sulasteri, Nur, & Kusumayati, 2020), Ethnomathematics on typical Yogyakarta batik patterns (Prahmana & D' Ambrosio, 2020) and others.

To date, many students have difficulty understanding mathematical concepts and understanding their application to solve everyday problems because mathematics learning is less related to the student life and culture (Hendriana, Prahmana, & Hidayat, 2019). This research bridges mathematics with the reality and perceptions of students' mathematics. This study will allow students to see that mathematics is very close to their culture and daily life, so they will easily grasp the meaning of the mathematical concepts and apply them in their daily lives (Risdiyanti & Prahmana, 2020).

Previous studies have shown the changes in students' perceptions regarding the relationship of mathematics to culture and daily lives through learning mathematics in the



context of Ethnomathematics. Among the studies is the use of the Minangkabau Gadang house in learning the Pythagorean theorem (Rahmawati, 2020), the use of the Soko Tunggal mosque in learning two-dimensional geometry (Putra, Wijayanto, & Widodo, 2020), the use of traditional cookie maker namely “*Kue Putu*” in learning surface area and volume of cylinder (Nursyahidah & Albab, 2021), and the use of woven bamboo in translational learning (Maryati & Prahmana, 2020).

Not only do Indonesian researchers’ study Ethnomathematics research but also researchers from other countries, such as ethnomathematics exploration of Malay-Islamic culture in Malaysia (Ismail & Ismail, 2010), ethnomathematics exploration of Hausa puzzles in Northern Nigeria (Waziri, Saidu, & Musa, 2010), ethnomathematics exploration on carnival in Brazil (de Freitas Madruga & Biembengut, 2015), and ethnomathematics exploration on braid craft in Argentina (Albanese, 2015). Various ethnomathematics studies in Indonesia and other countries indicate that worldwide, researchers have realized the importance of reconstructing mathematics so that it is re-rooted in the culture of each country. Thus, this research contributes to restoring mathematics to be rooted in Indonesian culture.

## Conclusion

Javanese people have used the concept of plane shapes and geometric transformations such as dilation, reflection, translation, and rotation as the results on Ethnomathematics exploration of the *Gringsing* batik motif. In addition, the *Gringsing* batik motif also contains a philosophy, such as prayers so that those using *Gringsing* batik are protected from harm and always given prosperity in life. The Ethnomathematics on the *Gringsing* batik motif can be used as a context in learning mathematics. However, it requires further research on implementing the context of the *Gringsing* batik motif to help students understand the concepts of plane shapes and geometric transformations. This research contributes to increasing the knowledge of mathematics and culture and enriches the reference for learning or similar research.

## Acknowledgement

We want to thank Mr. Prayogo and Mr. Utut, who has provided a more in-depth explanation of the philosophical aspects of Batik Gringsing and Irma Risdiyanti, for her assistance in providing suggestions on the final version of this work. Furthermore, we also appreciate the anonymous reviewers and the associate editor’s time, efforts, suggestions, and comments. Their recommendations were followed correctly and strictly, resulting in a significant improvement in the quality of our final paper. Finally, we would like to thank Universitas Ahmad Dahlan and Vietnam National University for providing us with the opportunity for research collaboration.

## Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been covered completely by the authors.

## References

- Alangui, W. V. (2010). Stone walls and water flows: Interrogating cultural practice and mathematics. *Doctoral Dissertation*. Auckland: University of Auckland.
- Albanese, V. (2015). Etnomatemática de una artesanía Argentina: identificando etnomodelos de trenzado [Ethnomathematics of an Argentine handicraft: Identifying ethno models of trainings]. *Bolema: Boletim de Educação Matemática*, 29(52), 493-507. <https://doi.org/10.1590/1980-4415v29n52a04>
- Arisetyawan, A., Suryadi, D., Herman, T. & Rahmat, C. (2014). Study of ethnomathematics: A lesson from the Baduy Culture. *International Journal of Education and Research*, 2(10), 681-688.
- D'Ambrosio, U. (1985). Ethnomathematics and its place in the history and pedagogy of mathematics. *For the learning of Mathematics*, 5(1), 44-48.
- de Freitas Madruga, Z. E., & Biembengut, M. S. (2015). Das relações entre modelagem, etnomatemática e carnaval: Reflexões para aplicação na educação básica [On the relations between modeling, ethnomathematics and carnival: Reflections for application in basic education]. *Fronteiras: Journal of Social, Technological, and Environmental Science*, 4(2), 31-52. <https://doi.org/10.21664/2238-8869.2015v4i2.p31-52>
- Dian. (2017). *Proses membuat, sejarah dan perkembangan batik di Yogyakarta [The process of making batik, history, and development of batik in Yogyakarta]*. (Personal Communication).
- Didik. (2017). *Filosofi dan makna batik khas Yogyakarta [The Philosophy and Meaning of Yogyakarta Typical Batik]*. (Personal Communication).
- Gerdes, P. (1986). How to recognize hidden geometrical thinking: A contribution to the development of anthropological mathematics. *For the Learning of Mathematics*, 6(2), 10–12.
- Hendriana, H., Prahmana, R. C. I., & Hidayat, W. (2019). The innovation of learning trajectory on multiplication operations for rural area students in Indonesia. *Journal on Mathematics Education*, 10(3), 397-408. <https://doi.org/10.22342/jme.10.3.9257.397-408>
- Hidayat, R. (2004). Kajian strukturalisme-simbolik mitos Jawa pada motif batik berunsur alam [Structuralism-symbolic study of Javanese myth on batik motifs with natural elements]. *Bahasa dan Seni*, 32(2), 289-303.

- Ismail, M. R., & Ismail, H. (2010). Exploring malay-islamic ethnomathematics: Al-Khatib's combinatoric theory in Àlam Al-Hussab and Raudah Al-Hussab. *Procedia - Social and Behavioral Sciences*, 8, 735–744. <https://doi.org/10.1016/j.sbspro.2010.12.102>
- Kusrianto, A. (2013). *Batik: Filosofi, motif, dan kegunaan [Batik: Philosophy, motives, and uses]*. Yogyakarta: Andi.
- Maryati & Prahmana, R. C. I. (2020). Designing learning rotation using the context of bamboo woven motif. *Prima: Jurnal Pendidikan Matematika*, 4(2), 100-108. <https://doi.org/10.31000/prima.v4i2.2600>
- Meaney, T., Trinick, T., & Allen, P. (2021). Ethnomathematics in education: The need for cultural symmetry. *Handbook of Cognitive Mathematics*, 1–29. [https://doi.org/10.1007/978-3-030-44982-7\\_4-1](https://doi.org/10.1007/978-3-030-44982-7_4-1)
- Muhtadi, D., Sukirwan, Warsito, & Prahmana, R. C. I. (2017). Sundanese ethnomathematics: Mathematical activities in estimating, measuring, and making patterns. *Journal on Mathematics Education*, 8(2), 185-198. <https://doi.org/10.22342/jme.8.2.4055.185-198>
- Nguyen, T. T. (2015). The symbol of the dragon and ways to shape cultural identities in Vietnam and Japan. *The symbol of the dragon and ways to shape cultural identities in Vietnam and Japan*. Harvard-yenching institute working paper series. <https://bitly.com.vn/stats/7mf9hd>
- Nguyen, T.-T., Trinh, T. P. T., & Tran, T. (2019). Realistic Mathematics Education (RME) and Didactical Situations in Mathematics (DSM) in the context of education reform in Vietnam. *Journal of Physics: Conference Series*, 1340(1), 012032. <https://doi.org/10.1088/1742-6596/1340/012032>
- Nguyen, T.T, Trinh, T. P. T., & Pham, A. G. (2020). Analysis of mathematics textbooks based on Realistic Mathematics Education theory and some recommendations. *Journal of Hanoi National University of Education, Science of Education*, 65(7), 136-149, <https://doi.org/10.18173/2354-1075.2020-0085>
- Nurhasanah, F., Kusumah, Y. S. & Sabandar, J. (2017). Concept of triangle: Examples of mathematical abstraction in two different contexts. *International Journal on Emerging Mathematics Education*, 1(1), 53-70. <https://doi.org/10.12928/ijeme.v1i1.5782>
- Nursyahidah, F., & Albab, I. U. (2021). Learning design on surface area and volume of cylinder using Indonesian ethno-mathematics of traditional cookie maker assisted by GeoGebra. *Mathematics Teaching Research Journal*, 13(4), 79-98.
- Nyoni, J. (2014). Indigenising mathematics mediations in South African high schools: Applying Ethnomathematics experiences in teaching and learning. *Mediterranean Journal of Social Sciences*, 5(15), 327-335. <https://doi.org/10.5901/mjss.2014.v5n15p327>
- Pham, M. H. A., & Lee, Y.-S. (2008). A study on the classifications and symbolic meanings of Vietnamese traditional patterns. *International Journal of Human Ecology*, 9(1), 29-40. <https://www.koreascience.or.kr/article/JAKO200828939697978.page>

- Prahmana, R. C. I., & D'Ambrosio, U. (2020). Learning geometry and values from patterns: Ethnomathematics on the batik patterns of Yogyakarta, Indonesia. *Journal on Mathematics Education*, 11(3), 439–456. <https://doi.org/10.22342/jme.11.3.12949.439-456>
- Prahmana, R. C. I., Yuniyanto, W., Rosa, M., & Orey, D. C. (2021). Ethnomathematics: Pranatamangsa system and the birth-death ceremonial in Yogyakarta. *Journal on Mathematics Education*, 12(1), 93- 112. <http://doi.org/10.22342/jme.12.1.11745.93-112>.
- Prayogo. (2021). *Motif Batik Gringsing [The motifs of Gringsing batik]*. (Personal Communication).
- Putra, R. Y., Wijayanto, Z., & Widodo, S. A. (2020). Etnomatematika: Masjid soko tunggal dalam pembelajaran geometri 2D [Ethnomathematics: Single pillar mosque in 2D geometry learning]. *Jurnal Riset Pendidikan dan Inovasi Pembelajaran Matematika (JRPIPM)*, 4(1), 10. <https://doi.org/10.26740/jrpipm.v4n1.p10-22>
- Rahmawati, Y. (2020). Pendekatan matematika realistik bernuansa etnomatematika: Rumah Gadang Minangkabau pada materi teorema Pythagoras [A realistic mathematical approach with ethnomathematical nuances: Rumah Gadang Minangkabau about the Pythagorean theorem]. *Jurnal Azimut*, 3(SMAR), 22-29.
- Risdiyanti, I. (2022). Pendesainan pembelajaran himpunan menggunakan wayang dan cerita Mahabarata [Designing learning set using shadow puppets and Mahabarata story]. *Thesis*. Yogyakarta: Universitas Ahmad Dahlan.
- Risdiyanti, I., & Prahmana, R. C. I. (2020). *Ethnomathematics (Teori dan implementasinya: Suatu pengantar [Ethnomathematics (Theory and its implementation: An introduction)]*. Yogyakarta: UAD Press.
- Risdiyanti, I., & Prahmana, R. C. I. (2021). Designing learning trajectory of set through the Indonesian shadow puppets and Mahabharata stories. *Infinity Journal*, 10(2), 331-348. <https://doi.org/10.22460/infinity.v10i2.p331-348>
- Rosa, M., & Orey, D. C. (2016). State of the art in Ethnomathematics. In *Current and future perspectives of Ethnomathematics as a program* (pp. 11-37). Cham: Springer. [https://doi.org/10.1007/978-3-319-30120-4\\_3](https://doi.org/10.1007/978-3-319-30120-4_3)
- Rouffaer, G. P. (1914). *Batik-Kunst in Niederländisch-Indien und ihre Geschichte*. Utrecht: A. Oosthoek.
- Sembinging, R. K. (2010). Pendidikan Matematika Realistik Indonesia (PMRI): Perkembangan dan tantangannya. *Journal on Mathematics Education*, 1(1), 11–16. <https://doi.org/10.22342/jme.1.1.791.11-16>
- Shirley, L., & Palhares, P. (2016). Ethnomathematics and its diverse pedagogical approaches. In *Current and future perspectives of Ethnomathematics as a program* (pp. 25-44). Cham: Springer. <https://doi.org/10.1007/978-3-319-59220-6>
- Spradley, J. P., & McCurdy, D. W. (1989). *Anthropology: The cultural perspective*. Reissued Long Grove, IL: Waveland Press.

- Suharta, I. G. P., Sudiarta, I. G. P., & Astawa, I. W. P. (2017). Ethnomathematics of Balinese traditional houses. *International Research Journal of Engineering, IT and Scientific Research*, 3(4), 47-56. <https://doi.org/10.21744/irjeis.v3i4.501>
- Sulasteri, S., Nur, F., & Kusumayanti, A. (2020). Ethnomathematics: The Exploration of Learning Geometry at Fort Rotterdam of Makassar. In *Proceedings Ofthe International Conference on Mathematics and Islam (ICMIs 2018)* (pp. 151-157). <https://doi.org/10.5220/0008518601510157>
- Sulistiyobudi, N. (2017). Batik *Gringsing* dan Ceplok Kembang Kates Bantul. *Dinamika Kerajinan dan Batik*, 34(2), 93-102. <https://doi.org/10.22322/dkb.v34i2.2861>
- Supiyati, S., & Hanum, F. (2019). Ethnomathematics in Sasaknese architecture. *Journal on Mathematics Education*, 10(1), 47-58. <https://doi.org/10.22342/jme.10.1.5383.47-58>
- Tereshkina, G. D., Merlina, N. I., Kartashova, S. A., Dyachkovskaya, M. D., & Pырrco, N. A. (2015). Ethnomathematics of indigenous peoples of the north. *Mediterranean Journal of Social Sciences*, 6(2), 233–240. <https://doi.org/10.5901/mjss.2015.v6n2s3p233>
- Utut. (2021). *Sejarah dan Filosofi Batik Gringsing [The history and philosophy of the Gringsing batik]*. (Personal Communication).
- Waziri, M. Y., Saidu, I., & Musa, H. (2010). A mathematical approach on solving Hausa Puzzles in Northern Nigeria. In *Procedia - Social and Behavioral Sciences* (Vol. 8, pp. 694–699). Elsevier Ltd. <https://doi.org/10.1016/j.sbspro.2010.12.096>



