



The geometric contents and the values of local batik in Indonesia

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Abstract

The culture was carefully associated with regular lifestyles, such as inside the discipline of education. However, there needs to be awareness among school members of the absorption of the culture around them through learning, especially mathematics. Therefore, this study aims to explore the geometric contents in the form of geometric transformations and the values of local batik Indonesia. This study was a qualitative study with an ethnographic approach. The techniques used in this study are observation, literature review, and interviews with Lampung cultural and batik craftsmen. Observations were made by observing batik activities and Lampung batik motifs and conducting interviews to find the mathematical and philosophical elements contained in them. The data were then completed and checked for correctness based on the results from the literature review. The outcomes of this observation imply that the human beings of Lampung utilize the idea of geometric transformation in making batik motifs, which include the *Siger* motif, *pohon hayat* motif, and *kapal* motif. The idea of geometric transformation used is reflection, dilation, and translation. Thus, this research can be a reference for learning mathematics and exploring other Lampung batiks motifs.

Keywords: ethnomathematics; geometric transformation; local batik; values

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Introduction

Indonesia is an archipelago country that is rich in culture. In addition to its large quantity, Indonesia's diverse culture requires its people to continue to preserve and maintain its authenticity from time to time. The thing that can be done to preserve culture is by growing awareness and a sense of belonging and love for one's own culture, especially for the nation's next generation (Nahak, 2019). However, it is undeniable that culture is closely related to everyday life, including in the field of education, especially in the field of mathematics. In this case, the social characteristics and cultural context in the student's environment can improve students' ability to build their knowledge of mathematics (Sharma & Orey, 2017).

Ethnomathematics is a program that uses cultural media to explore mathematical phenomena, which are then directed to the pedagogical realm (Choirudin et al., 2020). Ethnomathematics makes a significant contribution to the preservation of the nation's culture in education. Furthermore, learning mathematics is applied by using ethnomathematics as part of the activities carried out at school. It makes students better understand the benefits and uses of mathematics in everyday life to increase learning motivation, student activity during mathematics learning activities, and the value of learning outcomes for students, especially in mathematics subjects (Kencanawaty et al., 2020). The implementation of ethnomathematics can change the paradigm of children and society that mathematics has a relationship with daily activities and mathematics has a relationship with culture and can be learned in a fun way (Risdiyanti & Prahmana, 2018).

Observation, comparison, classification, evaluation, quantification, measurement, computation, representation, and inference are used in each location and culture to understand knowledge about culture. *Ethnomathematics* is the name given to the various knowledge systems that have emerged due to this culture's discovery of mathematical concepts (Prahmana & D'Ambrosio, 2020). Revealing the ideas contained in specific cultural activities or particular social groups to develop a mathematics curriculum for, with, and by these groups, it can be done through ethnomathematical research so that mathematics can have different forms and develop according to the development of the user community (Prabawati, 2016). Ethnomathematics can also be used to bridge formal mathematical concepts with the cultural diversity that exists in society (Nur et al., 2021).

Academics have widely carried out research on ethnomathematics, including ethnomathematics research in Indonesia during 2015-2020 (Hidayati & Prahmana, 2022). The results from this study stated that in 2020, the number of articles published in ethnomathematics decreased significantly. In Lampung, there is ethnomathematics of Lampung tapis exploration as a learning resource to protect cultural heritage (Dewi et al., 2019). In addition, mathematical concepts in *tapis* Lampung by Susiana and Noer (2020). These studies investigate the philosophy contained in tapis motifs and the mathematical concept to discover ethnomathematics approaches to mathematics learning. So, Ethnomathematics on *tapis* fabrics and Lampung traditional houses (Loviana et al., 2020). According to the study's findings, *tapis* and traditional Lampung houses have utilized mathematical concepts. Riswati et al. (2021) identified Gemisegh's nature as Lampung's

mathematical and cultural wealth. According to the findings of this study, ethnomathematics activities can be found in the *alam gemisegeh*. Next, study of ethnomathematics exploration of *arul* games Lampung culture (Cahyaningati & Diana, 2022). The findings revealed that arul discovered mathematical elements in traditional games. Some of these studies have yet to discuss ethnomathematics in Lampung batik motifs and their philosophy.

Besides Lampung *tapis*, Lampung also has a distinctive cloth that is also famous, namely Lampung batik. Although both come from Lampung and are made of cloth, Lampung batik is different from Lampung *tapis*. *Tapis* Lampung uses gold thread and is embroidered, while Lampung batik is written with this batik candle and is called "malam." Besides attending official events, the people of Lampung also use this batik cloth for casual events. It has even become a patterned cloth used daily according to its fashion design (Hidayatulloh, 2021; Humaidi, 2021). In 2021, based on the circular letter number: 045.2/3672/07/2021 regarding the adjustment to the use of official clothing for state civil servants in the Lampung Province environment, it is stated that Fridays are set to wear the Lampung Batik Daily Service Clothes (PDH) (Djunaidi, 2021). It makes Lampung batik official and mandatory clothing in the local government, including the educational environment. In addition, Lampung batik has also become a mandatory uniform for students in schools throughout the province of Lampung (Hidayatulloh, 2021; Humaidi, 2021). It can be seen in Figure 1 below.



Figure 1. Lampung batik as school and service uniforms, and fashion

Lampung batik was brought by the Javanese people who lived in Lampung for a long time because batik came from the Java area. The origins of batik birth in Indonesia are related to the development of the kingdoms of Majapahit, Solo, and Yogyakarta (Trixie, 2020). Budiarto (2020) stated that the process of migration of the Javanese to Lampung officially began in 1905 in the colonization program. It continued in the government of the Republic of Indonesia the frame of the transmigration program. Furthermore, the Javanese people adapted the existing culture in Lampung so that more and more batik cloth appeared with typical Lampung motifs called Lampung batik. Lampung batik began to develop in the 1970s and was pioneered by Andrean Sangaji (a Lampung culture).

Even though Lampung Batik has become part of the daily life of the Lampung people and is even familiar to the world of education, the Lampung people, especially students, need help understanding the philosophy of Lampung Batik. In addition, they need help understanding the relationship between Lampung batik and subjects, especially mathematics. Therefore, this study aims to explore the mathematical concept of geometric transformation and philosophies on local batik in Indonesia.

Several previous studies that have been described previously examined the ethnomathematics of various regional cultures, including Lampung. In this case, the researchers conducted an ethnomathematical study, specifically on the geometric concept for each type of Lampung batik motif. Studies on the application of geometric transformations have been carried out by [Fadila \(2017\)](#), but these studies are still general for Lampung batik motifs. Meanwhile, in this study, the author examines the Lampung batik motif, in particular, and explores the geometric concepts contained in the motif.

Batik is a picture cloth specially made by writing a motif with wax on it and then processing it through a particular process. Lampung Batik is the result of the development of Indonesian batik, which takes motifs from the characteristics of traditional characters of Lampung, one of which is the Lampung tapis woven fabric. The batik craftsmen in Lampung chose decorative patterns on filter woven fabrics as a source of inspiration. Besides being unique to the people of Lampung, the decorative variety of *tapis* woven fabric is seen as more exotic because it looks like it was in the stone-age era ([Fadila, 2017](#)). Therefore, in this article, the author explores the geometry of various Lampung batiks motifs. However, due to the limitations of researchers and the diversity of typical Lampung batik motifs, the authors only limit their exploration to the Lampung *siger* batik motif, *kapal* batik motif, and *pohon hayat* batik motif. Thus, this research can be a reference for further exploring other Lampung batiks motifs.

Methods

Ethnographic research was the method used for this study. This study examines the culture that exists in society, especially in the Lampung Batik motif. This research is included in ethnomathematical research because it aims to explore mathematical concepts and moral values contained in Lampung batik motifs. The data for this study were collected through field studies and interviews. Researchers used the observation technique to find data on the field regarding ethnomathematics in Lampung batik motifs. Researchers conducted observations by observing the activities of batik Lampung Batik motifs in Andanan batik Lampung and observing Lampung batik motifs to find their mathematical elements.

In this study, the researchers conducted interviews with purposively selected sources, namely Mr. Humaidi, a humanist and retired employee of the Lampung Cultural Park, and Mr. Hidayatulloh, a typical Lampung batik craftsman as well as an entrepreneur who owns Andanan Batik Lampung. Mr. Humaidi is a native of the Lampung tribe who was raised in an environment and family that is very strong in maintaining Lampung culture. After graduating high school, he served and was accepted as a civil servant at Taman Budaya Lampung Province. Through his place of work, he became a pioneer in preserving Lampung culture.

While Mr. Hidayatulloh was a native of the Lampung tribe, who was born and raised in an environment that is thick with Lampung culture, after graduating from the Strata 2 programs in mathematics education, he began to explore Lampung batik through various pieces of training. In 2018, he pioneered the Lampung batik craft business under Andanan Batik Lampung. Apart from having a business in Lampung batik, Mr. Hidayatulloh has also

been a resource person both locally and nationally, such as from the ministry of tourism and creative economy and the ministry of industry. Because Mr. Hidayatulloh has the expertise and is also an academic in the field of mathematics education, he also develops his batik products by applying mathematical knowledge to the batik cloth he produces.

The type of interview used by the researcher is a semi-structured interview. Questions in semi-structured interviews are more accessible and more flexible in their implementation when compared to structured interviews. Researchers still use interview guidelines in conducting interviews but can be developed conditionally when conducting questions and answers. It is so that when conducting interviews, an open and non-rigid situation is created. Interviews were conducted with two sources, Mr. Humaidi and Mr. Hidayatulloh, who were deemed able to provide in-depth information regarding Lampung batik motifs.

In addition, the researcher reviewed the literature on Lampung batik to complete the findings from these interviews and observations. Photos, videos, and field notes document all data. Furthermore, source triangulation methods were used to look for the data to see if there was a connection between mathematical concepts and values in Lampung batik motifs. The triangulation technique was used by comparing the data obtained from field observations, interviews, and a literature review on mathematical concepts and values in Lampung batik motifs. The last step is describing the data to investigate each study's findings.

This research is limited to informants who have the same background. In this case, are native Lampung people use the same language, namely Lampung language; have the same administrative area, namely being in Pesawaran Regency, Lampung Province; and possess the same historical knowledge as them, namely history when living, growing, and develop in Lampung. There are seven main descriptions produced in ethnographic research: language, technological system, economic system, social organization, knowledge system, art, and religion (Koentjaraningrat, 2015). In this study, the knowledge system is the primary focus of the research. It is because researchers must observe and investigate the community's knowledge and art system to discover the fundamental knowledge used to create the batik motifs and the cultural values incorporated into the art of batik motifs.

In the process of this research, the researcher uses an ethnographic research design adopted from the research design designed by Prahmana and D'Ambrosio (2020), which can be seen in Table 1 below.

Table 1. Ethnographic research design

General Questions	Initial Answers	Starting Point	Specific Activity
Where to start looking?	The Lampung people are responsible for the production of batik motifs, which incorporate mathematical techniques.	Culture	Interviewing members of the Lampung community who are familiar with Lampung culture or who make batik motifs in Lampung
How to look?	Analyzing the Quantitative,	Alternative thinking and	Find out what QRS concepts the Lampung people use to

General Questions	Initial Answers	Starting Point	Specific Activity
What it is?	Relational, and Spatial (QRS) aspects of Lampung residents' mathematics-related batik motif making practices. Evidence (The outcomes of the previous process's alternative thinking)	knowledge system Philosophy of mathematics	make batik motifs in activities that are related to math practice Identifying QRS characteristics in the mathematics-related activity of making batik motifs in Lampung society. It demonstrates that the process of creating batik motifs for the Lampung people does have a mathematical aspect, as evidenced by the components of knowledge and art systems that are utilized in everyday life.
What does it mean?	Valued important for culture and important value patterns for mathematics	Anthropologist	Describe the connections between the two cultures' and knowledge systems' of mathematics. Describe the mathematical concepts used in the process of creating batik motifs for the Lampung community.

Results

Lampung is famous for having an island with a million *siger*. In addition to the *siger*, there is also a Lampung elephant, a characteristic of the Lampung area. Thus, the people of Lampung developed *siger* and elephant images on filter cloth and batik. In addition, the most famous Lampung batik motifs are *kapal* motif and *pohon hayat*, or the tree of life. These two motifs are very distinctive for Lampung culture. They are Lampung's trademarks in the eyes of the international community because they are found in several museums in Australia, Hawaii, and America (Fitinline, 2013). Due to the diverse characteristics of Lampung culture, Lampung batik has various motifs, including the *siger* motif, *kapal*, *pohon hayat*, *gajah*, *kupu-kupu*, *sembagi*, *gamelan*, *pramadya* style, and others. Some of the oldest motifs include *kapal* motif and the *pohon hayat*, while one of the most famous Lampung regional icons is the Lampung *siger*. Thus, considering the author's limitations, the authors limit the study of exploratory geometric transformations to three motifs, namely the *siger* motif, the *kapal* motif, and the *pohon hayat* motif.

The geometric transformation consists of translations, reflections, rotations, and dilations. The translation is a transformation that moves points in a plane with a particular direction and distance. In addition, reflection is a transformation that moves each point in the plane by using the properties of the image by a mirror. The rotation is a transformation that moves points by rotating them by an angle α to a certain point. The dilation is a transformation that changes the distance from the points by a specific multiplier to a certain point. It can be seen in Figure 2 below.

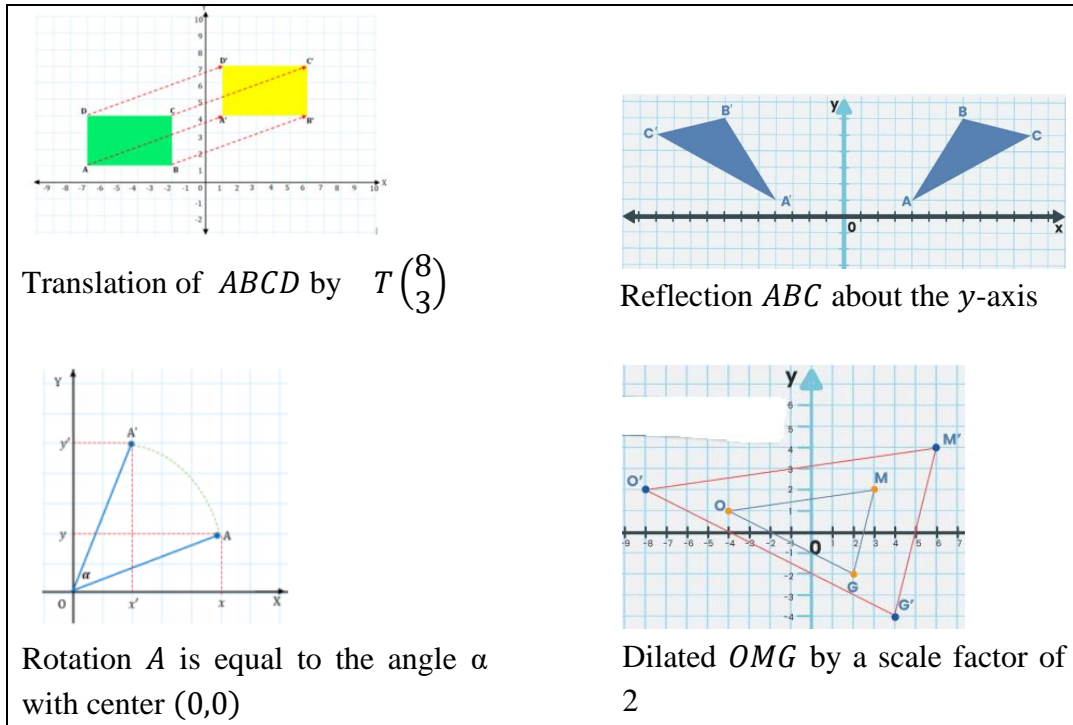


Figure 2. Transformation geometry concept

Value and Geometry Transformation in Lampung Siger Batik

The *siger* symbol for Lampung women and its application to Lampung batik motifs can be seen in Figure 3 below:



Figure 3. *Siger* and Lampung *siger* batik motifs

Figure 3 shows *siger*, a Lampung women's jewelry worn at traditional events and poured into the cloth as a typical Lampung batik motif. Based on the results from an interview with Mr. Humaidi indicated that:

Researcher : Sorry sir, I want to ask about the *siger* motif in Lampung batik. Actually, what is the philosophy of this *siger* for the people of Lampung themselves?

Humaidi : Siger is worn by Lampung women as a magnificent piece of jewelry. This symbolizes that behind the softness of a woman has strength.

Besides batik motifs that have a philosophy, the Lampung *siger* batik motif also uses the concept of geometric transformation in the form of reflection, translation, and dilation, as shown in Figure 4.

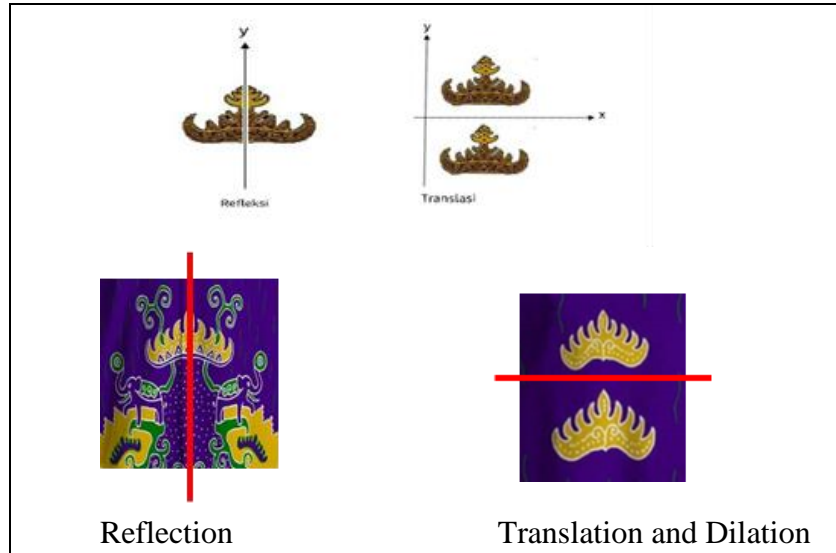


Figure 4. Geometry transformation of Lampung *siger* batik motifs

In Figure 4, it can be seen that there is a reflection where the image is the result of a reflection of the axis of symmetry. Figure 4 also shows the results of translation and dilation where the resulting image is the result of both shifting and shrinking (shrink). Applying *siger* motifs with different batik patterns allows for different geometric transformation results.

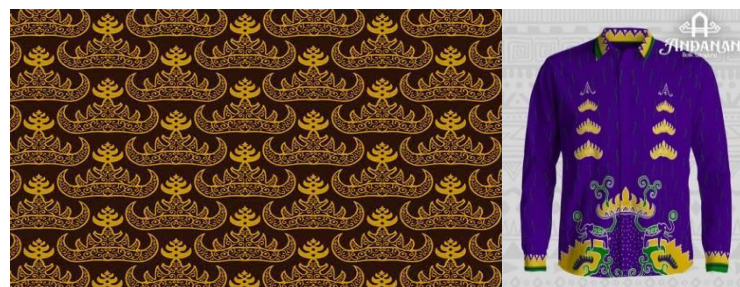


Figure 5. The motif of batik *siger* Lampung

Figure 5 shows the *siger* motif applied to Lampung batik. *Siger* is a unifying symbol of the tribes in Lampung Province. *Siger* was a description of the uniqueness of the Saibatin and Pepadun people, symbolized in the form of a *siger* curve.

Values and geometry transformations in *kapal* batik

As shown in the following excerpt from the interview with Mr. Humaidi:

Researcher : What do you think is the philosophy of this ship's batik motif, sir?

Humaidi : Well, ma'am, the Lampung area is mostly water, so many people make a living as fishermen. In this way, this ship became one of the characteristics of the people of Lampung. This ship also has a philosophy/value, Ms. If you see that the ship is balanced, it symbolizes the harmony between its citizens. It indicates that humans and nature are interrelated.

Besides batik motifs that have values, the ship batik motif also uses the concept of reflection as a form of geometric transformation, translation, and dilation, as shown in Figure 6.

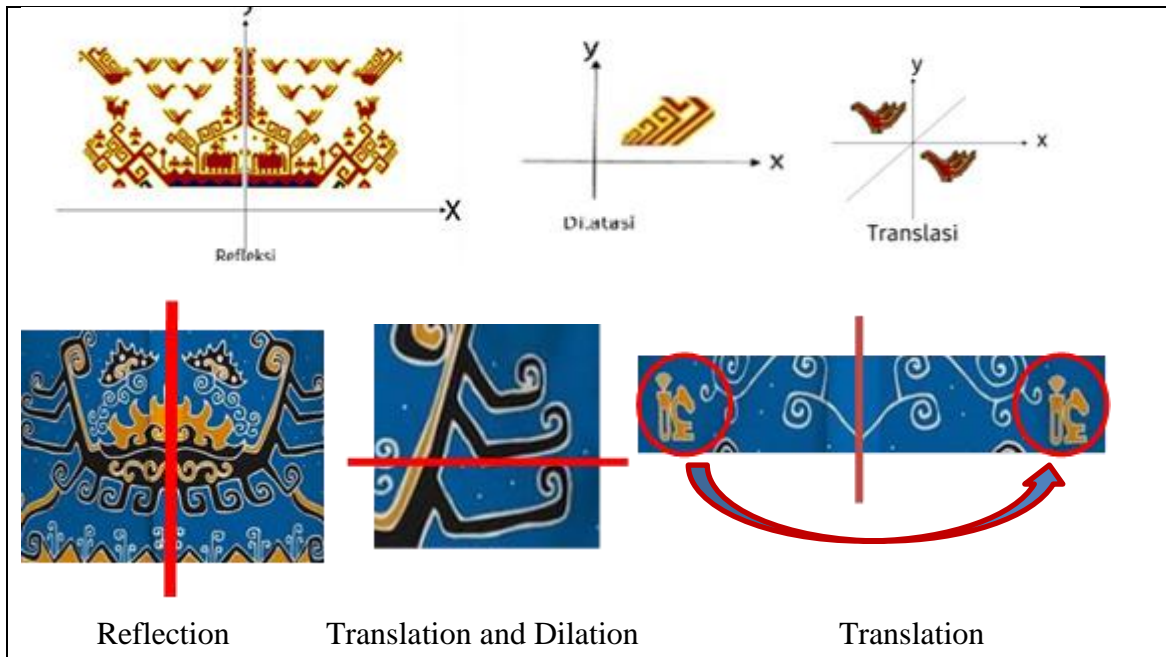


Figure 6. Geometric transformation of a ship/*kapal* in batik motifs

In Figure 6, it can be seen that there is a reflection where the image is the result of a reflection of the axis of symmetry. Figure 6 also shows the translation results where the resulting image results from a shift. In addition, there are translation and dilation results where the resulting image results from both shifting and shrinking (shrink). Applying *kapal* motifs with different batik patterns allows for different geometric transformation results.



Figure 7. Batik motif of ship (*kapal*)

Figure 7 shows the ship motif found in Lampung batik. At first, the ship motif's philosophy was considered a journey of the human spirit that had just died to the afterlife. However, after Islamic teachings entered the people of Lampung, the philosophy of the ship motif turned into a journey of human life. In addition, the ship is also the harmony between its citizens, indicating that humans and nature are interrelated.

Value and geometry transformation of the tree of life (*pohon hayat*)

As shown in the following excerpt from the interview with Mr. Humaidi:

Researcher : What do you think is the philosophy of *pohon hayat's* batik motif, sir?

Humaidi : *Pohon hayat* means the tree of life, which is the source of life. It signifies the existence of God Almighty as the giver of life.

The batik motif also employs the idea of geometric transformation in the form of reflection. In addition to having a philosophy, as shown in Figure 8.

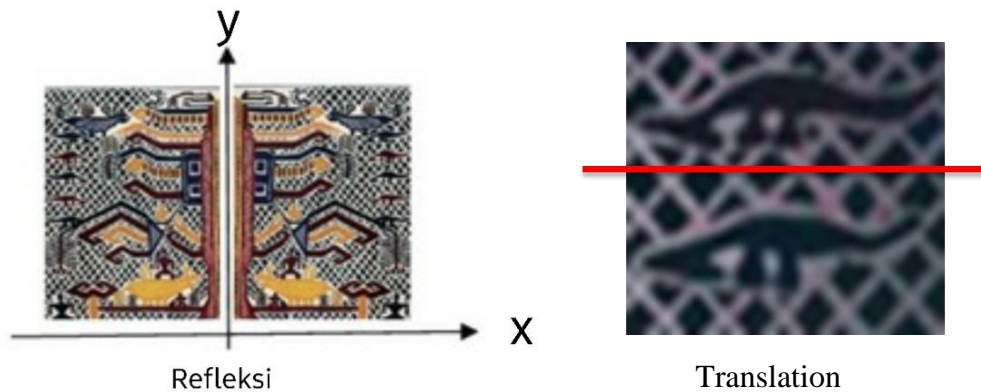


Figure 8. Geometry transformation of the tree of life (*pohon hayat*) batik motif

In Figure 8, it can be seen that there is a reflection where the image is the result of a reflection of the axis of symmetry. Figure 8 also shows the translation results where the resulting image results from a shift. Applying *pohon hayat* motif with different batik patterns allows for different geometric transformation results.



Figure 9. Batik motif of tree of life (*pohon hayat*)

Figure 9 shows the tree of life motif, originally mostly applied to the Sarongs of Lampung women. However, this motif is widely used for clothing according to fashion developments. *Pohon hayat* batik motif is dominated by Buddhist and Islamic cultural

influences. This motif, also known as the Tree of Life, has a deep philosophical meaning for the people of Lampung. *Pohon hayat* means the tree of life, which is the source of life. It signifies the existence of God Almighty as the giver of life.

Discussion

Geometric transformation is a part of geometry that discusses changes in location and presentation based on images and matrices (Iswahyudi, 2003). The making of Lampung batik cannot be separated from the role of the science of geometric transformation, which has been taught in schools. Simple transformations, such as translation, reflection, rotation, and dilation, can be applied to make batik, especially the Lampung batik motif (Fadila, 2017).

Value and geometry transformation in Lampung *siger* batik motifs

Lampung *siger* batik motifs are very popular in Lampung society. This batik motif reflects the hallmark of Lampung, namely *the siger*. Everyone wearing this batik motif is proud because the beautiful batik is *a siger* from Lampung (Novitasari, 2020). *Siger* is a crown for the bride of Lampung, which has a bilaterally symmetrical shape, displaying to the left and right. The *siger* has a specific number of indentations that characterize the region of origin of the *siger*. *Siger* is the *Saibatin* custom that lives in coastal areas has seven curves which mean seven *adoq* (traditional titles in the Saibatin community), namely *suttan/dalom/pangeran (kepaksian/marga)*, *raja jukuan/depati*, *inner*, *radin*, *minak*, *kimas*, and *mas/itton*. Whereas in the *Pepadun* custom, the *siger* has nine indentations which symbolize the existence of nine clans (*abung siwo megou*) (Deslima, 2021).

The *siger* motif in Lampung batik symbolizes the strength behind the softness (feminism) of a woman. There is hard work, independence, persistence, and so on behind the softness of a woman. However, the people of Lampung adhere to the *patrilineal* or *patrilineal* lineage. However, the vigor of a woman is essential, at the same time, inspiring and driving her life partner's progress (Deslima, 2021; Humaidi, 2021). The geometric transformations in the *Siger* batik motif include reflection, translation, and dilation.

Values and geometry transformations in *kapal* batik motifs

The ship (*kapal*) batik motif symbolizes the Lampung area bordered by water areas. This motif describes the characteristics of Lampung (Novitasari, 2020). The Lampung area is mostly water, so many people make a living as fishermen. This ship became one of the characteristics of the people of Lampung (Humaidi, 2021). Initially, *kapal* motif was considered as the journey of the human spirit that had just died to the afterlife, but after Islamic teachings entered the people of Lampung, the philosophy *kapal* motif turned into a journey of human life (Nugroho et al., 2021). *The Kapal* motif contains a profound philosophy that symbolizes harmony, balance, and interrelationships between human life and the natural surroundings (Humaidi, 2021). The geometric transformations in *the kapal* batik motif include reflection, translation, and dilation.

Value and geometry transformation of the *pohon hayat* batik motifs

The tree of life (*pohon hayat*) batik motif has a deep philosophy for the people of Lampung. The tree depicted here symbolizes life with the curtains of life. Usually, this cloth is used for subordinates by women as a complement to clothing (Novitasari, 2020). The *Pohon hayat* motif symbolizes unity and God Almighty as the creator of the universe (Humaidi, 2021). In addition, the tree of life symbolizes a person's ability to place himself with people who can determine his life path (Isbandiyah & Supriyanto, 2019). The geometric transformations in the *pohon hayat* batik motif include reflection and translation.

The findings from the investigation of the application of mathematical concepts for the production of Lampung batik motifs demonstrate that the inhabitants of Lampung have used the idea of geometric transformation. The concept of this geometric transformation has been self-taught and creative ideas have emerged in making Lampung batik motifs based on their experience with the batik process (Hidayatulloh, 2021). It indirectly shows the application of mathematics in a culture often known as ethnomathematics.

Even the results of ethnomathematics exploration have been used to teach mathematics in Indonesian schools. As with several results from the development of teaching materials and learning tools that have been carried out by several researchers that can be used in mathematics learning, including-based geometry transformation teaching materials discovery learning through an ethnomathematical approach (Fitriyah et al., 2018), the development of geometric transformation worksheet's with the Lampung filter motif (Khasanah & Fadila, 2018), the development of teaching materials characterized by the ethnomathematics of the Komering tribe in elementary school students (Nelawati et al., 2018) ethnomathematics in the traditional *engklek* game and its tools as teaching materials (Aprilia et al., 2019), the development of worksheets Timor woven ethnomathematics-based student work on number pattern material (Disnawati & Nahak, 2019), development of ethnomathematical-based teaching materials for one-variable linear equations and inequalities (Lakapu et al., 2020), and development of ethnomathematical-based teaching materials on geometric transformation materials (Nurmaya et al., 2021). It demonstrates that ethnomathematics-based mathematics instruction can alter students' perceptions of the connection between mathematics and their own culture and real-world experiences, thereby reducing mathematics anxiety (Prahmana & D'Ambrosio, 2020). Some of this research has successfully incorporated ethnomathematical investigation into the design of mathematics instruction. It has been demonstrated to increase student comprehension and make them feel that the mathematics they study has more significance.

In addition, the results of this study also show that every Lampung batik motif has moral values that can be reflected in everyday life regarding symbols of strength, balance, and unity (Humaidi, 2021). In addition to the use of Lampung *tapis*, the Lampung batik motif marks the characteristics within the Lampung region so that people can use Lampung batik as a symbol of their regional identity (Hidayatulloh, 2021; Humaidi, 2021). Lampung batik, as a uniform throughout the world of education, can also be used as a tangible medium in introducing the application of mathematical concepts in everyday life (Hidayatulloh, 2021).

Thus there is no doubt that mathematics is closely related to culture. In this case, ethnomathematics can be used to introduce culture to the younger generation and maintain its sustainability. The results from this study are expected to a contribution to further research to develop ethnomathematics-based mathematics learning tools, especially geometric transformation materials in Lampung batik motifs.

Conclusion

The inhabitants of Lampung frequently use the idea of geometric transformation to create batik motifs like the *siger* batik pattern, *pohon hayat* motif, and *kapal* motif. The geometric contents concept of geometric transformation used are reflection/reflection, dilation/scaling, and translation/shift. In addition, Batik Lampung has a history, philosophy, and values in each motif. These principles, such as the importance of God Almighty, unity, harmony, balance, and the strength of women's femininity, can be seen in daily life. Due to the limitations of researchers and the diversity of typical Lampung batik motifs, the authors only limit their exploration to the Lampung *siger* batik motif, the ship batik motif, and the tree of life batik motif. Thus, it is hoped that this research can be a reference for further exploring other Lampung batiks motifs. This ethnomathematical study on the culture of the Lampung batik motif can be used as a starting point in introducing culture to students in Lampung and throughout Indonesia through learning mathematics.

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Conflicts of Interest

There are no conflicts of interest to the publication of this work, according to the authors. Furthermore, the authors have addressed all instances of plagiarism, misconduct, data fabrication and/or falsification, multiple publication and/or submission, and redundancy in great detail.

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Author Contributions

Noerhasmalina: data collection and data analysis; **Binti Anisaul Khasanah:** writing, data collection and data analysis.

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