Jurnal Elemen, 11(3), 704-719, July 2025
https:/doi.org/10.29408/jel.v11i3.30721

e- ISSN: 2442 - 4226

Geometric transformation and cultural values in traditional *batik* of Banyumas and Pekalongan: An ethnomathematics study

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Abstract

Banyumas and Pekalongan *batik* are local cultural heritages of Central Java that contain philosophical values, regional identity, and geometric patterns. Although batik has been widely known as a uniform, its use as a medium for learning mathematics, especially transformation geometry, is still limited. This study aims to examine the relationship between Banyumas and Pekalongan batik motifs with the concept of transformation geometry and the cultural values contained. A qualitative approach with ethnographic methods was used through observation, documentation, in-depth interviews, and field notes. The subjects of the study included cultural figures, batik craftsmen, and tour guides at the *Anto Jamil Batik* Center (Banyumas) and the Pekalongan *Batik* Museum. The study focused on the *Jahe Srimpang* and *Babon Angrem* motifs (Banyumas), as well as *Jlamprang Gunungan* and *Jlamprang Seamless* (Pekalongan). The results showed that these motifs contain elements of geometric transformation such as translation, rotation, symmetry, reflection, and dilation. This study recommends the use of batik as a source of mathematics learning based on local wisdom.

Keywords: cultural values; ethnomathematics; geometric transformation; traditional *batik*

How to cite: Kusno, Gunawan, Nalim, Setyaningsih, E., Furqon, M., & Faiz, M. (2025). Geometric transformation and cultural values in traditional *batik* of Banyumas and Pekalongan: An ethnomathematics study. *Jurnal Elemen, 11*(3), 704-719. https://doi.org/10.29408/jel.v11i3.30721

Received: 10 June 2025 | Revised: 23 June 2025
Accepted: 9 July 2025 | Published: 31 July 2025

Introduction

Batik is an Indonesian cultural heritage that is full of aesthetic, philosophical, and scientific values. Due to its multidimensional nature, batik has long been used as a clothing material, a symbol of cultural identity, and a learning medium (Irawan et al., 2022; Kumala et al., 2022). In the context of education, batik has even been used in art and ethnomathematics learning to support culture-based education policies (Nurhusain & Upu 2025; Abduh et al., 2023). Ethnomathematics itself emphasizes the relationship between mathematics and culture, including in the geometric patterns of traditional batik (D'Ambrosio, 2017; Astriandini, 2021). Banyumas and Pekalongan batik, for example, contain a variety of motifs with distinctive characteristics that contain geometric concepts of transformation such as translation, reflection, rotation, and dilation (Kusuma et al., 2024). Transformation geometry is an abstract material and is often difficult for students to understand if it is not linked to a concrete context (Fauzi et al., 2023; Hada et al., 2021). In this case, batik has great potential as a contextual media that is close to students' daily experiences.

However, until now the use of batik as a learning resource in learning transformation geometry is still very limited (Deka & Badu, 2024). In fact, in batik producing areas such as Banyumas and Pekalongan, there have not been many systematic efforts to integrate batik motifs into formal mathematics learning. In fact, the ethnomathematics approach has been proven to be able to improve student understanding and engagement through meaningful cultural contexts (Bimantara, 2024 & Kusno et al., 2023). This disconnection between local culture and mathematical material is the gap in current learning. In addition, there are not many references or learning modules that explicitly convey between batik motifs and the concept of geometric transformation (Sape & Syamsuddin, 2025), both in textbooks and in classroom learning practices. This causes the educational potential of batik to be less than optimally explored, especially in mathematics subjects. This condition creates a blend between the richness of local culture possessed by students and their learning experiences at school. In fact, the integration of local cultural values into learning can strengthen students' identity and love for their national heritage (Sakti et al.,2024).

Banyumas batik is known for its rich and diverse motifs rich in philosophical meaning, and implicitly reflects various mathematical objects (Novikasari & Febriana, 2024). Banyumas batik motifs are inspired by nature and rural life, such as plants, birds, and local symbols (Rahayuningtyas et al., 2024). Meanwhile, Pekalongan batik is known for its diverse colors, feminine nature, and motifs influenced by foreign cultures such as India and Arabia (Rahmaputri, 2023). Among the famous Banyumas batik are the Jahe Srimpang and Babon Angrem motifs

Meanwhile, the famous Pekalongan batik motifs are Jlamprang Gunungan and Jlamprang Seamless (Kirana et al., 2021). Research by Kumala and Tsabitah (2022) shows that some Banyumas batik motifs reveal the concept of transformation geometry, and Karomah et al. (2024) found that some Pekalongan batik motifs also contain elements of transformation geometry. However, both studies are still descriptive and have not systematically linked them to the context of mathematics learning, especially through an ethnomathematics approach in

transformation geometry (Pathuddin & Busrah, 2024). This study is here to fill this gap by analyzing Banyumas and Pekalongan batik motifs in more depth through a transformation geometry approach and designing their use as contextual learning resources. Thus, this study not only identifies mathematical elements in batik, but also offers innovation in integrating local culture into school mathematics learning in a concrete manner.

This strengthens the findings of Sumarni et al (2024) and Prahmana (2021) which emphasize that the ethnomathematics approach can improve students' understanding of mathematical concepts by integrating materials with local culture. Jatayu et al., (2024) recommend the use of batik as a bridge between formal mathematical concepts and students' daily experiences. In addition, Rohim (2021) revealed that students are more enthusiastic and find it easier to understand the material when it is associated with local culture. Shofiyati (2021) even emphasizes the importance of various forms of transformation in Javanese batik, to develop meaningful learning. Batik is expected to be a contextual and realistic learning medium that is able to present various examples of interesting presentations of transformation geometry material for students (Siswanto, 2025). Based on this background, this research aims to: 1) to reveal the local cultural values contained in these motifs, (2) to identify and analyze the types of geometric transformations found in traditional Banyumas and Pekalongan batik motifs, and (3) to formulate an integration model for the results of this analysis into contextual mathematics learning in schools.

Methods

This study applies qualitative methods to explore, discover, and describe a phenomenon in human life naturally and in depth. In addition, an ethnographic approach is also used to identify and describe cultural objects through field studies (empirical) and theory (Yusanto, 2020). The choice of an ethnographic approach is based on its suitability to the objectives of ethnomathematics, namely to examine mathematical ideas, processes, and practices in a cultural context from the internal perspective of the community. In this study, observations were made on the variety of Banyumas and Pekalongan batik which required researchers to observe, listen, interact, and act in a distinctive way. The research process was carried out in a cycle, which means that data collection, analysis, and interpretation can be carried out simultaneously and repeatedly (Mezmir, 2020).

The steps in the ethnographic approach included: (1) searching for literature related to Banyumas and Pekalongan batik motifs and relevant mathematical elements; (2) selecting informants who have knowledge of Banyumas batik motifs, including their history, motifs, and philosophical values; (3) conducting interviews based on the guidelines that have been prepared; (4) recording the results of interviews in the form of ethnographic notes; (5) conducting direct observations of the determined motifs; (6) collecting documents of artifacts related to the research object; and (7) analyzing data from the observations, documentation, and interviews with 4 research subjects, which were then linked to relevant ethnomathematics literature. The objects in this study are Banyumas Batik, with Jahe Srimpang and Babon Angrem motifs, as well as Pekalongan batik with Jlamprang Gunungan and Seamless motifs.

The selection of objects was targeted because of their relevance to the material on geometric transformation, the uniqueness and philosophy contained therein. The data collection technique is based on Spradley's (2016) ethnographic approach, which includes in-depth interviews, observations, documentation, and field notes.

This study involved various informants to explore the cultural aspects of batik in depth. The informants consisted of (1) Two cultural figures, namely Sugeng Priyadi (R1) & Deni Pujianto (R2) to provide insight into the symbolism, philosophical meaning, and cultural values in batik motifs, (2) Traditional figures, one people, namely Arifin (R3) to explain the function of batik in tradition, traditional ceremonies, and the moral and social values contained therein (3) The general public (teachers) two people, namely Fitriyani (R4) and Budi Utami (R5) to explore the perception and use of batik in everyday life, (4) One Batik entrepreneurs and craftsmen, namely Septi (R_6) to provide information about production, and design inheritance of batik.

The interview process was based on three ethnographic principles: clarity of purpose, description of ethnographic context, and selection of ethnographic questions. Documentation was used to complement data from the observations and interviews, in the form of photos of activities and artifacts related to Banyumas batik. Meanwhile, ethnographic notes included various forms of documentation such as field notes, recording devices, pictures, artifacts, and other objects that can provide a picture of the atmosphere in the batik process. In this study, the researcher himself serves as the main instrument in implementing all data collection methods and techniques, as well as in the use of aids, so as to enable the formation of new information that leads to the final results of the study.

Data analysis in this study was conducted descriptively qualitatively with an ethnographic approach based on the Spradley (2016) model. The process includes four stages: (1) Domain Analysis, to identify general categories from interviews and observations; (2) Taxonomic Analysis, to compile hierarchical relationships between categories of batik motifs based on geometric shapes and philosophical meanings; (3) Componential Analysis, by comparing elements such as symbolic meanings between Banyumas and Pekalongan motifs; and (4) Cultural Theme Analysis, to find hidden cultural themes that are connected to the concept of learning mathematics. Interpretation is carried out through a combination of meanings from local languages, cultural symbols, and researcher interpretations to explain the relationship between batik motifs and transformation geometry.

Moreover, this study was conducted with reference to ethical principles. Each participant received an explanation of the purpose and steps of the study and were given informed consent. The researcher ensures that the identity and personal information of the participants are kept confidential. The entire recording process was carried out with the knowledge of the participants, and the final results of the study were shown to them for verification.

Results

The Banyumas *batik* motifs tend to be straightforward and symbolic, reflecting the values of simplicity, local wisdom, and closeness to nature and the agrarian life of the local community.

This is in line with Apriliyanto's statement (2019) that Banyumas batik is very philosophical. In contrast, Pekalongan batik tends to be complex and varied, reflecting cultural openness, the influence of acculturation, and the expressive spirit of coastal communities. Visually and mathematically, these two types of batik show the application of the principles of transformation geometry in the arrangement of motifs and their composition. Of the various Banyumas batik motifs, the most relevant to the Transformation Geometry material are the Jahe Srimpang and Babon Angrem motifs, which are full of meaning about balance and the role of women in the family. Meanwhile, in Pekalongan batik, the Jlamprang Gunungan and Jlamprang Seamless motifs not only display geometric transformations, but also contain spiritual and philosophical values about the journey of life and infinity. Thus, this study not only finds the integration between batik motifs and the concept of geometric transformation, but also reveals the cultural meaning inherent in it, which has the potential to be integrated into contextual mathematics learning in schools. The results of interviews with respondents at the Anto Jamil Banyumas Batik Center and the Pekalongan Batik Museum are as follows:

Researcher	:	In Banyumas Batik, the Jahe Srimpang Batik Motif is symbolized by birds, ginger and creeping roots. While in the Babon Angrem motif it is symbolized by a mother hen incubating her eggs. What do you mean, sir?
Sugeng Priyadi (S_1)	:	Birds symbolize freedom and spirituality, ginger symbolizes resilience or healing, while the creeping roots depict a life journey full of twists and turns but meaningful. While the Baboon incubating its eggs symbolizes my love, patience and willingness to sacrifice.
Researcher	:	In Pekalongan Batik, the Jlamprang Gunungan Batik Motif is symbolized by repeated triangles and colorful flowers. While the Jlamprang Seamless motif is symbolized by a repeating circle pattern filled with symmetrical flowers. What do you mean, sir?
Deni Pujianto (S_2)	:	In the Jlamprang Gunungan Motif, the triangle symbol represents the relationship between humans, God and nature, colorful flowers symbolize passion. While in the Jlamprang Seamless Motif, the repeating circle symbol shows continuity while the symmetrical flowers show beauty and fertility.
Researcher		In your opinion, how is batik utilized in society?
Arifin Suryo (S_3)	:	Yes, there are many, for example office uniforms, school uniforms, traditional clothing, and so on.
Researcher	:	As a teacher, how do you use batik in learning?
Budi Utami (S_4)	:	Sometimes participants are taught to observe batik motif images that represent mathematical concepts. Students can also display batik motifs to teach cultural values as well as learning with learning materials in class.
Fitriyani (S_5)	:	In my experience, sometimes participants are asked to design batik using mathematical concepts. Sometimes students are also given the task of analyzing the mathematical concept of the batik motifs provided.
Researcher	:	Ma'am, what is this motif and how do you make it?

Septi (S_6)	:	That is the Jahe Srimpang motif. The bird and ginger plant images are made with a horizontal repeating pattern. The ginger plant is made symmetrically.

The artifacts resulting from documentation of the object or focus of the research are presented in Figure 1, as follows:

(a) Jahe Srimpang Motif (b) Babon Angrem Motif

(c) Jlamprang Gunungan Motif (d) Jlamprang Seamless Motif

Figure 1 :Banyumas and Pekalongan Batik Motifs

Banyumas batik

From the observation results in Figures 1a and 1b, it appears that the Banyumas batik motif is simpler, bolder, and dominated by dark colors such as blackish brown. In addition, it also appears that the motifs displayed depict many natural elements, such as plants, animals, and geometric shapes. This is in line with what was stated by Wulandari (2022) that Banyumas batik displays many flora and fauna elements. Currently, Banyumas batik has many motifs that carry modern themes with a combination of bright colors, but still maintain their traditional values. Of the various motifs, some of the most popular among the community include the Jahe Srimpang and Babon Angrem motifs.

1. *Srimpang* Ginger motif

From Figure 2, it can be seen that the Jahe Srimpang Motif displays elements of birds, ginger, and irregularly spreading roots, each with a philosophical meaning. Based on the results of the interview with R_1, birds symbolize freedom and spirituality, while ginger symbolizes resilience and healing. The spreading roots reflect a life journey full of twists and turns but meaningful. Natural colors such as brown, green, and brick red indicate closeness to nature and contain the philosophy of *Sangkan Paraning Dumadi* (Javanese) which means understanding the origin and purpose of life according to Javanese spiritual views.The geometric properties of the transformation in the Jahe Srimpang motif are presented in Figure 2 below:

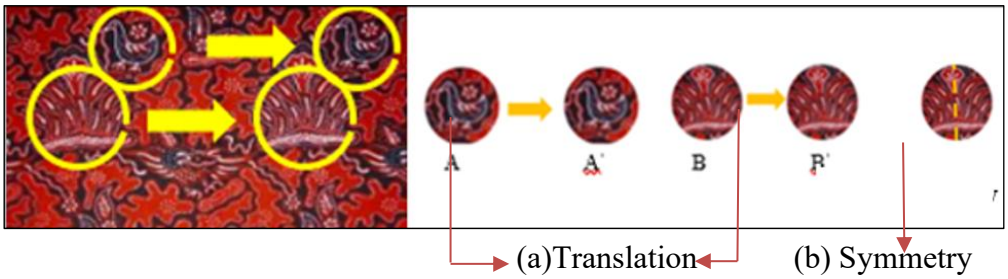

Figure 2. Geometric Transformation of Srimpang Ginger Motif

In terms of transformation geometry, this motif contains elements of (1) Translation, shown by birds and ginger plants that are moved horizontally to form a repeating pattern, (2) Folding Symmetry (Reflection), shown by the image of a ginger plant that is folded vertically, and shows balance between the left and right sides. Thus, this motif contains visual and mathematical messages that teach order and direction in life. In school learning, students can observe images of batik motifs that represent the concept of transformation so that the learning material is integrated with cultural elements.

2. *Babon* Angrem motif

From Figure 3, it is clear that the Babon Angrem motif depicts a hen incubating eggs. According to R1, this shows a symbol of affection, sacrifice and patience. The addition of natural elements such as flowers and leaves creates a harmonious atmosphere. Furthermore, the geometric properties of the transformation in the Babon Angrem motif are presented in Figure 3 below.

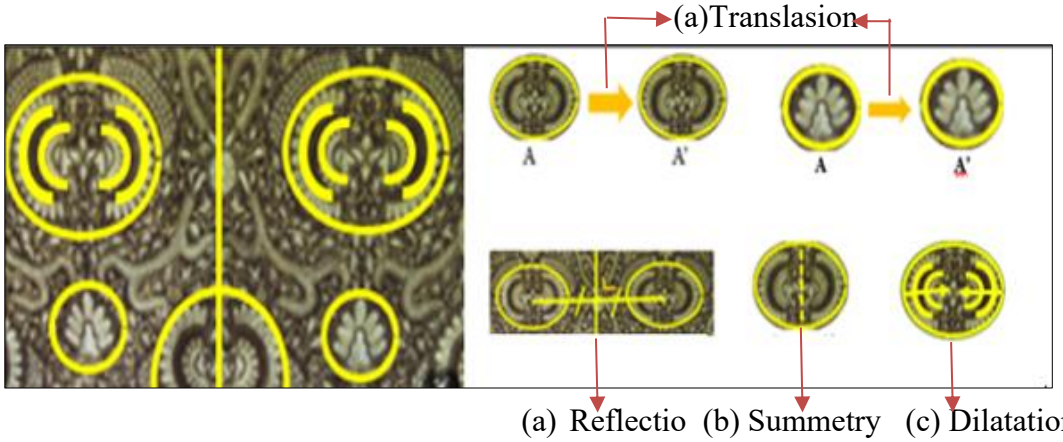

Figure 3. Geometric transformation of the Angrem Baboon motif

The geometric transformations in this motif include: (1) Translation, shown by the hen arranged repeatedly in a straight line, (2) Reflection, shown by the left and right wings of the hen which appear symmetrical, (3) Rotation, shown by a pattern that remains stable when rotated, and (4) Dilation, shown by several ornaments that appear to enlarge or shrink proportionally from a central point. In school learning, teachers can use batik motifs as a means to instill the values of patience and beauty, while also linking them to classroom learning materials.

Pekalongan Batik

Pekalongan *batik* is part of Indonesian culture that is famous for its beauty and diverse motifs. One of the characteristics of Pekalongan batik is its creative nature and is not bound by rules. The colors are bright, such as red, blue, yellow, and green, which show freedom in creating works. After Indonesia's independence, Pekalongan batik developed rapidly and became an important part of the community's industry. The city of Pekalongan is called the City of Batik because it has a Batik Museum and often holds the Nusantara Batik Week. Currently, Pekalongan batik is made not only in the traditional way such as hand-drawn batik, but also with stamp batik and printing batik techniques to meet market needs. The motifs are also influenced by foreign cultures, such as Indian and Arabic culture in the Jlamprang motif, Chinese culture in the Encim motif, and the Dutch style. The famous Jlamprang motifs are Jlamprang Gunungan and Jlamprang Seamless (Afifi & Supatmo, 2023)

1. ***Jlamprang Gunungan* motif**

   The *Jlamprang Gunungan* motif in Figure 4 reflects a blend of Javanese, Islamic, Indian, and Dutch cultures, manifested in the form of repeating triangles, floral motifs, and bright colors. Based on the results of the interview with R_2 the triangle symbolizes the relationship between humans and God and nature, The floral motif represents beauty, growth, and purity, while the colors red, blue, and yellow symbolize passion, peace, and nobility. All of these motifs imply harmony between cultural and spiritual values. The Jlamprang Gunungan motif can be presented in Figure 4 below.

(a) Translation (b) Symmetry

Figure 4. Transformation geometry in the *Jlamprang Gunungan* motif

The transformation geometry in this motif includes (1) Translation, which is indicated by small triangles that repeat horizontally and (2) Reflection, which is indicated by a symmetrical triangle pattern when divided by a center line. According to Kusrianto (2024), this motif contains spiritual values and balance that are reflected in the regularity of universal geometric patterns. An integration model that can be carried out in schools through creative projects such as designing batik based on mathematics.

2. ***Jlamprang* Seamless motif**

   The *Jlamprang* Seamless Batik Motif shows a repeating circle pattern filled with symmetrical flowers that are neatly arranged continuously. Based on the results of the interview with R_2 this continuous design represents the concept of balance between physical

and spiritual aspects, as well as the harmony of human relations with nature according to the Javanese cultural perspective. Flowers in a circle are a symbol of fertility, aesthetics, and order in the cycle of life. Furthermore, the geometric properties of the transformation in the Jlamprang Seamless motif are presented in Figure 5

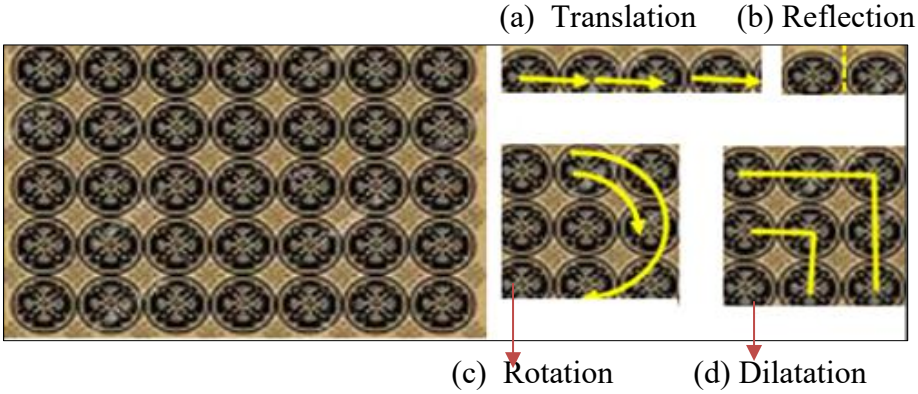

Figure 5. Geometric transformation in the Seamless *Jlamprang* motif

The transformation elements seen in this motif include (1) Translation, indicated by a circular flower pattern that repeats horizontally, vertically, and diagonally, (2) Reflection, indicated by a flower pattern that has symmetry to a certain line, (3) Rotation, indicated by a pattern that remains the same when rotated, and (4) Dilation, indicated by a motif that experiences proportional changes in size from the center. This motif is proof that traditional culture can be combined with technology and mathematical principles to produce modern visual works that remain meaningful. The integration model that can be carried out in schools is through an ethnomathematical data analysis model in the form of geometric studies on local culture. In general, the analysis of the results of the properties of geometric transformation in Banyumas and Pekalongan Batik, especially in the Jahe Srimpang, Babon Angrem and Jlamprang motifs can be presented in Table 1 below.

Table 1. Properties of geometric transformations in Banyumas and Pekalongan *batik*

Transformation Batik Motifs	Translation	Symmetry	Reflection	Rotation	Dilation
Jahe Srimpang	√	√	√	-	-
Babon Angrem	√	√	√	√	√
Jlamprang Gunungan	√	√	√	√	-
Jlamprang Seamless	√	√	√	√	√

From Table 1 above, it can be seen that Translation, Symmetry, and Reflection are the most common transformations in all motifs, reflecting the principle of order and symmetrical aesthetics in traditional batik. Rotation appears in more complex motifs (Babon Angrem, Jlamprang), showing dynamics and visual movement. Dilation is only found in modern motifs such as Jlamprang Seamless, which indicates innovation in exploring shape and size in contemporary design. Geometric transformation is not only part of formal mathematics, but the soul of batik design itself. Each transformation gives a deep visual meaning and supports the philosophical message of the motif.

Discussion

The Jahe Srimpang motif contains deep philosophical meanings, reflected in its visual elements such as ginger plants, branching roots, and birds (Syafi'i & Khomsah, 2024).The term Jahe Srimpang refers to the shape of ginger that branches sideways irregularly, depicting the dynamics of life that are not always straight and predictable. Ginger, as a herbal plant, has many benefits in people's lives, ranging from traditional medicine, cooking spices, to part of traditional rituals. According to Widia et al. (2022), ginger symbolizes healing power, resilience, and the spirit to continue growing despite facing various obstacles. The branching roots reflect the complexity of socio-cultural life, showing that humans have various choices and paths in life. Meanwhile, the birds in this motif symbolize freedom, spirituality, and the relationship between nature and the divine dimension. According to R_1, Birds symbolize freedom and spirituality, while ginger symbolizes resilience and healing.In Javanese culture, birds are often understood as a symbol connecting the real world and the spiritual world. The entire Jahe Srimpang motif is seen as a representation of *Sangkan Paraning Dumadi* as stated by Panjaitan (2022), namely an invitation to understand the origin of life and the purpose of human existence in the world.

The results of an interview with R_8 showed that the Jahe Srimpang batik motif applies the principles of translation and reflection. The fauna (bird) and flora (ginger) patterns are translated horizontally, forming a repeating pattern as in Figure 2, for example $A \rightarrow A'$ and $B \rightarrow B'$. This translation is described by the formula $A(x, y) \rightarrow A'(x + a, y + b)$. In addition, this motif also uses the principle of reflection on the vertical axis (Y axis), so that the left and right sides of the motif form symmetrical shadows. The shape of the ginger plant can be folded vertically and both sides will cover each other, showing symmetry in shape and size, as shown in Figure 2. The integration model that can be developed in schools is a visual contextual model where the motif is a representation of a mathematical concept. In this case, the batik motif is a visual medium to introduce mathematical concepts, for example (1) Students are asked to identify the types of geometric transformations found in the motif, (2) Students are asked to redraw the batik pattern and mark the axis of symmetry, center of rotation, or direction of translation.

Babon Angrem is a traditional batik motif originating from Banyumas. The Babon Angrem motif highlights the figure of a hen, eggs, and other natural elements such as leaves or flowers, which give a warm and natural impression. The coloring of the motif tends to use earth colors such as brown, soga, and cream, so that Istiqomah and Amboro (2024) call it a form of simplicity and harmony with nature. The complete Babon Angrem batik motif is presented in Figure 3. According to R_1, Babon Angrem this shows a symbol of affection, sacrifice and patience. This is in line with Amrozi and Sami (2023), that Babon Angrem shows a symbol of a mother's affection, sacrifice, and hope for a new life. Babon Angrem conveys a message of deep affection from a mother to her child. Amrozi and Sami (2023) characterize a hen incubating eggs depicting sincerity in caring for and looking after her child by sacrificing time and energy as a form of affection, devotion, and sacrifice of a mother. Incubating eggs requires patience and perseverance, because the hen must maintain body temperature and not move to

ensure the eggs hatch perfectly. Eggs symbolize the beginning of life. The incubation process is a symbol of the process of growing hope, until a new life of a chick is born.

The Babon Angrem motif applies various geometric transformations such as translation, reflection, symmetry, rotation, and dilation. Translation is seen from the chicken pattern that repeats in a straight line (Figure 3a), while symmetry and reflection are seen in the arrangement of the left and right wings that are symmetrical to the chicken's body in the middle (Figures 3b and 3c). This reflection reflects the same shape in the opposite direction to the vertical axis. In addition, the principle of dilation is applied to decorative motifs that are arranged concentrically (Figure 3d), where the small shapes in the middle are enlarged outward without changing their basic shape. This shows the use of dilation to create symmetrical beauty and harmony (Sahara et al, 2024). The integration model that can be carried out in schools is the reflective ethnomathematics model, namely learning from cultural values. In this case, students are asked to associate mathematical concepts with cultural values contained in batik, such as order, balance, and precision. Associate the symmetrical pattern in batik with social values such as justice and balance in society. Students are asked to reflect on cultural values in the process of solving mathematical problems.

The Jlamprang Gunungan motif features a triangular shape that symbolizes the journey of human life and a geometric structure that reflects ethnomathematic concepts, such as symmetry, repeating patterns, and order. In this batik, the gunungan shape is arranged into a small triangular pattern (tumpal) and ornaments resembling mountain peaks, with strong vertical lines as a symbol of the order of the cosmos and the relationship between humans and nature and God. The cultural values reflected include openness to other cultures, social harmony, precision in design, and a balance between tradition and modernity. This motif also reflects cultural assimilation, where local Javanese elements are adapted into the context of Pekalongan Jlamprang batik which is influenced by Islamic culture and Gujarati trade. The bright and contrasting colors used maintain harmony, depicting the dynamics of life in order. Through an ethnomathematic approach, this batik reveals a way of mathematical thinking that is integrated into the cultural expression of the community. The Jlamprang Gunungan motif uses a repetitive geometric pattern to avoid the forms of living things such as humans and animals. The batik above has a pattern of sharp triangles that are the same size and arranged horizontally with the same distance. The tip of the triangle points upwards, giving the impression of God's majesty. This batik pattern uses geometric transformation properties such as translation, symmetry, and reflection. In this motif, if point A(x, y) on the triangle is translated one unit to the right and b units up, then the reflection of point A is A'(x + a, y + b). The triangle pattern in this batik is in the form of an isosceles acute triangle (Roza et al, 2024). If a line is drawn in the middle, the fold symmetry will be visible, like a reflection in a mirror. This pattern shows the reflection property. In this triangle, if point A(x, y) is reflected against its center line, it will become A'(-x, y).

The integration model that can be chosen in learning at school is the creative project model by practicing designing batik based on mathematics. Students are asked to create simple batik designs using mathematical principles. For example, through (a) Group projects creating

batik motifs with translation or rotation patterns using grids (b) Group presentations explaining the form of transformation and the cultural meaning of the design.

The Jlamprang Seamless Batik motif displays a repeating pattern in the form of a circle containing symmetrical flowers, arranged regularly and connected without breaking. This pattern reflects the value of longing, balance between the outer and inner worlds, and harmony between humans and nature in the Javanese cultural perspective. Flowers arranged in a circle symbolize fertility, beauty, and a regular cycle of life. The symmetry in this motif both in rotation and translation shows the values of justice, social balance, and inner peace. The Jlamprang motif also reflects the influence of Islamic culture, seen from the use of geometric patterns without figures of living creatures, which reflect the values of monotheism and the order of God's creation. In addition, the neatness and repetition of the pattern reflect the values of precision, patience, and hard work that are important parts of the traditional batik process. The complete Jlamprang Seamless batik motif is presented in Figure 5. The Jlamprang Seamless batik at the top contains several transformation patterns, namely: (1) Translation, because the flower circle repeats with the same shape and size, both horizontally as in Figure 5(a), vertically, and diagonally. (2) Symmetry, because against a certain line the shadow of the flower circle looks the same, or reflection occurs, namely a change in the position of the flower circle by reflecting it against a certain line as in Figure 5(b), (3) Rotation, because if the flower circle is rotated 90° or 180° its shape will be as before, as in Figure 5(c), (4) Dilation, because from a certain position its size will increase or decrease proportionally, as in Figure 5(d). Therefore, Afifi and Supatmo (2023) stated that the Jlamprang Seamless motif is often used to make wallpaper, custom products, and background designs.

The integration model that can be carried out in school learning, for example, with the ethnomathematical data analysis model, namely the study of geometry in local culture. In this case, students are asked to analyze local cultural data mathematically to understand the relationship between traditional patterns and geometric concepts. For example, (a) Students measure the size of the angle, area, or circumference of batik elements using measuring tools or software, (b) Class discussions about how these concepts emerge naturally in local batik motifs.

Conclusion

The four batik motifs, Jahe Srimpang, Babon Ayam Banyumas, Jlamprang Gunungan, and Jlamprang Seamless are a harmonious blend of cultural values, life philosophies, and mathematical principles, especially geometric transformations (translation, reflection, rotation, and dilation). Each motif not only conveys meaningful visual messages such as resilience, compassion, spirituality, and modernity, but also shows order through mathematical elements such as translation, reflection, rotation, and dilation. Therefore, batik is not only a legacy of fine art, but also an educational medium that unites local wisdom with a scientific approach and contemporary aesthetics. However, these findings are still limited to batik motifs from Banyumas and Pekalongan regions, and even then they are still few. The contribution of this research lies in revealing the potential for integration between cultural elements and the concept

of transformation geometry that can be the basis for developing local culture-based learning models in the future.

Acknowledgement

Thank you to all the resource persons, especially Mr. Sugeng Priyadi, a Banyumas Cultural Figure, Deni Pujianto, a cultural figure and guide at the Pekalongan Batik Museum, Arifin Surya, a traditional figure in Banyumas, Budi Utami and Fitriani, mathematics teachers and community members who use batik, and Septi, a senior Banyumas batik practitioner, Anto Jamil, who has provided the author with good information about Banyumas and Pekalongan Batik.

Conflict of Interest

The authors declared that there is no conflict of interest related to the publication of this manuscript. In addition, the author also maintains the ethics of writing by closing the possibility of plagiarism, fraud, engineering and/or falsification of data, multiple publications and/or submissions.

Funding Statement

This research was funded by the Domestic Collaborative Research Grant of Muhammadiyah University of Purwokerto with contract number: Number: A.11-III/7896-S.Pj./LPPM/II/2024: We would like to thank the Rector of Muhammadiyah University of Purwokerto for his support in implementing this research.

Author Contributions

Kusno: Initial idea, Draft, writing, editing, visualization and data analysis. **Gunawan:** data collection and data interpretation; **Nalim:** Methodology, validation, monitoring, editing. **Eka Setyaningsih:** editing, validation. **Miftahul Furqon:** Language, validation; and **Mohd Faiz:** language, validation.

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