Exploration of Ethnomathematics in Batik Pandanwangi as a Source of Contextual Learning

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Abstract
Ethnomathematics can serve as a bridge between school mathematics learning and everyday culture. Mathematical concepts found in cultural artifacts can be used as learning resources, allowing students to gain two or more types of knowledge simultaneously, at least in terms of culture and mathematics. Cianjur Regency is famous for Pandanwangi rice, known for its distinct fragrance. The uniqueness of Pandanwangi rice is expressed in batik. This study aims to explore the ethnomathematics present in Pandanwangi Batik, which can be utilized as a learning resource for teaching mathematical concepts. A qualitative research approach with an ethnographic method was employed to explore the mathematical concepts embedded in Pandanwangi Batik. Data were collected through observation, in-depth interviews with traditional confectionery makers, and documentation of the production process. The study used a human instrument, where the researcher directly acted as the data collector by interacting with the research environment. Data collection techniques included observing the activities of batik-making, conducting interviews to understand cultural and mathematical aspects, and documenting patterns and processes involved. The research findings indicate that Pandanwangi Batik contains various ethnomathematical concepts, including proportions (e.g., proportionality, equivalent ratios, inverse ratios), number patterns, geometry, geometric transformations (translation, reflection, rotation), and social arithmetic. These mathematical concepts are derived from the production process, crafting techniques, patterns, and sales outcomes of the batik.
Keywords: Ethnomathematics, Pandanwangi Batik, Learning Resource.

Introduction

Mathematics is related to the science of measurement and numeracy, as well as logical matters, and is often identified with exact sciences. According to Kusaeri and Pardi (2019), mathematics is the result of human thought reflection, stemming from human intellect and effort. Referring to the opinion of Fauzi and Gazali (2022), mathematics is perceived in various situations as a subject associated with formulas, calculations, numbers, and as a challenging subject. The perception of mathematics as a difficult subject is a problem commonly encountered in schools today (Merdja and Restianim, 2022).

Mathematics is closely tied to social habits, particularly in communities in West Java. One of the regencies located in West Java Province is Cianjur Regency. According to information obtained from (Fikri, 2022), Cianjur Regency ranks 27th out of 27 regencies/cities in West Java in terms of the Human Development Index (HDI) score. In other words, the HDI of Cianjur Regency is the lowest in West Java, with a score of 65.56

points in 2021. Efforts are needed to help improve the HDI in Cianjur Regency, particularly in the field of education. Specifically, there needs to be an improvement in critical and logical thinking processes, which are among the skills connected to mathematics as a subject. Innovations are required to teach mathematics to students through aspects related to their daily lives, such as culture.

When learning mathematics, students are influenced by the life, experiences, and culture constructed within themselves, which they acquire from their environment, family, and local community (Kusaeri & Pardi, 2019). Culturally-based mathematics learning can serve as a medium for students to transform their discoveries and experiences integrated with culture as part of the mathematics learning process (Noto, Firmasari, & Fatchurrohman, 2018). Ethnomathematics contributes significantly to mathematics learning as it allows for cross-cultural socialization in formal education institutions, which are distinct social entities (Zayyadi, 2017).

Ethnomathematics is a form of mathematics influenced by or based on the culture of a community (Nurhasanah & Puspitasari, 2022). Ethnomathematics plays an important role in introducing culture to the younger generation while simultaneously learning mathematical concepts (Amanda & Putra, 2022). Therefore, numerous studies have examined ethnomathematics (Sugiarni et al., 2023). The abundance of studies on ethnomathematics has made it a trend in cultural education, contributing to preserving cultural values for future generations (Muhammad et al., 2023).

Ethnomathematics, as an approach that bridges mathematics and culture, offers significant opportunities to create more meaningful and relevant learning experiences for students. The novelty of this study lies in the use of Cianjur Batik as a source of contextual learning, emphasizing its potential to integrate local cultural values into mathematics education through an ethnomathematical approach, which has not been thoroughly explored in the context of Cianjur Batik. Unlike previous studies by Zayyadi (2017) and Yudianto, Susanto, and Priciliya (2020), which focused more on batik from other regions such as Madura and Bondowoso, Cianjur Batik presents unique motifs, such as *silat*, *kecapi*, and rice grains, reflecting the local wisdom of the Cianjur community. These motifs not only serve as tools for understanding mathematical concepts but also have the potential to develop numeracy ability, critical thinking, and creativity in designing culturally inspired mathematical patterns. Ethnomathematics can assist students in the mathematics learning process by studying mathematics through culture, changing their

mindset to see mathematics as an easily learned subject connected to everyday life (Wulandari & Kusumah, 2022). Furthermore, this approach opens new opportunities for preserving local culture through education, making mathematics learning not only relevant to students' daily lives but also a means to enhance cultural awareness (Sugiarni et al., 2022). Thus, the use of Cianjur Batik as a learning medium offers a unique approach that connects mathematics, art, and culture, which has not been widely implemented in educational settings.

A review of previous studies reveals a gap related to the ethnomathematics of Cianjur culture. No research has specifically explored the ethnomathematics found in Cianjur batik. Further exploration of the ethnomathematics in Cianjur batik is needed. The novelty of this research lies in exploring the ethnomathematics of Cianjur batik motifs and implementing their use in mathematics learning. This effort aims to make Cianjur batik a tool and medium for students in Cianjur Regency to learn mathematics. Thus, it is hoped that mathematics learning in Cianjur will improve and progress further.

Method

This study adopts an ethnographic approach with a qualitative method. Considering the method and approach, the research utilizes human instruments, where the researcher acts as the primary data or information collector, directly involved with the research object. The researcher's role in this context is irreplaceable. The ethnographic or ethnomethodology model is a qualitative research model aimed at describing the cultural characteristics of individuals or groups of people who are members of a cultural community (Hanurawan, 2016). Additionally, ethnography is a method concerned with describing people and their behaviors, both as individuals and as part of a group, influenced by the culture or subculture in which they live and operate (Hammersley & Atkinson, 2007). The data collection methods employed include observation, interviews, and documentation.

The research procedure adopts the steps used in ethnographic research according to Spradley (1997), consisting of six stages. The first step is selecting the ethnographic project. At this stage, the process begins with selecting an ethnographic project based on the scope of the research. The scope of this research is limited to exploring ethnomathematics related to Pandanwangi Batik.

The second step involves formulating ethnographic questions. During this stage, the researcher seeks information about Pandanwangi Batik by asking an informant. The selected informant is the owner of one of the Pandanwangi Batik businesses, who is actively involved in the production and sales processes of Pandanwangi Batik.

The third step is collecting ethnographic data. At this stage, the researcher directly visits the Pandanwangi Batik production site to gather data and information. The collected data is presented in descriptive form, including the questions and responses from the informant related to the research questions, as well as direct observations.

The fourth step involves making ethnographic records. At this stage, the ethnographic notes created by the researcher include field sketches and audio recordings of interviews with the informant. The captured images depict the production process of Pandanwangi Batik.

The fifth step is analyzing the ethnographic data. During this stage, the researcher analyzes the collected data. The analysis involves domain analysis and taxonomic analysis. Domain analysis is used to obtain comprehensive information about Pandanwangi Batik as the focus of the research. Additionally, domain analysis emphasizes grouping data based on these categories. Subsequently, taxonomic analysis is carried out by detailing the categories based on mathematical concepts related to Pandanwangi Batik.

The sixth step is writing the ethnography. This stage involves presenting the research findings, including the results of interviews, field observations, and documentation, which provide a description of the relationship between mathematical concepts and Pandanwangi Batik.

Results and Discussion

Based on the exploration results on Batik Pandanwangi, there are mathematical content and contexts found so that they can be a source of contextual learning in mathematics subjects in schools. This shows that local culture, especially Batik Pandanwangi, has great potential to enrich mathematics learning through an approach that is closer to everyday life. The mathematical content and context of Batik Pandanwangi are as follows:

1. Concept of Ratio and Proportion

The exploration of ethnomathematics in Pandanwangi Batik reveals the concept of time comparison in the production process between stamped batik and hand-drawn batik.

Stamped batik requires less time as the motifs are printed using a stamp tool, whereas hand-drawn batik takes longer since each motif is manually drawn using a canting tool. This time comparison, for example, can be expressed as a ratio such as 5:1 if hand-drawn batik takes five times longer than stamped batik. This concept is relevant for mathematics education, particularly in understanding proportions and ratios, while also introducing local culture to students, thereby integrating tradition with the strengthening of mathematical competencies.

The time required to complete stamped batik is 2 days, while hand-drawn batik takes 10 days. Thus, this can be expressed in the form of a ratio of 2:10 or 1:5.

The proportional relationship between the number of batik pieces produced and the time spent can be explained through proportional relationships (Figure 1). For instance, if a batik maker can produce 5 pieces of stamped batik in 10 hours, whereas, in the same amount of time, they can only complete 1 piece of hand-drawn batik, then the ratio of the number of batik pieces produced is 5:1, while the time spent remains equal, i.e., 10 hours. In this context, the greater the number of stamped batik pieces that can be produced within a given time period, the more efficient the stamping method compared to the hand-drawing method. This relationship can be formulated as:

Many Batik: Processing Time

Thus, the production efficiency ratio can be used to teach students the concept of equal comparison. In Pandanwangi batik workers, the relationship between the number of workers and the time it takes to make batik tulis reflects the concept of inverse comparison. For example, if there is an order for 6 batik tulis cloths, and 3 workers can complete the order in 60 days, then by increasing the number of workers to 6 people, the processing time can be reduced to 30 days. This happens because the more workers there are, the tasks can be divided equally so that the processing time is reduced. This relationship can be formulated as Number of Workers × Processing Time = Constant, where in this example, $3 \times 60 = 6 \times 30 = 180$, which means the number of "worker-days" remains the same. This concept can be used to teach inverse comparison in mathematics, while at the same time relating learning to the real life of Pandanwangi batik workers.

Figure 1. Pandanwangi Batik Making Process

2. The concept of sequence patterns

The Beasan (rice grain) motif follows the pattern 1, 3, 5, …, which means each term in the Beasan motif pattern has a difference of 2 with the next term. If adjusted to the arithmetic sequence pattern with a common difference of 2, the nth term can be determined as (Figure 2). Meanwhile, the Rice (padi) motif follows the pattern 2, 4, 6, …, which means each term in the Rice motif pattern has a difference of 2 with the next term. If adjusted to the arithmetic sequence pattern with a common difference of 2, the nth term can be determined as . $U_n = 2n - 1$.

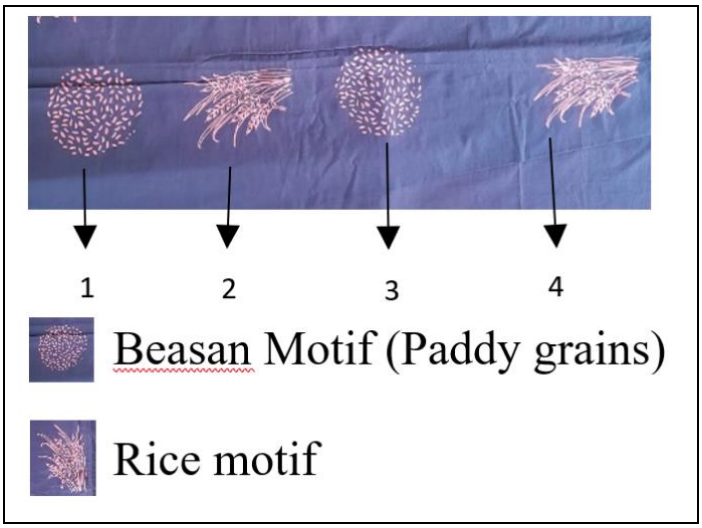

Figure 2. Pandanwangi Batik Motif

3. Geometry Concept (Planet Shapes)

It is said to be included in geometry because it can be seen in figure 3 which is circled in green, the motif is in the form of a flat shape, namely a circle.

Figure 3. Geometric Motifs on Pandanwangi Batik

4. Concept of Geometric Transformation

In the process of stamping Pandanwangi batik, there is an application of the concept of geometric transformation, especially translation (shifting). The technique of moving sideways is done by shifting the stamp print that has been dipped in batik wax onto the fabric as far as x units to the right, where x is the length of the batik print. This process ensures that the batik motif is printed sequentially and neatly arranged without overlapping or gaps as in Figure 4.

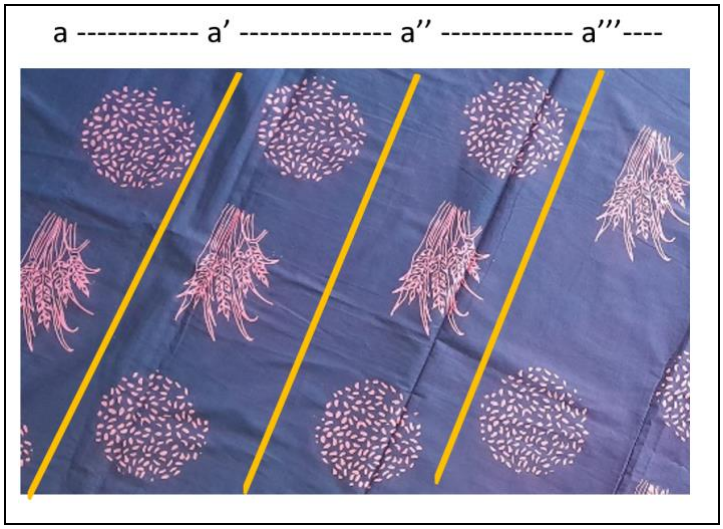

Figure 4. Geometric Transformation Motif on Pandanwang Batik

In mathematics, this translation can be represented in Cartesian coordinates. If the initial position of the lower left corner of the print is (a,b), then after the print is shifted x units to the right, the new position becomes (a+x,b). This shift is repeated until the entire fabric is filled with the motif. This concept shows how geometric transformations are applied practically in art and culture, providing an opportunity to relate mathematics learning to the real activities of batik workers.

5. Social Arithmetic

In the sale of Pandanwangi batik, the concept of social arithmetic can be used to calculate sales turnover based on the number of batik sold and its selling price. For example, if the stamped batik with the Cianjur Manjur motif is sold for Rp200,000.00 per cloth and the hand-drawn batik with the Pandanwangi motif is sold for Rp500,000.00 per cloth, then the total turnover can be calculated using the formula:

Turnover = (Number of Stamped Batik × Price of Stamped Batik) + (Number of Hand-drawn Batik × Price of Hand-drawn Batik)

For example, if in one month 30 stamped batik cloths and 10 hand-drawn batik cloths are sold, then the sales turnover is:

Turnover = (30×200.000)+(10×500.000)=6.000.000+5.000.000=11.000.000

Thus, the concept of social arithmetic can be used to teach students about the application of mathematics in real life, especially in calculating income from businesses such as batik sales. The exploration of ethnomathematics in batik has also been studied by several researchers. For example, research by Nisa et al. (2019) revealed the application of the concept of line symmetry and rotational symmetry in typical Solo batik motifs, which are used as geometry teaching materials in schools. Another study by Hidayah and Kusuma (2021) showed that the technique of making hand-drawn and stamped batik contains the concept of translation and pattern repetition, which can be used for mathematics learning, especially in geometric transformation material. In addition, Rahmawati et al. (2022) identified the use of the concept of comparison in the processing time and efficiency of batik production in Pekalongan, which is relevant for learning social arithmetic. These studies show that batik is not only a cultural heritage, but also a contextual and applicable source of mathematics learning.

Conclusion and Suggestion

The results of ethnomathematics exploration on Pandanwangi batik show that various mathematical concepts, such as comparison, sequence patterns, geometry,

geometric transformation, and social arithmetic, can be found in the process of making and selling batik. The concept of comparison is seen in the analysis of the processing time of stamped and hand-drawn batik, as well as in the relationship between the number of workers and the time required. Geometric transformation is applied to the stamping technique with a sideways translation as far as the length of the batik print. Meanwhile, social arithmetic is used to calculate sales turnover based on the number of batik sold and its selling price. By linking these concepts to local culture, Pandanwangi batik can be used as a contextual and meaningful learning resource for students, improving mathematical understanding while strengthening appreciation for Indonesian cultural heritage.

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