Ethnomathematics: Exploration in Javanese culture

Irma Risdiyanti and Rully Charitas Indra Prahma
Universitas Ahmad Dahlan, Jl.Soepomo 55164,Yogyakarta,Indonesia

E-mail: irma.risdiyanti28@gmail.com

Abstract. This research is the exploration study to indicate the correlation between mathematics and Javanese culture. These studies have a purpose of exploring Javanese culture in Yogyakarta that contains mathematics concept namely Batik. The activity of society in making Batik in all regency at Yogyakarta is the focus of this study. The research use ethnography method. The technic to collection data uses principles in ethnography such as observation, interview, documentation, and field note making with the original ethnography description. The result is exploration ethnomathematics in the several motifs of Yogyakarta batik that contains philosophy, deep cultural value, and mathematics concept, especially geometry transform subject.

1. Introduction
Developing and applying mathematical concepts based on daily-life problem situations is a part of student learning process [1]. The activity is also explained by Freudenthal [2] if mathematics is a human activity and must be related to real life. However, nowadays, mathematics is still viewed as something that far from the human life [3]. Karnilah [4] explains that the rational reason if society considers that mathematics is not related to culture, it starts with the behavior of students who not understand to use mathematics to solve the daily life’s problem. So this makes society even less the benefit of mathematics. Prabawati [5] also explain that mathematics regarded as a perfect science, the truth is objective and far away from the reality of daily life. Similarly, explain by Suyitno [6] one form of misunderstanding of mathematics is the assumption that mathematics is an exact whose truth is absolute.

Mathematics always taught in school as a cultural subject that involves learning supposedly from universally accepted facts, concept, and content [7-9]. The learning of mathematics that far from daily life and detaches itself from the culture has an impact on the ability of the student in solving mathematical problems related to the real life [9]. The learning process evidenced in the results of PISA (Programme for International Student Assessment) that was analyzed by Stacey [10] has shown that Indonesian student was not able to use mathematical concepts to solve the real-life problems. They are difficult to solve the math problem in the form of the mathematical project because during this time students tend to be taught practical formulas that will be used to answers the exam questions.

Arisetyawan [11] explain that the one reason student not able to use mathematics concepts to solve the real-life problem is because the teacher in the school does not relate the cultural and daily activities in the learning process. So, learning mathematics, students need a bridge between mathematics and culture that is ethnomathematics [12]. It means that ethnomathematics is a cultural-influenced mathematical form. D’Ambrosio [13] explain that ethnomathematics has a purpose to recognize that to
doing mathematics there are have different ways with considering academic knowledge developed by a different sector of society and by considering different modes in different cultures.

Indonesia is one country that has much cultural diversity from Sabang to Merauke, including on the Java Island, especially in Yogyakarta known as a cultural city. There are some cultural activities in Yogyakarta. They have implemented some mathematics concept namely the batik home industries activity. The activity is almost doing by society in all regency of Yogyakarta. Danoebroto [14] explain that in the art form of batik is produced the transformation of points, lines or data fields through translation, rotation, reflection or dilation.

Yogyakarta has a typical batik or known as batik keraton (palace) which has a philosophy and contain full deep of meaning. Ethnomathematics not only math but also explore the cultural values that existed inside. Researchers are interested in exploring how the exploration of ethnomathematics in Javanese culture, especially in the activities of batik and digging the cultural values in this activity. It expected that the result of this research could bridge math with culture and also cultural values can be used as learning and applied in daily life or classroom learning.

2. Method
Implementation of the research procedures doing from April until June 2017 done with three main steps that is an analysis of the data in pre-field, analysis of the data during of field and analysis of the data overall [12]. The research used qualitative descriptive as the research’s type to explain and obtain information overall, extensively and deeply [15].

In the other than, this research uses the ethnographic approach as a research approach. Three research boundaries used to be the base of research which is consisting of the unity society who is just using single language dialect, the unity of society bundled with the boundaries of political administration and the unity of society who have same historical experience, so can get the data from the native source. In this research to selected the boundaries determine based on the boundary set of ethnographic research [12]. The technic of collection data uses principles in ethnography such as observation, interview, documentation, and field note making with the original ethnography description [15].

3. Results and discussion
The research output shows that culture inheritance such as batik still be interested and be kept by Javanese people. Didik [17] explain that Indonesia batik is the Indonesian kingdoms inheritance, while in Yogyakarta batik was heritage by the Mataram Kingdom that became the basic design motif of keraton Yogyakarta and keraton Surakarta batik. He also said if batik of Yogyakarta does not only have a beautiful motif, yet containing philosophy, full of deep meaning and there are prayer and hope inside.

Batik as one of the cultural heritage needs to be positioned strategically, mainly through education as a means of resistance so that local identity can incise and strengthen local character [18, 19]. In another fact, apparently in batik motif of Yogyakarta making, it is used transformation geometry concepts such as reflection, rotation, and dilation.

3.1. The philosophy, cultural values and the application of geometry transformation in motif of Semen Rama batik
Semen Rama batik is a batik that made in Paku Buwono IV government who had the throne in 1788-1820 M [17]. This motif gives a lesson to his son who has chosen as Putra mahkota (princes). In history, the motif of Semen Rama batik is taken from Prabu Wijaya’s advice to Raden Gunawan Wibisono when he would replace king of Alengka Kingdom after Prabu Dasamuka had passed away. The advice of Prabu Wijaya is called Hasta Brata that has eight advice that must be done by the leader or king of a Kingdom. The eight messages are as follows Indrabrata symbolized by plants. This symbol has meaning, if it is a leader must to give the prosperity and save the earth. Yamabrata symbolized as a mountain or something high; this symbol has meaning if a leader be must give justice to other people. Sasibrata symbolized as a star, the meaning of this symbol that if be a leader must give brightness for they are in the darkness. Suryabrata symbolized as a garuda; the meaning is if be a
leader must have a strong heart and no halfway in taking a decision. Bayubrata symbolized as flying animal or bird; this is advising the goodness or high position that does not show off the authorization. Barunabrata symbolized by a dragon or something that have related to water; the is advising wellas asih or the attitude to easy, forgiving fault. Agnibrata symbolized by fire as a meaning of power to grab the angkara murka (natural appetite or desire) and the power to safeguard other people. Danabrata symbolized by heirloom; the meaning is if be a leader must giving reward or blessing to other people. Furthermore, to making motif of Semen Rama batik, students can apply geometry transformation seen in Figure 1.

![Figure 1](image1.png)

**Figure 1.** The application of geometry transformation in motif of Semen Rama batik

Figure 1 describes the application of geometry transformation in the motif of Semen Rama batik, to making this motif can the applied reflection of several ornaments using y-axis in Cartesian coordinate system.

3.2. The philosophy, cultural values and the application of geometry transformation in motif of Kawung batik

The motif of Kawung batik has a form like four circles or ellipse that is similar to the coconut or kolang-kaling (the fruit of sugar palm) that arranged neatly and geometrically [20]. The four of circles represent the four directions of the wind that pivot on the force of the east as the source of life, north as the dwelling place of God, west as the source of luck and south as the center of everything. The circle’s center that pivot the center of power is symbolized as king, in this case, the king as a center surrounded by his people as a center of science, art, culture, religion, government, and economy. The people must obey the king, but a king is also always giving protect to his people. Also, the motif of Kawung batik also interpreted as a symbol of the simplicity of a king who is always giving justice and prosperity to his people. Furthermore, to making motif of Kawung batik, students can apply geometry transformation that describes in Figure 2.

![Figure 2](image2.png)

**Figure 2.** The application of geometry transformation in motif of Kawung batik
Figure 2 explains the application of geometry transformation in the motif of Kawung. To making this motif can applied reflection of an ornament by x and y-axis and also can using rotation with $0^\circ$, $90^\circ$, $180^\circ$ and $270^\circ$ toward x or y-axis or can also use the translation by the axis in the Cartesian coordinate.

3.3. **The philosophy, cultural values and the application geometry transformation in motif of Sidoasih batik**

The word of Sidoasih came from the word of *sido* that have to mean making something come true and the word of *Asih* that have mean affection [20]. The motif of Sidoasih batik describes if to build a family should build with full affection. So, the gotten value from the motif of Sidoasih batik is when through the family life it should use affection as the base to the built family. Furthermore, to making motif of Sidoasih batik, students can apply geometry transformations that explain in Figure 3.

![Figure 3. The application of geometry transformation in motif Sido Asih batik](image)

Figure 3 describes the application of geometry transformation in the motif of Sidoasih batik, to making this motif can apply reflection of several ornaments in the motif using y-axis in Cartesian coordinate system, and also can to applied dilatation of an ornament, so can get the motif that has the same form but have different size.

3.4. **The philosophy, cultural values and the application of geometry transformation in motif of Wahyu Temurun batik**

Didik [17] explain that the word of Wahyu Temurun is mean blessing that gave to people, on this motif, there are have several elements, one of them are semen’s motif that have characteristic as plants form. The element in this motif represents blessing that symbolized by lung-lungan (the branch of a vine), the word of lung in the Javanese language have mean tetulung (helping other people). So, this motif has meaning if it wants to get the blessing must help many people and also pray for hopefully the blessing of God. Furthermore, to making motif of Wahyu Temurun batik, students can apply geometry transformation that seen in Figure 4.
Figure 4. The application of geometry transformation in Wahyu Temurun batik motif

Figure 4 explains the application of geometry transformation in the motif of Wahyu Temurun batik. To make this motif, can apply the translation of several ornaments by an axis and also can apply reflection of several ornaments in this motif by an axis in Cartesian coordinate system.

3.5. The philosophy, cultural values and the application of geometry transformation in motif of Parang Pamor batik

Parang Pamor batik is a batik appeared in the Mataram Kuthagedhe Kingdom in XVI centuries, came from the word Pamor means the light or light [20]. This batik motif is like knife blade digger radiating light of beautifulness that gives daya perbawa or authority. The prosperity, the people who wear the batik motifs Parang Pamor, the aura will be appeared or lighting. Furthermore, to make the motif of Parang Pamor batik, students can apply geometry transformation that seen in Figure 5.

Figure 5. The application of geometry transformation in Parang Pamor batik motif

Figure 5 describes the application of geometry transformation in the motif of Parang Pamor batik, to making this motif can the applied translation of an ornament in the motif using an axis in the Cartesian coordinate system.

4. Conclusion
The research shows that culture inheritance such as batik still be interested and be kept by Javanese people. Batik of Yogyakarta does not only have a beautiful motif, yet containing philosophy, full of deep meaning and there are prayer and hope inside. Moreover, also in the making of this motif applied the geometry transformation concepts such as reflection, translation, rotation, and dilatation. From the motif of batik, design student can easily to learning the concept of geometry transformation especially to a student in junior high school because the motif is familiar in the daily life of a student. To make
student easily to view the connections of mathematics concept in batik design can be done by making
the design of learning using batik design to be a starting point and using activities drawing the motif of
batik and introduce the concept of transformation in the design learning.

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