Exploration of Javanese culture ethnomathematics based on geometry perspective

K Pramudita and R Rosnawati
Universitas Negeri Yogyakarta Jln. Colombo No. 1, Karangmalang, Sleman, DI Yogyakarta, Indonesia
Email: kartikapramudita24@gmail.com

Abstract. This study aims to explore the ethnomathematics of Javanese society using cultural elements of living equipment and technology systems that are based on geometry perspective. The method used in this study was exploration. Data collection was collected through document collections, interviews and observations. Life equipment and technology systems includes in the form of transportation equipment, housing, and clothing materials. Types of transportation equipment, housing, and clothing are artefacts. Mathematics elements are explored on horse-drawn carriages, Joglo houses and batik (Lereng, Ceplok, and Jlamprang motifs). This research is important to explore information related to ethnomathematics in Java that can be used for mathematics in schools. Batik motifs (Lereng, ceklok, and Jlamprang) are ethnomatematics related to lines and angles, triangles and quadrilaterals, circles. Ethnomatematics in Joglo homes can be associated with line and angle material, triangles and quadrilaterals, constructing flat side spaces, building curved, congruent and Pythagorean theorems. Ethnomatematics in horse-drawn carriages can be associated with constructing curved side spaces.

1. Introduction
Nowadays, ethnomathematics is one of the popular issues. According to D’Ambrosio ethnomathematics is defined as mathematics practiced in cultural groups (national societies, tribes, labor groups, children of certain age groups and professional classes) [1]. From this definition ethnomathematics has a broader understanding than just ethno (ethnics) so that ethnomathematics is defined as cultural anthropology of mathematics and mathematics education. Moreover, ethnomathematics is influenced by culture. Ethnomatematics is classified into two views, namely the recognition of mathematics in cultural practices and the discovery of various ways of thinking [2].

Ethnomathematics then reaped many criticisms from philosophers and mathematicians. One of them was raised by Rowlands and Carson who criticized Ethnomatematics in learning mathematics in schools [3]. According to Rowlands and Carson, mathematics is universal and cultural linkages in learning mathematics will threaten the universal nature of mathematics [3]. The criticism was later denied by Adam, Alangui, and Barton who explained that the Second International Congress in Brazil in August 2002 on ethnomathematics had discussed formal mathematical concepts [4]. So formal mathematics is still considered in ethnomathematics [4]. Furthermore, ethnomatematics also drew criticism from several scientists.

Pais elaborated ethnomatematics at school [5]. Ethnomatheatics in schools have good goals, but not necessarily the results will be good by bringing a certain culture in schools that have a wide variety of students with many cultures [5]. Dowling explained that the implementation of ethnomatheatics
would result in poor and minority students being oppressed, felt they always need help, and were victims [6].

In 2007 D’Ambrosio wrote an article to answer the criticism regarding Ethnomatematics [7]. D’Ambrosio responded to the criticism that has been widely made regarding ethnomatematics. The purpose of ethnomatematics is to eliminate arrogance, bigotry and hatred. Presenting ethnomathematics is more friendly to students. Ethnomatematics provides motivation for students to learn mathematics. Formal mathematics and ethnomatematics each have their disadvantages. Mathematics and ethnomatematics should be side by side to complement each other in order to achieve learning goals. The modern world requires humans to be open and understand various cultures and languages so that they can support success [7].

This shows that ethnomatematics can be used as a context for school mathematics learning but still must pay attention to formal mathematics. Ethnomatematics has increasingly become a material for learning mathematics in schools. This increases the need for learning instruments and assessments that can support the implementation of ethnomatematics learning in schools. In order to compile learning instruments and assessments it is necessary to have an ethnomatematics exploration that can be used as a source of student learning.

Specific exploration related to any culture that can be used as learning material and the context of mathematics assessment in schools has been widely carried out. Javanese culture has also been used frequently in mathematics learning. However, the exploration that has been done has not linked the school curriculum. Exploration carried out tends to link culture with mathematical concepts broadly. Whereas in order to compile learning instruments and assessments in schools at certain levels, one of them in junior high school needs to be explored specifically for junior high school material with certain topics. So that the results of this study are explorations specifically aimed at junior high school material on the topic of geometry. This research is an initial research that requires follow-up. The follow-up of this study is the development of learning instruments or ethnomatics-based assessment in junior high school.

In order to conduct exploration, it should use certain tools. The tool for exploring Javanese cultural ethnomatematics is to use elements of living equipment and technology in the topic of geometry. The geometry topic was chosen because based on the results of previous studies many ethnomatics were found on the topic of geometry. On the other hand, cultural elements that can be related to the topic of geometry are on technology systems and living equipment. Ethnomatematics exploration is carried out using a geometry perspective. One of the examples is the ethnomathematics in Anatolia which is related to building construction, carpet motifs, and local game tools.

All physical forms needed by certain groups of people are included in the elements of living equipment and technology systems. So that building construction, carpet motifs and local playing equipment are cultural aspects of living equipment and technology systems. The research has been carried out in Anatolia Turkey. The results of the study can be used as a basis for designing learning instruments and assessing schools based on ethnomatics in the Anatolian region of Turkey on geometry learning [8]. The universal element of culture one of which is the living equipment and technology system [9]. The system does not only exist in Anatolia but also in various regions of the world. One of them is in Java. Java is famous for its cultural diversity. One of them is in living equipment and technology systems. The existing ethnomathematics of the island of Java will be explored based on the culture found in Anatolia in Turkey. Exploration studies have been carried out in the Balinese, Sundanese and parts of Java. However, in this study, it observed culture and ethnomathematics in general. There is still little concern about ethnomathematics which is devoted to the context of geometry using living equipment and technology systems. In addition, there is little concern about exploration that links exploration results with curriculum at certain levels of education. Even though this is needed to be used as a basis for the preparation of learning and assessment instruments.

This article describes ethnomathematics in Javanese society based on the geometry perspective on living equipment and technology systems. This exploration is expected to specifically provide
information to practitioners and people who are active in the field of junior high school mathematics to develop learning and assessment tools using the ethnomatics context in Java on the topic of geometry.

2. Method

This research is an exploratory research. Data collection in the study used document collection, interviews, and observations. Interview was conducted with Javanese people who understood the culture and wealth of Java in the system of living equipment and technology. The document study was carried out to find out relevant research in order to explore ethnomathematics in other regions and review the junior high school mathematics curriculum on the topic of geometry. The aim was to determine the direction of research and be used as a tool for exploration in Javanese society. This can be done because according to Koentjaraningrat [9], seven cultural elements, one of which is the living equipment system and technology are universal elements. On the other words, these elements exist in every region of the world. Observations were made on living equipment and technology commonly used by Javanese people. Equipment and technology were observed to be limited to residences, clothing and transportation equipment. The reason for limiting the scope of residence, clothing, and transportation because that is related to the topic of geometry in the middle school that is dominant in the three aspects of the living equipment system. These three aspects are similar to the exploration conducted by Ahmed Kucuk in Turkish Anatolia [8].

3. Result

The following is the result of Javanese ethnomathematics exploration using cultural elements of living equipment and technology systems in the form of clothing, shelter, and transportation.

| Life Equipment and Technology System | Ethnomathematics | Result |
|-------------------------------------|------------------|--------|
| Clothing Material                   | Line             | Batik motifs *Lereng* can be associated with lines parallel, coinciding, and intersecting. |
|                                     | Angle            | Batik motifs *Ceplok* can be linked to the material of angles. |
| Life Equipment and Technology System | Ethnomathematics | Result |
|-------------------------------------|------------------|--------|
| **Square**                          |                  | In *Jlamprang batik* motif, in addition to the circle, on the outside of the circle there is a square that forms a square. |
| **Housing**                         |                  | **Triangle** The roof of a *Joglo* house has a section that can be associated with the concept of a triangle. |
|                                     |                  | **Rectangle** Joglo houses door have several rectangular shapes. |
|                                     |                  | **Parallelogram** Roofs of traditional Javanese houses sometimes use bamboo braided with various patterns. One pattern can resemble a parallelogram. |
|                                     |                  | **Rhombus** Carving on bamboo where the lights in a *Joglo* house are like pictures resembling a rhombus. |
|                                     |                  | **Congruent** The *Joglo* house door has the same rectangular shape. So that it can be associated with congruent material. |
|                                     |                  | **Trapezoid** The roof of the *Joglo* house has a trapezoidal shape when observed from the front. |
| Life Equipment and Technology System | Ethnomathematics | Result |
|-------------------------------------|------------------|--------|
| Kite                                |                  | The woods that make up the Joglo roof on the inside can form a kite build using certain parts. |
| Pythagoras                          |                  | On the roof can form a right triangle of wood that composes it. |
| Beam                                |                  | The wood that supports Joglo can be associated with beam material. |
| Prism                               |                  | On the roof of the house can be associated with a triangular prism. |
| Pyramid                             |                  | The entire Joglo roof when observed from the inside is a slice of quadrilateral pyramid. This can be utilized in learning quadrilateral pyramid material. |
| Ball                                |                  | Traditional lighting places that are usually used in Joglo houses can be associated with ball material. |
4. Discussion
One of the results of the exploration of Ethnomatematics in Javanese society are on batik motifs. Batik motifs (motifs of Lereng, ceplok, and Jlamprang) have ethnomatematics which are related to lines and angles, triangles, quadrilaterals, and circles. In French and Canada motifs on traditional Ukrainian egg ornaments can be used as learning in triangular material and motifs on sling can be associated with geometric concepts [10]. Typical motifs on Spanish Alhambra paintings can also be used for learning geometry concepts especially angles [11]. Another finding, Sudirman's research shows that Paoman Indramayu batik motifs can be associated with mathematics learning in elementary school, namely the concept of dots, straight lines, curve lines, zigzag lines, line height, parallel lines, angles, triangles, rectangles, folds of symmetry, rhombus [12].

Another result of the Javanese ethnomatematics exploration is in the aspect of living in the form of traditional houses. The parts of the traditional house building, especially Joglo, are ethnomatematics which are related to lines and angles, triangles and rectangles, constructing flat side spaces, constructing curved sides, congruent, and pythagorean theorems. Architectural forms in Anatolia also have ethnomatematics which can be related to geometry [8]. Exploration carried out using a system of technology and living equipment in the aspect of transportation equipment in the form of horse carts. Constructing curved side space can be associated with ethnomatematics in the “andon” (horse carriage). Hasanudin found that in the canoe transportation there is ethnomatematics which can be used for mathematics learning [13].

Based on the explanation, it can be seen that ethnomatematics, which are cultural elements from several regions, can be related to mathematics learning. Several studies have implemented ethnomatematics in learning. In Papua New Guinea a teacher professional development program has been carried out that links mathematics with culture and it has been proven to motivate teachers to teach mathematics more meaningfully [14]. Scott examines the problem of the low mathematical abilities of African-American students [15]. Based on the results of the study, it was found that students had low motivation towards mathematics, but had a high pride in their culture so it was
necessary to associate mathematics with culture in learning, one of which was ethnomathematics [15]. Amit and Qouder conducted experimental research to test the effectiveness of curricula involving ethnomathematics [16]. The results showed that a curriculum that is integrated with culture can increase student motivation but has not been able to improve achievement. This needs to be investigated further because there are many other factors that can influence the research. One of them is time especially time of treatment or length of teaching will have an impact on the success or failure of learning. Moreover, using ethnomathematics, of course, requires a relatively longer time to determine the impact.

5. Conclusion
Ethnomathematical exploration of the elements of the technological system and living equipment produces some information. Exploration results show that traditional houses, especially Joglo houses, have ethnomathematics related to lines, triangles, rectangles, quadrilaterals, congruency, and pythagorean theorems. Batik motifs (Lereng, ceplok, and Jlamprang motifs) are ethnomathematics related to lines and angles, triangles, quadrilaterals, circles, and congruency. While the lines, rectangles, circles, and curved side spaces can be associated with ethnomathematics in andong (horse cart).

References
[1] D’Ambrosio U 1985 Source Learn. Math. 5 45
[2] Albanese V, Adamuz-povedano N, and Bracho-I R 2017 Ethnomathematics and its Diverse Approaches for Mathematics Education ed Rosa M., Shirley L., Gavarrete M., Alangui W (Hamburg: Springer) pp 307–328
[3] Rowlands S and Carson R 2002 Educ. Stud. Math 50 98
[4] Adam S, Alangui W and Barton B 2004 Educ. Stud. Math 52 334
[5] Pais A 2010 Educ. Stud. Math 76 213
[6] Dowling P 1998 The sociology of mathematics education: Mathematical myths, pedagogic texts. (Washington: Falmer Press)
[7] D’Ambrosio U 2007 Peace, Social Justice and Ethnomathematics (São Paulo, Brazil: State University of Campinas) pp 25–34
[8] Kucuk A 2013 Rev. Latinoam. Etnomatemática 7 183
[9] Koentjaraningrat 1990 Metode-metode Antropologi dalam Penyelidikan Masyarakat dan Kebudayaan Indonesia (Jakarta: UI Press) p 113
[10] d’Entremont Y 2015 Procedia - Soc. Behav. Sci. 174 2821
[11] Turmudi T 2017 Ethnomathematics: Apa Mengapa dan Bagaimana Implementasi dalam Pembelajaran Matematika di Kelas (Seminar Universitas PGRI Semarang, SENATIK) p 7
[12] Sudirman S, Son A L, and Rosyadi R 2018 Indonesia Mathematics Education 1 33
[13] Hasanuddin H 2017 Sos. Budaya Sos. Budaya 14 143
[14] Owens K, Edmonds-Wathen C, and Bino V 2015 Rev. Latinoam. Etnomatemática 8 49
[15] Le B and Scott A 2018 African American High School Students’ Attitudes Toward Mathematics and Perceptions of Extant Culturally Relevant Pedagogy and Ethnomathematics (Electronic Theses, Projects, and Dissertations) p 698
[16] Amit M and Abu Qouder F 2017 Ethnomathematics and its Diverse Approaches for Mathematics Education ed Rosa M., Shirley L., Gavarrete M., Alangui W. (Hamburg: Springer) pp 23-50

Acknowledgements
A big thank you to the people in the Cibuk Kidul who have provided information regarding the culture in Java. Then I thank to Mrs. Umi as a junior high school mathematics teacher who has provided
information related to junior high school mathematics subjects. As well as the family of Mr. Beni who has given permission to observe his *Joglo* house and Mr. Manto has allowed to observe horse carriage.