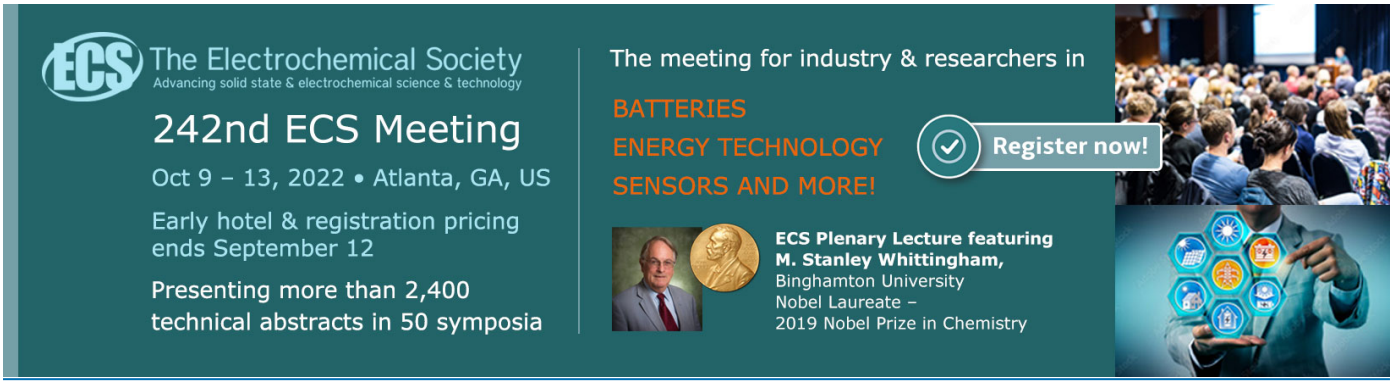
Exploration on Ethnomathematics Phenomena in Kudus Regency and its Optimization in the Mathematics Learning



Exploration on Ethnomathematics Phenomena in Kudus Regency and its Optimization in the Mathematics Learning

Zaenuri*, A N Cahyono, N Dwidayanti

Mathematics Department, Universitas Negeri Semarang, Indonesia

*Corresponding author : zaenuri.mipa@mail.unnes.ac.id

Abstract. This study aims to explore the ethnomathematics phenomena in Kudus, a regency in Central Java province, Indonesia, and its optimization in mathematics learning. We explored the cultural sites and customs of the Kudus community, including the traditional clothing, traditional food, local units, and children's traditional games. We conducted some observations, interviews, documentation, and literature review to collect data, and then the data were analysed descriptively. The results suggest that there are various forms of ethnomathematics found in Kudus Regency. The mosque of Menara Kudus and the Kudus traditional house consist of many mathematical concepts such as planar figures and solid figures. The embroidery designs in the Kudus traditional clothing and some traditional equipment also show many figures, such as caping which has a cone shape. Furthermore, we also found some local units used in daily life, such as sa-unting, sa-ombyok, and se-tandan which each represents a different number of things. The children's traditional game, gundu, was also interesting and potential to be used in mathematics learning. Various forms of ethnomathematics can be optimized to improve the quality of mathematics learning using problem-based learning and project-based learning models.

1. Introduction

Kudus is one of the regencies in Central Java province, Indonesia. The society in Kudus is very rich in local wisdom. The Colo village community, for instance, has local wisdom regarding the use of local plants for medication, such as pakis haji, pohon mranti, pring towo, and parijoto [1]. The community also has traditional ceremonies representing how the community communicates to nature and God, such as sedekah bumi and kupatan. Now, the tradition has been conducted in a spectacular event called the parade of Sewu Kupat held in Colo village as illustrated in Figure 1.

Figure 1. The parade of Sewu Kupat

The parade of Sewu Kupat is always fun. The parade usually starts from the site of the Sunan Muria tomb, a Muslim religious leader at his era. Then, the participants drink the water from the barrel which is believed as the Sunan Muria belonging and wash their feet. The journey of the festival is then continued by parading 18 gunungan, small mountain-like structures made of kupat and agricultural products (See Figure 1). Kupat or ketupat itself is traditional sticky rice usually made during some religious events in Indonesian society. The gunungan can be associated with cone shape as an ethnomathematics study.

Ethnomathematics is defined as the cultural anthropology of mathematics and mathematics education [2]. In other perspective, ethnomathematics is a relation between mathematics (and mathematics education) and socio-cultural reality [3]. Freudenthal also asserts that mathematics must be connected to reality [4]. Many argue that mathematical ideas and practices, such as geometry principles, were born from handicraft making activities, architectural concepts, and artefacts from many native and local cultures and languages [5].

Mathematics must be connected to reality. It also needs to be close to students and relevant to the human's life to possess human values. Mathematics material must be transmitted as human activities. Education should provide students with the opportunity to reinvent mathematics through practice. Thus, in mathematics education, mathematics should not be a closed system but as an activity in the 'mathematization' process. The culture-based learning grew rapidly during the 1980s and early 1990s as a result of diversity and concern over the lack of success of the students coming from minorities [6]. Mathematics teachers have to implement the principle of cultural conformity and to integrate the cultural values and products in mathematics learning.

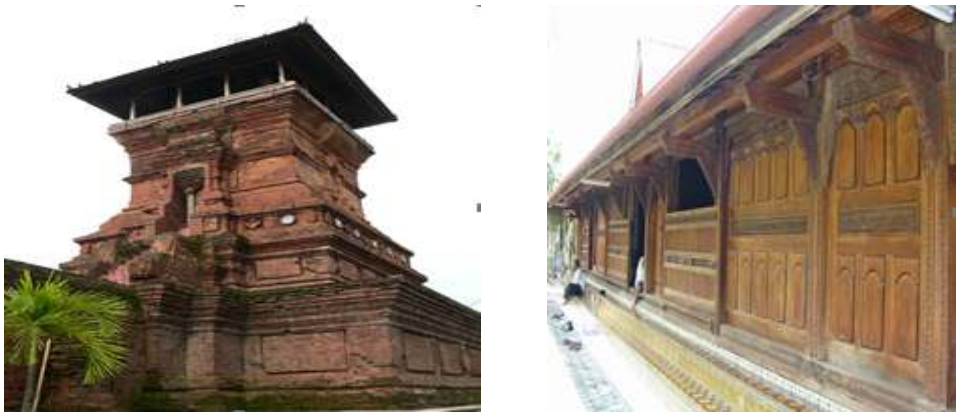
2. Method

This study used a survey method. The survey was conducted from January to February 2019. We determined the survey locations and the research subjects purposively. The survey method used the steps: reviewing literature, collecting data, describing and analyzing the findings. The study of the literature review was done by examining various documents related to ethnomathematics in Kudus, such as the history of Kudus Regency, the customs, and the culture. We used the results of the literature study to establish various shapes of building and characteristics of culture which would be further observed. The observation results are documented as material for analysis. We conducted some observations, interviews, documentation, and literature review to collect data. The three methods were used hand in hand to equip each other. The data were analyzed descriptively.

3. Results and Discussion

A building which is believed to be the foundation of a temple was once found in Kudus, but it is not explored further. However, there is a mosque minaret building which has a shape of Javanese-Hindu temple. The minaret was made of red brick and was installed without cement adhesive. The minaret is known as the Menara Kudus (See Figure 2a). The 18-meter-high minaret was decorated with 32 illustrated ceramic plates, all of which are 32 pieces. Twenty of them are blue and painted with mosques, humans with camels, and palm trees. Twelve others are red and white depicted with flowers. Beside the minaret, the Kudus traditional house (See Figure 2a) is also a building which is full of ethnomathematics. From Figure 2, we could identify various planar figures, such as square, rectangle, trapezoid, triangle, isosceles triangle, equilateral triangle, pentagon, and rhombus. We could also find solid figures, such as cube and cuboid, mathematical properties model, including properties of symmetry, translation, rotation, and dilation.

In the other region in Kudus, Ngetuk is a village producing genteng, a roof made of clay. There are various brands produced, such as morando, milano, perdana magase, mantili, kodok, plentong bundar, plentong papak, kerpus bundar, kerpus papak, and kerpus lancip. The various shapes of genteng are associated with the rectangle shape.

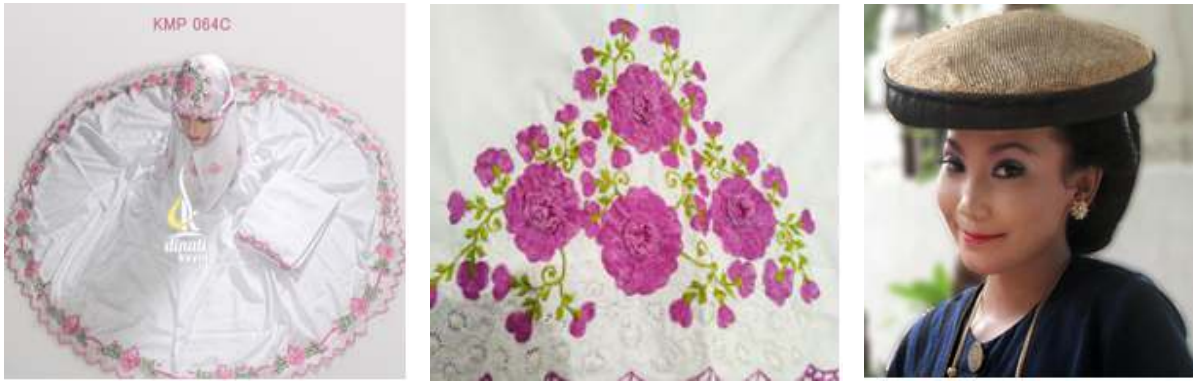


(a) **(b)**

Figure 2. Traditional buildings in Kudus which are full of ethnomathematics; (a) the Mosque of Menara Kudus, (b) the traditional house.

The use of local units in Kudus is not much different from the other regions in Central Java. The units are usually used for local food ingredients, such as sajumput and sacakup are units used for chilli; unting is used for bundles of water spinach, mustard greens, and long beans; dompol or ombyok are used for twisted cluster bean; tundun and cengkeh are used for banana; and sejinah is used for 10 corns, cakes, and certain foods.

The embroidery design of clothing in Kudus contains the concept of a circle and the circle-shaped flowers construct a triangle shape (See Figure 3a and 3b). From the two figures, we could see the concept of lines, curve, symmetry, reflection, dilation, translation, and rotation. These phenomena also found in the Kudus traditional dress, such as caping having a circle shape (See Figure 3c).



(a) **(b)** **(c)**

Figure 3. Traditional clothing in Kudus are also full of ethnomathematics: (a) the embroidery design of *mukena*, (b) the embroidery design of flowers, (c) traditional dress with *caping kalo* on the head.

Ethnomathematics could also be found in traditional games. There are various types of traditional games, both indoors and outdoors. The indoor games include dakon, snakes and ladders, bingo, siapa aku, cublak-cublak suweng, and bekelan. The outdoor games include betengan, gobak sodor, singkongak, jump rope, engklek, bakiak, and egrang. All traditional games were modified according to the local wisdom in Kudus.

Dakon or congklak (See Figure 4a) is a traditional game which is usually played by two little girls sitting opposite each other. They use a board having seven holes. During the game, the board holes will be filled by shells or seeds in order. At the end of the game, the players will count the number of shells or seeds they get during the game. The player who gets the more seeds wins the game. This game is useful for children to practice counting skill.

(a) **(b)**

Figure 4. Traditional games in Kudus are useful to practice counting skill; (a) *dakon*, (b) *gundu*.

Gundu or marbles (See Figure 4b) is a traditional game usually performed by a group of boys. First, some marbles were thrown by the players into a circle, a triangle, or a line. Then, each player, in a certain order, tries to remove the other players' marbles from the circle by hitting them using his own. If he successfully hit the marbles and removing them outside the circles, then the marbles belong to him, but if he fails to do so, then his turn ends, and the other player will take the next chance. This traditional game is very useful to train the children's concentration while introducing the concept of circles or triangles.

Various forms of ethnomathematics can be optimized to improve the quality of mathematics learning. Problem-Based Learning (PBL), Project-Based Learning (PjBL), and Inquiry Learning are some of the learning models recommended by the Indonesian 2013 Curriculum. The ethnomathematics is relatively more suitable to be integrated into mathematics learning using PBL or PjBL.
Mathematical problems need to be reformulated by integrating various cultural products in PBL. To analyze the students' problem-solving abilities, we can use indicators based on the stages of problem-solving proposed by Polya, including (1) understanding the problem, (2) devising a plan, (3) solving the problem, and (4) looking back at the solution. Case 1 and Case 2 are examples of ethnomathematics integration in learning.
Case 1. Gobak Sodor.
This game is usually played at the sports time at school. You must recognize this game. Yes, it is Gobak Sodor. The Gobak Sodor game can be played by two groups; each consists of 3 to 5 members. This morning, the students of SD 3 Temulus will play Gobak Sodor by making 8 congruent squares. If the perimeter of a square is 12 m, what is the length and what is the area of each square? (See Figure 5).

Figure 5. Gobak Sodor

Case 2. The door of Menara Kudus. The entrance door of Al-Aqsa mosque next to the Menara Kudus has a rectangle shape with the area of 15.000 cm^2. If the length of the door is 200 cm, what are the width and the perimeter of the door? (See Figure 6).

Figure 6. The door of Menara Kudus

Problem-solving skill can be optimized through the implementation of Problem-Based Learning (PBL). The PBL is a learning model which allows students to learn through a problem and to solve the problem. PBL is a learning process to determine the problems' solution through activities leading to the understanding the problem-solving results. In the PBL, students engaged in practical, ill-structured, or open-ended problems as the stimulus of learning.
The implementation of PBL and PjBL also dismiss an argument that teaching mathematics at schools is different from mathematics in daily life since it is not entirely true [7]. Ethnomathematics-based learning approach is a reasonable choice of teaching method used by mathematics teachers

4. Conclusion

Based on the results and discussion, we can conclude that there are various forms of ethnomathematics found in Kudus Regency. The mosque of Menara Kudus and the Kudus traditional house consist of many mathematical concepts such as planar figures and solid figures. The embroidery designs in the Kudus traditional clothing and some traditional equipment also show many figures, such as caping

which has a cone shape. Furthermore, we also found some local units used in daily life, such as sa-unting, sa-ombyok, and se-tandan which each represents a different number of things. The children's traditional game, gundu, was also interesting and potential to be used in mathematics learning. Various forms of ethnomathematics can be optimized to improve the quality of mathematics learning using problem-based learning (PBL) and project-based learning (PjBL) models.

References

[1] Wibowo, H. A., Wasino, W., & Setyowati, D. L. (2012). Kearifan lokal dalam menjaga lingkungan hidup (Studi kasus masyarakat di Desa Colo Kecamatan Dawe Kabupaten Kudus). *Journal of Educational Social Studies, 1*(1), 25-30.

[2] D'Ambrosio, U. (2006). *Ethnomathematics link between traditions and modernity*. AW Rotterdam: Sense Publishers.

[3] Zhang, W., & Zhang, Q. (2010). Ethnomathematics and its integration within the mathematics curriculum. *Journal of Mathematics Education, 3*(1), 151-157.

[4] van den Heuvel-Panhuizen, M. (2003). The didactical use of models in realistic mathematics education: An example from a longitudinal trajectory on percentage. *Educational Studies in Mathematics*, *54*(1), 9-35.

[5] Orey, D. C. (2000). The ethnomathematics of the Sioux tipi and cone. In *Mathematics Across Cultures* (pp. 239-252). Dordrecht: Springer.

[6] Nicol, C., Archibald, J. A., & Baker, J. (2013). Designing a model of culturally responsive mathematics education: Place, relationships and storywork. *Mathematics Education Research Journal*, *25*(1), 73-89.

[7] Hiebert, J. & Carpenter, T. P. (1992). Learning with understanding. In D. G. Grouws (Ed), *Handbook of Research on Mathematics Reaching and Learning*. New York: Macmillan.

[8] Abiam, P. O., Abonyi, O. S., Ugama, J. O., & Okafor, G. (2016). Effects of Ethnomathematics-based Instructional Approach on Primary School Pupils' Achievement in Geometry. *Journal of Scientific Research & Reports*, *9*(2), 1-15.