Ethnomathematics study: cultural values and geometric concepts in the traditional "tanean-lanjang" house in Madura - Indonesia

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ABSTRACT
One of the cultural outcomes of the Madurese community is the traditional *tanean lanjang* house with a long front yard, designed from several *batih* (nuclear) families, consisting of a married couple with unmarried children. This study explores geometric concepts of the traditional house to demonstrate how they can be useful for learning mathematics. The descriptive qualitative study described the mathematical concepts found in the *tanean lanjang* traditional house or settlement in Madura. Furthermore, an ethnographic method was also used to analyze documents, ethnographic notes, and documentation (photos). Data analysis techniques employed an interactive model of data collection, data reduction, data presentation, and conclusion. The results of the study show that the cultural values and geometric concepts of the *tanean lanjang* traditional house comprised (1) kinship and brotherhood values, (2) harmony in the household, and (3) strength in the household. The geometric concepts contained in the traditional *tanean lanjang* house include 2-dimensional shape (i.e., rectangle, trapezoid, triangle), perimeter of 2-dimensional shape, area of 2-dimensional shape, 3-dimensional shape (i.e., triangular prism), the volume of 3-dimensional shape, curve, and the concept of reflection in geometry.

INTRODUCTION

The Madurese community's history, mythology, and communication method showed a similar culture to Javanese. However, the community was influenced by Malay, European/Dutch, and Chinese cultures. The Madurese community is focused on the culture of the monarch or Javanese aristocracy at the highest and medium levels of high culture and other nobles. In the lower community levels, they are more inclined to Malay, Bugis, and Acehnese Islamic cultures. The look of Madurese homes is based on the design of a Javanese building, where the left and right sides seem to be cut (Wiryoprawiro, 1986). This is most likely because the Madurese people state that the Madurese culture is not similar to Javanese one.

Human civilization cannot be separated from the development of culture and mathematics. Therefore, culture cannot be separated from the development of mathematical activity (Muhtadi, 2017). Mathematics and science also develop in cultural development through the ethnomathematics program and the concepts can be learned through cultural activities (Umbara, U., Wahyudin, W., & Prabawanto, S., 2021). Mathematical ideas are constructed by cultural people who can solve difficulties in their surroundings and develop them to act as a thinking tool to simplify complicated situations (Budiharto, 2016). This condition allows for a merger between the

concepts in mathematics with the culture in the community. Integrating the two results in contextual and realistic mathematics can be easier for students. The concept of mathematics taught by considering the culture in the cultural community, which has been introduced to students since preschool age, will be more meaningful (Budiarto, 2019).

Ethnomathematics is a branch of mathematics that focuses on the knowledge of mathematical ideas, methods, and procedures, constructed by members of cultural groups, used, and produced by cultures or people of other cultural groups (Risdiyanti & Prahmana, 2020). The primary foundation is an understanding of many methods to see and think about mathematics concerning values, ideas, notes, techniques, and mathematical practices utilized in daily activities (D'Ambrosio, 2006). As seen in Figure 1, ethnomathematics is a collection of intersections between cultural anthropology and institutional mathematics that use mathematical modeling to cope with real-world issues (Orey & Rosa, 2004).

Rosa and Orey (2011) also asserted that using culturally relevant math questions in the classroom will help students understand the content better. Therefore, this study describes the effect of the social and cultural environment internalization model on classroom mathematics learning. Culture is one of the most critical factors in making it easier for students to understand the context. Furthermore, school mathematics learning, cultural and social values that develop inside a community will be more effective in helping understand mathematical knowledge. As a result, the context can be the starting point for encouraging students to construct their thinking (Webb, Van Der Kooij & Geist, 2011)

One of the cultural values of the Madurese community is the *tanean lanjang*, a traditional house with a long yard designed for several nuclear families – consisting of a married couple with child or children. One of the smallest or the first building clusters (*tanean*) comprises multiple structures or rooms. Among them are *romah* (women bedrooms), *langgar* (praying room, religious studies), living room, boys bedroom, *dapur* (kitchen), *kandang* (cage - a place for livestock), *lumbung* (rice barn for storing staples, such as rice/corn), *gardu* (guardhouse, usually located in the middle of *tanean*), and *jeding* or *pakeban* (bathroom and WC). *Tanean* may be made up of multiple homes due to the presence of several primary families, allowing it to reach five magnificent levels; therefore, *tanean* can be elongated to be known as *tanean lanjang* (Wiryoprawiro, 1986).

With the pattern in the Madurese community, this study explores the cultural values and geometric concepts of the *tanean-lanjang* house. It will be beneficial for learning mathematics, specifically introducing the concept of geometry. Furthermore, it is expected to increase students' motivation in learning since ethnomathematical practices can build and develop motivation and positive attitudes towards mathematics (Shirley, 2001). According to Shirley (2001), ethnomathematics may improve motivation and favorable attitudes toward mathematics.

METHODS

This is a descriptive qualitative study. According to Prahmana (2017), it uncovers and obtains comprehensive, broad, and in-depth information. This describes the mathematical concepts found in the *tanean lanjang* traditional house with a long yard in Madura using the ethnography method. The data are cultural values and geometric concepts found in the *tanean lanjang* traditional house. Oral data in the form of informant explanations were obtained during interviews. Other data are literature reviews, ethnographic notes during field observations, and documentation (photos). Furthermore, field data sources were taken in Pamekasan and Sumenep districts, Madura, East Java, Indonesia.

The human instrument was used in a qualitative study through an anthropological approach. Data collection techniques included library data, namely various kinds of literature related to the pattern of the Madurese *tanean lanjang* traditional houses and Madurese traditional carvings. Data collection in the field comprised interviews, observation, and documentation. The interview was realized by gathering verbal data that cannot be observed directly and the unstructured interview method means free interviews where guidelines that are arranged wholly and systematically were not used. The observation was realized by gathering data in the field to find out interpretations, social meanings, and other matters related to study. The documentation means taking photos of the house as data to be analyzed.
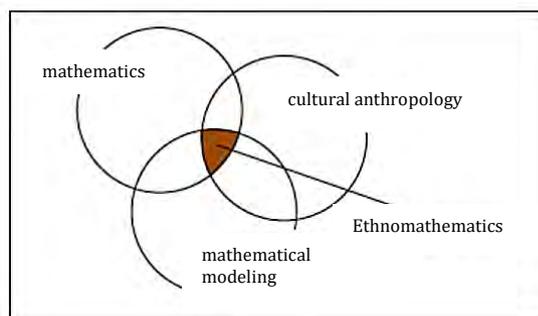
Figure 1. Ethnomathematics as an intersection of cultural anthropology,
institutional mathematics, mathematical modeling

The data analysis technique consists of 1) data reduction (taking steps to reduce data (translating recorded data/figures into textual form and choosing data that is required against those not required to become available for analysis, 2) data presentation (collecting and organizing data so that analysis is easier), 3) data interpretation (interpreting any geometric notions contained in the Madurese *tanean lanjang* traditional house), and 4) conclusion.

FINDINGS AND DISCUSSION

Tanean lanjang is a Madurese community's traditional house or settlement with a long front yard occupied by married children. It is derived from *tanean* (*yard*) and *lanjang* (*long*). Furthermore, due to the number of families living in the settlement to have developed and grown, *tanean* in the community becomes more extended, causing the front yard of the house to keep developing and growing, known as *tanean lanjang*.

Observations were conducted from 23 to 25 April 2021. They were carried out in a few areas in Pamekasan and Sumenep, Madura. It is due to the restricted area and homes that keep adhering to the idea of *tanean lanjang* traditional house. The examples of *tanean lanjang* houses. The documentations of the houses in Pamekasan (Cempaka hamlet, Candi Burung village, Pamekasan Proppo subdistrict – Madura) are presented in Figure 2. Figure 2 shows several houses that still use the concept of the *tanean lanjang* traditional house. Four families have inhabited this settlement from one lineage since 1985. Based on interviews, the *tanean lanjang* traditional houses were designed because they (from the same parents) wanted to stick together and kept kinship within the same lineage.

The daughter of the house owners, with an informant initial "RH" – from Proppo Pamekasan village, was interviewed. She stated that the *tanean lanjang* settlement consists of 4 houses. One main house is occupied by parents (main house/*tongghu* house) and the other three houses are occupied by their married children. They have lived there since 1985. The informant stated that the *tanean lanjang* house design or structure was developed to keep parents and children living together and having a mutually close relationship. Data were obtained from the interview on December 30, 2021, conducted in the Madurese language, but some excerpts are translated into English (R = Researcher).

R   :   Please, give me information regarding the size of the house owned by the mother. What is the total length and width of your *tanean* (a front yard of the *tanean lanjang* house)?
RH   :   10 meters long and 8 meters wide
R   :   Are there specific rules in making this *tanean* size? (maybe by custom, there are rules)
RH   :   There is no fixed rule, but when parents own a piece of land, they will make it a tanean house to share with their children.
R   :   Because of the absence of traditional rule, what is the area's size (length and width) in building a house and land, based on what is determined?
RH   :   Just an estimate, when an elder owns a piece of land, it will be divided equally among his children.
R   :   Usually, this *tanean* is used for what activities?
RH   :   Drying rice, drying tobacco, and performing religious events or ceremonies.
R   :   What is the length, width, and height (from floor to ceiling) of the main /older parents' house?

RH : Outside 3x5 meters, inside 4x4 meters.

R   : Is it permissible for married/unmarried children to freely circulate among their parents' (elderly) or other relatives' households when each is given a separate house?

RH : It is permitted even when you have your own house

R   : What about when the children are involved? (Is it permissible to move freely in other people's houses?)

RH : It is permitted.

R   : Does the family eat together, or does each part of the family in their own houses eat?

RH : Each family eats in their own houses.

The observation results of the *tanean lanjang* house are situated in a hamlet called Gutogu, Poreh Village, Lenteng sub-district, Sumenep, Madura. Some obtained documentation/photos are presented in Figure 3. Figure 3 shows the settlement of *tanean lanjang* houses for several families from the respondent's descendants, called *bujuk buntek*). The oldest person in the family occupies the main house (Figure 3b).

Judging from the layout in the settlements, the location of the building surrounds a courtyard, called *tanean* because this page has an elongated shape called *tanean lanjang* (Wiryoprawiro, 1986). The houses face north-south, which is inextricably linked to the direction/orientation of traditional Madura houses. The placement of houses in this settlement has stages. At first, the building only consisted of *langgar* and the main house *tongghu* consists of a kitchen and a stable (see Figure 4). Parents frequently select a spot to the east of the *tongghu* house for their children's new home. It turns out that superiority or a higher position (*Roma tongghu* for the parents) and inferiority or a lower position (extra house for married children) are denoted by the location to the right and left of the home.

A new house will be added by taking the same rules: to the left of the existing home when more than one child get married. This will also apply to the next building to line up to the east. The new house will be placed south of the yard (south of *tanean*) when it is impossible to add it to the east. The fascinating part is that the *tanean* will extend westward according to the same criteria (see Figure 5). From the decorations and pillars of the traditional Madurese house, the door/window tends to be decorated with green and red carvings, symbolizing loyalty and struggle. The house's front wall will usually be pasted a painting of flowers depicting family harmony, a dream of a happy future home. Some pillars in the *tanean lanjang* house are strong supports. These pillars are connected based on the principles and values of the philosophy of life that prioritizes kinship and brotherhood.

From the shape of the roof in settlement of *tanean lanjang* houses, most of the structures are (a) *bangsal*, namely a rectangular and tapered roof with a ridge that forms the body of a boat (similar to a *joglo* traditional house) but on the sides of the roof are beheaded. (b) *Pegun* is a rectangular roof but not too sharp, similar in shape to a pyramid but the sides are beheaded. (c) *Pacenan* is the form of a simple roof with one elongated *wuwung* and ends with *gewel*. (d) *Perisai* is a roof formed from two triangular and trapezoidal planes where the trapezoids on the roof will meet in a straight line. (e) *Jadrih* is a house with a roof and two ridges which can also be called *Pacenan* because the shape of the ridge characterizes it. (f) *Trompesan* is also the term for a village roof with a three-part broken fragment (Tulistyantoro, 2005). Figure 2(b) is an example of a house with a *Jadrih* type roof. Some mappings of geometric concepts found in the *tanean lanjang* houses are reported in Table 1.

The design of the *tanean lanjang* houses in this study is described by Wiryoprawiro (1986: 145). The Madurese a traditional architectural design is reported in Figure 6. In addition, some geometric concepts related to those of flat shapes/ 2-dimensional shapes were used to design these houses. Several geometric concepts are also found in the ornate carvings of the main pillars. These include curved lines and geometric transformations (mirror/reflection) as shown in Figure 7. The carved ornament on the pillar is one of the characteristics found in the *tongghu* house from the Bujuk Buntek family in Sumenep. The examined carving motif showed a swastika design, a Hinduism-adopted Javanese cultural element. Swastika motifs, sometimes referred to as geometric motifs, feature distinct lines and recur (Agustin, et al. 2020).

(a) Photo from the entrance of the house

(b) Main house (parents house)

(c) The house occupied by children/relatives

(d) *Langgar*
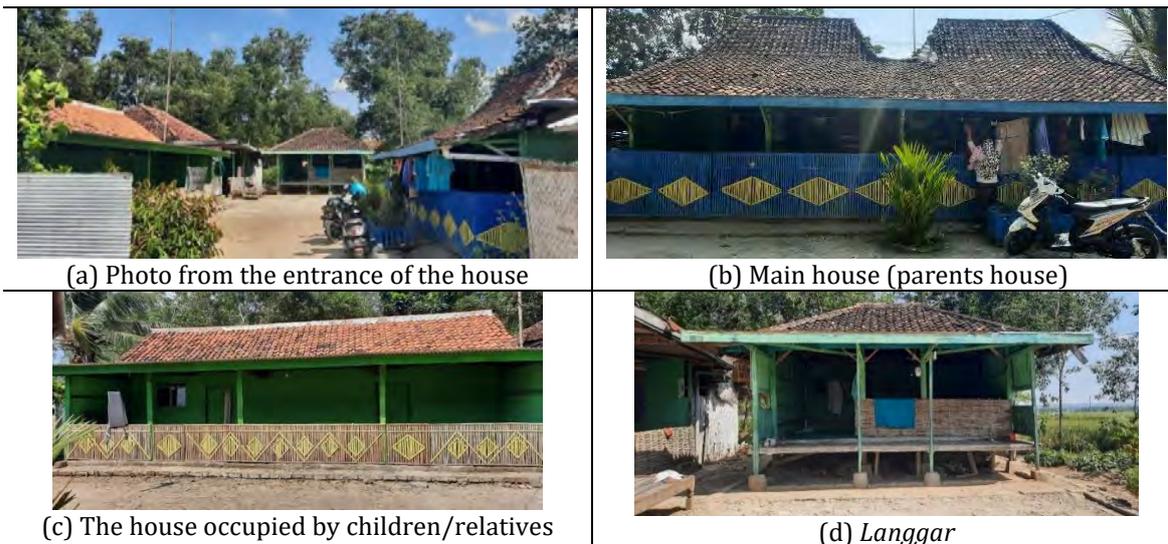
Figure 2. Settlement of single farmhouse location in Pamekasan (location: Cempaka hamlet, Candi Burung village, Pamekasan Proppo subdistrict – Madura)

(a) Photo of the *tanean lanjang* house settlement of Bujuk Buntek's family

(b) the main house, called *tongghu* (house occupied by the oldest elder/parent in the family)

(c) Ancient carvings found on one of the pillars/ pillars supporting the front porch of the house (called *amper*) on the main house

(d) One of the ancient carvings found on the top of the door in the house of *ongghu*.

Figure 3. Documentation of single farmhouses in Gutogu hamlet, Poreh village, Lenteng subdistrict, Sumenep regency, Madura Island
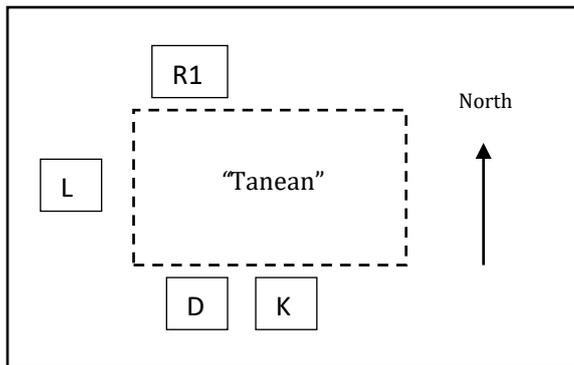
Note:
R1 = Main house (*tongghu*)
L = *Langgar*
D = *Dapur* (Kitchen)
K = *Kandang* (cage)

Figure 4. House plan at first (Wiryoprawiro, 1986)
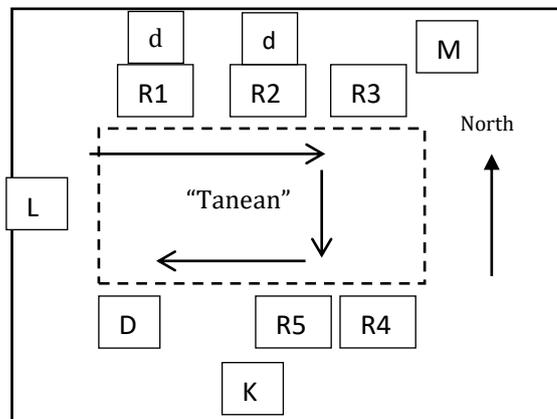
Note:
R1 = Main house (*tongghu*)
R2, R3, R4, R5 = married children's house
L = *Langgar*
D = Outdoor kitchen
d = Indoor kitchen
K = *Kandang* (Cage)
M = Bathroom

Figure 5. House development plan (Wiryoprawiro, 1986)

(a) View from the South

(b)View from the North

(c) View from the East

(d) View from the West
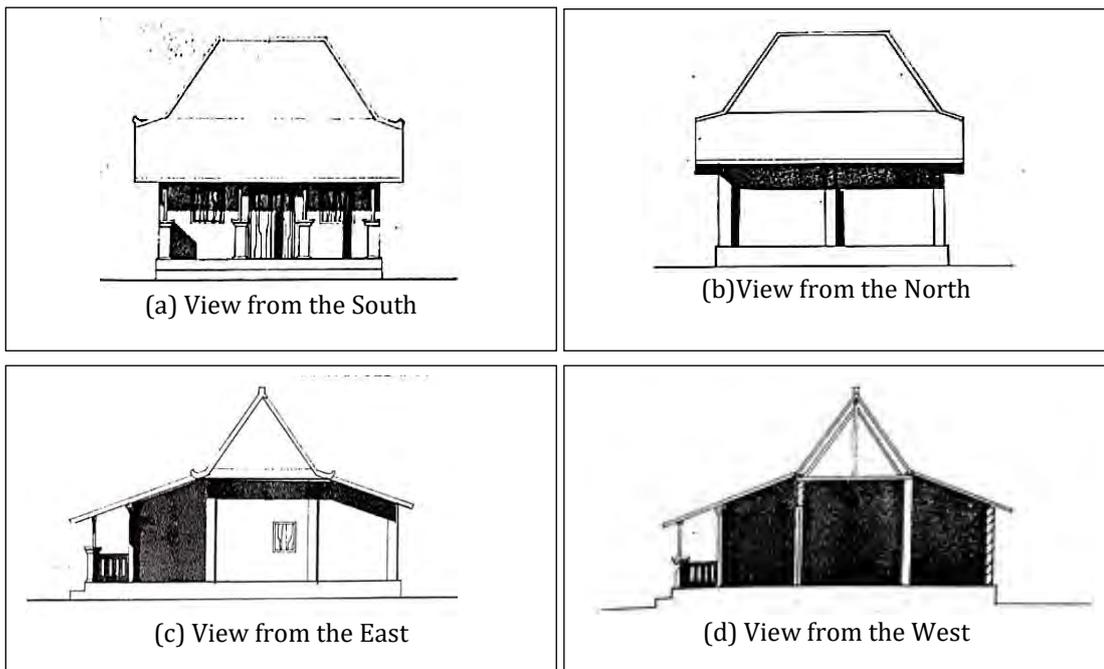
Figure 6. The design of the tanean lanjang house

Curve

angle

The engraving pattern on the right is a reflection of the engraved pattern on the left. Reflection about the x-axis, *x* = 0

Figure 7. The concept of geometry on the carving of the pillars of the *tanean lanjang* house

Table 1

Mapping of geometric concepts in the *tanean lanjang* traditional house.

Related geometry concepts	The residential part of *tanean lanjang* house
2-dimensional shape (i.e. rectangle), perimeter, area.	*Tanean Lanjang* (front yard) *Tanean Lanjang*
2-dimensional shape (i.e., triangle, rectangle), perimeter, area. 3-dimensional shape (i.e., Triangular prism), Volume.	The shape of the roof (*Perisai* form)
2-dimensional Shape (i.e triangle, trapezoid), perimeter, area.	The shape of the roof of the main house (*Bangsal form*)

After obtaining the geometric concepts in the *tanean lanjang* houses of the Madurese community, teachers are expected to use this information for learning mathematics in school. As Abdullah (2016) states, in learning mathematics, a bridge is needed to connect mathematics with culture and daily life, namely ethnomathematics. For example, in primary education, teachers can introduce the concept of "rectangular" geometric shapes in mathematics learning by involving pictures/photos of the front yard in the *tanean lanjang* houses." Likewise, teachers can explain the concept of a 3-dimensional "prism" by giving an example of a "prism" geometric shape found at the top of the *tanean lanjang* traditional house in Madura.

The shape of the building in the *tanean lanjang* houses can be used as an example in contextual problems on geometry material for primary schools. For example, when the length of the front yard of the houses is 10 meters and the width is 8 meters, students can calculate the perimeter of the *tanean* using the formula 2p + 2l because the front yard is rectangular. They can also be asked to calculate the volume of a room in the house or its roof (called *wuwung*). For instance, the roof of the house is designed as a prism, with the measurements as follows: 4 meters in length (p), 2 meters in width (l), and 3 meters in height (t). Students may be asked to calculate the volume of one of the roofs of the house using the prism volume formula.

Teachers should contextualize mathematics learning by connecting the content to the culture and real-life experiences of lower grade students at the Elementary School level (Muhammad, 2021). Contextual problems offer some potential to engage and motivate them to learn mathematics, however, they present some challenges in the classroom (Widjaja, 2013).

CONCLUSIONS

The Madurese traditional architectural houses are treasures and cultural heritage in East Java, Indonesia. The kinship system in Madura is characterized by house units, each of which is inhabited by a prominent family. Through this ethnomathematical study, cultural values and mathematical concepts contained in the *tanean lanjang* traditional house are obtained. The values included in the house are (1) kinship and brotherhood, manifested in the formation of the house, (2) the harmony in the household, manifested in the forms of the carvings, and (3) the strength, manifested through the existence of pillars. The intersection between mathematics, anthropology, and mathematical modeling is realized through the geometric concept of the house, underlying cultural values. The geometric concepts are 2-dimensional shape (i.e., rectangle, trapezoid, triangle), the perimeter of a 2-dimensional shape, area of 2-dimensional shape, 3-dimensional shape (i.e., triangular prism), the volume of 3-dimensional shape, angle, curve, and the concept of transformation in geometry (reflection). Therefore, teachers can use ethnomathematics studies to learn mathematics by seeing the cultural values and geometric concepts of the *tanean lanjang* traditional house.

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