JAMI' DARUL MUTAQQIM MOSQUE: ETHNOMATHEMATICS EXPLORATORY

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ABSTRACT

The purpose of this research is to explore the concepts contained in the building of the Jami' Darul Mutaqqim Mosque and identify learning resources for ethnomathematics of it according to the subjects, materials, and basic competencies of students based on the Revised 2013 Curriculum. This study uses a qualitative method with an ethnographic approach. Research using ethnography attempts to describe, explain, and analyze all elements of culture that exist in society. This research is collecting data using deep observation and documentation, also analyzing across the curriculum. Based on the results and discussion, it can be concluded that there are ethnomathematical values in the Jami' Darul Mutaqqim Mosque. Ethnomathematics appears in the shape of the parts of the mosque building. The parts of the mosque are 1) the adzan tower; 2) the mosque roof; 3) the main prayer room (liwan); 4) the mihrab; and 5) the porch. The mathematical concepts found are number, number operation, three and two-dimensional shape, geometry transformational, and integral. Variations, according to D'Ambrosio, are counting, measuring, and classifying. The Jami' Darul Mutaqqim Mosque has elements of mathematics that can be used as a reference in the development of teaching materials in schools.

Keyword: ethnomathematics, Jami' Darul Mutaqqim Mosque, 2013 Revision Curriculum

INTRODUCTION

Mathematics is considered a scary and difficult subject, but it can equip students to think logically, critically, systematically, creatively, and analytically. However, learning mathematics in the classroom is not connected to everyday life, and students aren't allowed to rediscover and construct mathematical ideas by themselves [8]. In Ministerial Education Regulation number 21 from 2016 about Standard Content, the unit of mathematics aims at students having abilities to 1) understanding mathematical concepts, explaining the interrelationships between concepts and reversing concepts or logarithms flexibly, accurately, efficiently, and precisely in solving problems; 2) using reasoning on patterns and traits, making mathematical manipulations in making generalizations, formulating evidence or explaining mathematical ideas and statements; 3) solving problems that include the ability to understand, designing mathematical models, completing models and interpreting solutions obtained; 4) communicate ideas with symbols, tables, diagrams or other media to clarify the situation or problem; and 5) have an attitude of appreciating the usefulness of mathematics in life.

Mathematics teaching in schools is rigid, often limited to rote memorization, and only talks about numbers and formulas [40]. On the other hand, school learning activities are still fixated on abstract sources and cannot be observed or experienced directly by

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students ([23]; [35]). Furthermore, mathematics learning has not been fully linked to the local culture ([1]; [4]; [11]; [25]; [27]; [33]). Thus that learning mathematics in schools is not yet meaningful. One way to support the meaningfulness of mathematics learning is through learning related to local wisdom ([24]; [40]).

The cultural context can stimulate learners' knowledge to be easily remembered, and learners can also connect directly with their daily lives ([3]; [26]; [28]; [38]). In addition, culture-based learning emphasizes achieving an integrated understanding rather than just an inert understanding [14]. Culture-based learning can be divided into three types: learning about culture, learning with culture, and learning through culture [14]. This form of integration of mathematics with culture is then known as ethnomathematics ([22]; [32]; [40]).

Ethnomathematics was introduced by a Brazilian mathematician named D'Ambrosio. Ethnomathematics is mathematics learning that raises conceptually local cultural themes, including the habits of students or the community around them [40]. Culture-based mathematics learning is contextual learning closely related to the cultural community, thus making learning more interesting ([4]; [21]). Ethnomathematics is applied to motivate, stimulate, overcome student boredom and provide a new nuance in learning mathematics [31]. Cultural objects whose presence is close to the daily lives of students are needed. One of the cultural objects that are very close to students' life is the Mosque ([2]; [40]).

The mosque was chosen as a cultural object based on curriculum development in 2013, which wants the formation of character and the attitude of students' devotion to God Almighty. It is hoped that by tracing the history of places of worship found in each student's area, students can build the values of their religious life. Apart from being a place of worship for Muslims, the mosque is also a center for Islamic arts and culture that breathes their respective nationalities, so that the building is a group of monumental buildings, Islamic architecture, and the characteristics of the area where the mosque was built [19]. Several researchers have previously researched ethnomathematics in mosque buildings. One of them is the discovery of several mathematical aspects at the Saka Tunggal Mosque [24], Bengkulu City Jamik Mosque [15], Jami' Al Baitul Amien Mosque in Jember [40], Great Mosque of Yogyakarta [29], Mataram Kotagede Mosque, Yogyakarta [5], and Sunan Bonang Mosque [12]. As an effort to reform, this research aims to explore the ethnomathematics of the Jami' Darul Mutaqqim Mosque.

The Jami' Darul Mutaqqim Mosque is a historical relic from the Islamic period in Indonesia [6]. The Jami' Darul Mutaqqim Mosque is also known as the Jami' Darul Mutaqqim Mosque. This mosque is located in the center of Purworejo city, to the west of Purworejo square. Inside the mosque is the Pendowo Bedug, the largest drum in the world ([13]; [30]). Bedug is made of very large intact wood, without any joints. The Jami' Darul Mutaqqim Mosque is visited by many tourists and becomes the center of religious tourism. The Jami' Darul Mutaqqim Mosque was built in 1762 Java or 1834 AD, with a colonial architectural style that has only undergone slight changes.

The Jami' Darul Mutaqqim Mosque is one of the proud mosques in Purworejo Regency, which has a unique, artistic, and different shape from other mosques in general. The architectural form of the main prayer building and gandok lor and gandok kidul are still original. The main prayer building uses traditional Javanese architecture with a three-tiered roof called the paniting roof, pananggap roof, and brunjung roof. The main pillar (Soko Guru) directly supports the roof [30]. The shape and architecture of the Jami' Darul Mutaqqim Mosque need to be explored to find the ethnomathematics values used in a more realistic mathematics learning process. Thus, the Jami' Darul Mutaqqim Mosque

can be used as a source of learning. Concerning mathematics learning resources, D'Ambrosio distinguishes the existing ethnomathematics categories into counting, weighing, measuring, comparing, sorting, and classifying [7]. This category can be used as an analytical tool to identify learning resources in basic mathematics learning. Thus, the purpose of this research is to explore the concepts contained in the building of the Jami' Darul Mutaqqim Mosque and identify learning resources for ethnomathematics of it according to the subjects, materials, and basic competencies of students based on the Revised 2013 Curriculum.

RESEARCH METHOD

The study uses a qualitative method with an ethnographic approach. Qualitative education is a research procedure that produces descriptive data from all forms of speech, writing, and description of the objects and subjects observed. Research using ethnography attempts to describe, explain, and analyze all elements of culture that exist in society. This research is collecting data using deep observation and documentation, also analyzing across the curriculum. The activity of research is exploring learning resources at Jami' Darul Mutaqqim Mosque based on ethnomathematics. The data obtained is then analyzed using three stages: data reduction, data presentation, and concluding. In the data reduction stage, the researcher analyzed content, material, grade, basic competencies in the 2013 Revision Indonesian Curriculum, then found the appropriate learning resources from Jami' Darul Mutaqqim Mosque. Then the data is presented, and using Ambrosio's category as another tool for analyzing, researchers get the result that sorting category doesn't occur in the ethnomathematics resources. Then, conclusions are drawn.

RESULTS AND DISCUSSION

A. Results

Based on the data collection results, the results obtained that there are ethnomathematics values in several parts of the Jami' Darul Mutaqqim Mosque building. The parts of the mosque building are: 1) the adzan tower; 2) the mosque roof; 3) the main prayer room (*liwan*); 4) the *mihrab*; and 5) the porch.

1. Adzan Tower

Adzan tower is located in front of the mosque. It was built in 1993 with a pentagonal form that symbolizes the designer pillars of Islam as the basis of *aqidah* and *Pancasila* as the foundation of statehood [30]. The shape of this tower does not reflect the form of traditional Javanese architecture, which was the architectural form of the Jami' Darul Mutaqqim Mosque at first. The tower is 15 meters high. A loudspeaker is installed at the top of the tower to announce the mosque's call to prayer and announcements. However, the call to prayer tower has been renovated into Figure 1.

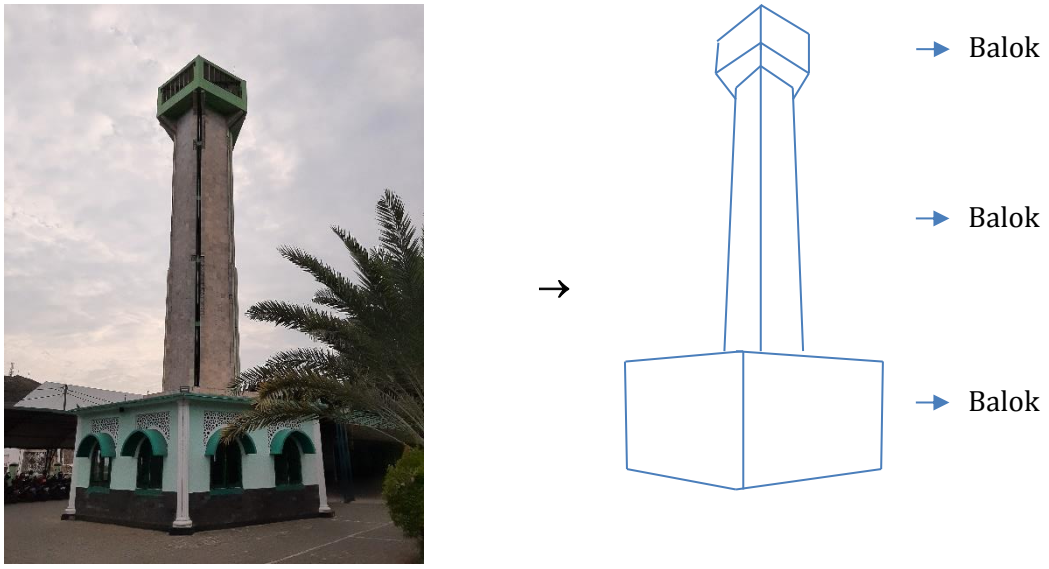

Figure 1. Adzan Tower

Several mathematical contexts can be found in the Adzan Tower. The call to prayer tower is shaped like a three-dimensional shape: cuboids of three sizes stacked in one building. A room is created with some mathematical context for the lower part, as shown in Figure 2.

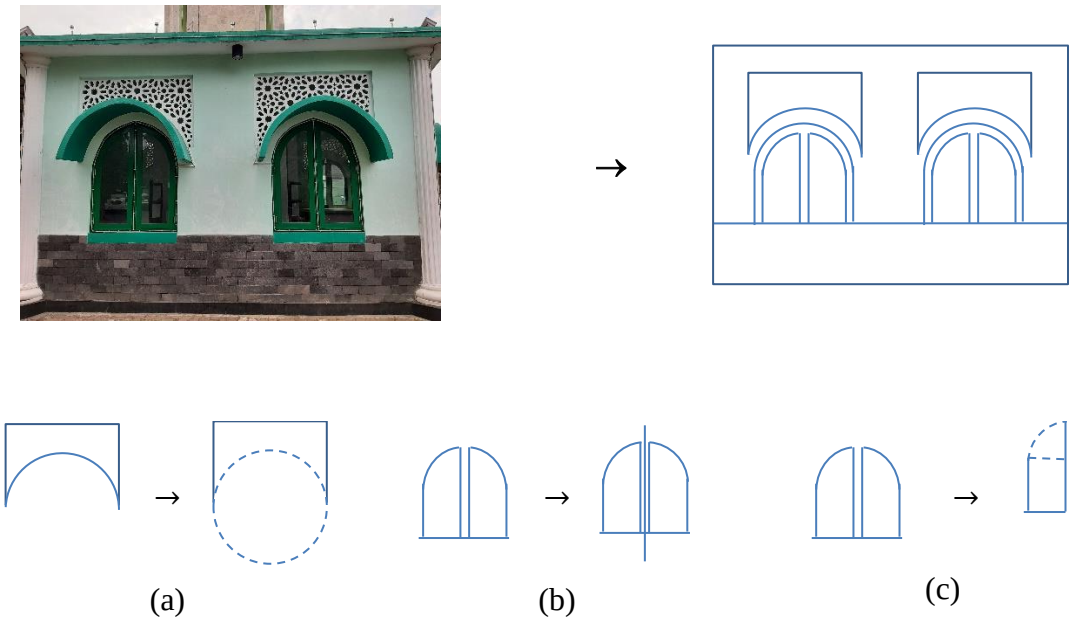

Figure 2. Adzan Tower Window

In Figure 2, in the lower room of the Adzan Tower, the window section has several mathematical contexts. The top of the window is a combination of a circle and a rectangle, as shown in Figure 2. In addition, the window frame is a combination of rectangles and semi-circles and windows that reflect the other window.

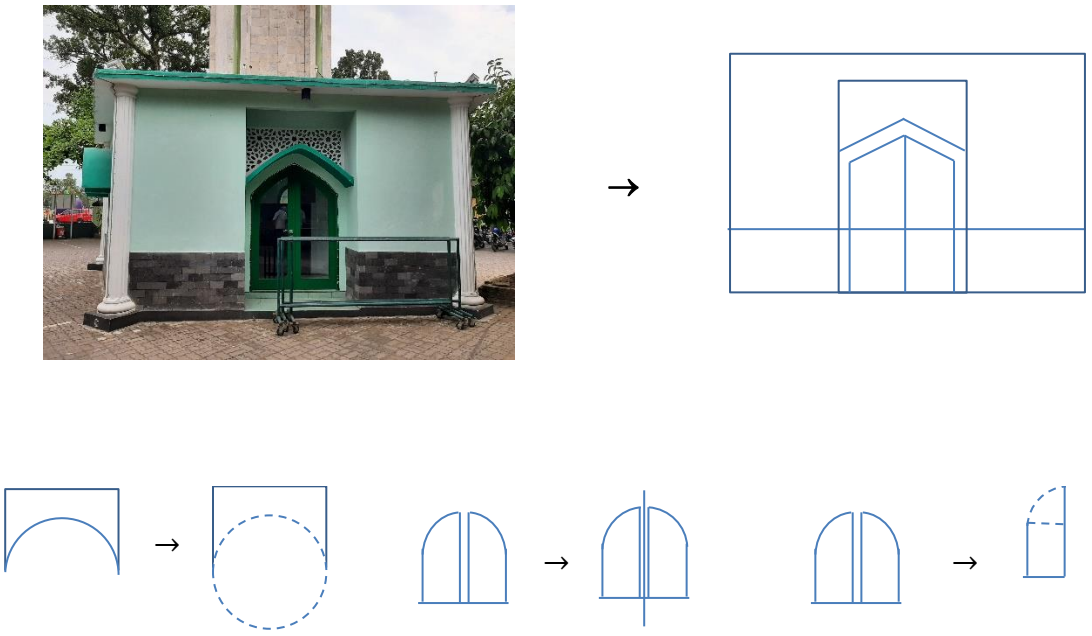

Figure 3. Bagian Atas Jendela Menara Adzan

In Figure 3, there is a lower room of the Azan Tower. The door in there has some mathematical context like the door is a combination of triangle and rectangle. Based on the research results, it can be seen that the Azan Tower has the concept of spatial structure, flat wake, and geometric transformation (translation, rotation, and reflection). The table describes the results of identifying the part of the Adzan Tower of the Jami' Darul Mutaqqim Mosque based on the classification of D'Ambrosio [7].

Table 1. Subject, classification, and Learning resources at Menara Adzan

Gambar	Learning Activity	Subject: Grade/ Basic Competences	D'Ambrosio Clasification
1	Determining the volume and surface area of the Adzan Tower	Solid Geometry dan Plane Geometry	Measuring
2,3	Classify the flat shapes that make up the doors and windows in the room in the Adzan Tower	Plane Geometry	Classifying
2,3	Determine the area or perimeter of the windows and doors of the room in the Adzan Tower	Plane Geometry	Measuring
2,3	If the doors and windows of the right side of the room of the Adzan Tower are drawn in Cartesian coordinates, then the other parts can be determined using the principle of reflection	Transformational Geometry	Measuring

2. The mosques' roof

The initial architectural form of Jami' Darul Mutaqqim Mosque is traditional Javanese architecture by using a *brunjungan* roof like the three-story *meru* on the main

building [30]. In Serat Kawruh Kalang's book, this kind of roof is called *tajug lawakan lambang teplok*, where the main pillar (*Soko guru*) directly supports the roof (*brunjung*). The mosque roof is also made tapered upwards to depict a mountain, as shown in Figure 4. Besides its tapered shape, the roof of this mosque consists of 3 levels which in traditional Javanese architecture are each named:

a. *Panitih* roof is the first level roof which is at the bottom. The roof of the *panitih* and its floor symbol *Syariah* andize human deeds.
b. The roof of the *pananggap* is the second level roof which is above the *panitih* roof. The roof of the *pananggap* symbolizes *thariqah*, which is the way to achieve the pleasure of Allah SWT.
c. The *brunjung* roof is the top roof. At the top of this *brunjung* roof, a *mustoko* is installed. *Mustoko* symbolizes *ma'rifah*, which is knowing Allah the Highest and this is the highest peak of the faith and purity of a Muslim. The *brunjung* roof symbolizes the essence, namely the spirit or the nature of one's deeds.

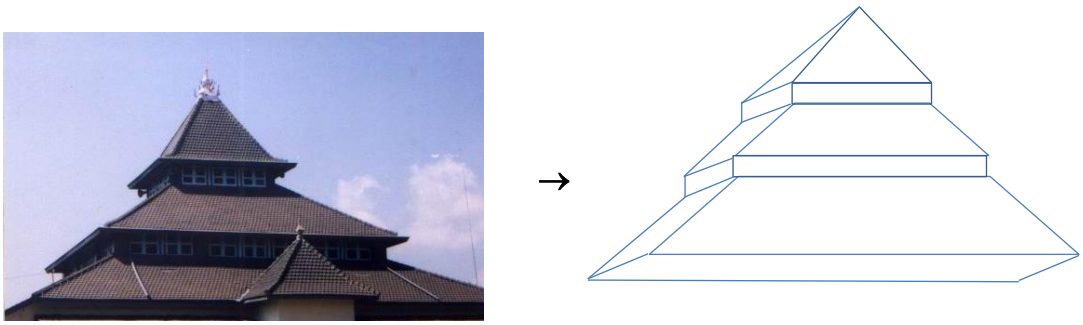

Figure 4. Jami' Darul Mutaqqim Mosque Roof

The roof of Jami' Darul Mutaqqim Mosque is covered by an isthmus, while the *mustoko* is made of bronze with a forest *kadaka* leaf motif. The gaps on each level of the roof are covered with colorful glass mosaics. This gap serves as a bouvenlight, so that sunlight can enter the living room as natural lighting during the day.

Figure 5. The *bouvenlight*

Several mathematical contexts can be found on the roof of the mosque. The roof of the mosque has two truncated pyramids and one whole pyramid. On the side of the building, there is also a small building with a pyramid-shaped roof.

In front of the mosque, is given a tarpaulin to protect visitors from the heat, as shown in Figure 5. The tarpaulin is semicircular and placed in front of the mosque.

Figure 6. Tarpaulin in Jami' Darul Mutaqqim Mosque

The mathematical context of this tarpaulin is that the area of the tarpaulin can use the integral concept or by using the concept of a tube space. Based on the study results, it can be seen that the Adzan Tower has a spatial and integral concept. Table 2 describes the results of identifying the part of the Adzan Tower of the Jami' Darul Mutaqqim Mosque based on the classification of D'Ambrosio [7].

Table 2. Subject, classification, and Learning resources at Jami' Darul Mutaqqim Mosque Roof

Figure	Learning Activity	Subject: Grade/ Basic Competences	D'Ambrosio Clasification
4	Determine the volume and surface area of the roof *brunjung*	Three and Two Dimensional Shape	Measuring
	Determining the volume and surface area of the *panangkat* roof and *panitih* in the shape of a truncated pyramid	Three and Two Dimensional Shape	Measuring
5	Calculate the number of *bouvenlight*	Integer Operation	Counting
6	Calculate the area of the tarpaulin in the form of a tube using the integral concept.	Integral	Measuring
	Calculate the number of thickest support poles needed	Integer Operation	Counting

3. Main Prayer Room (Liwan)

This main prayer room (*liwan*) is part of the Jami' Darul Mutaqqim Mosque, which is still in its original shape. The elements contained in the *liwan* room include the main door and the main pillar (*Soko Guru*). The door above that connects to *Liwan* (Figure 7) is written in 3 languages: Dutch, Javanese, and Arabic. The first line of writing, which is written in Dutch, mentions the name of the Dutch Resident in Bagelen, namely *A.I. Ruintenback*, which has been removed. The second and third lines of writing in the Javanese language read: *R.A. Cokronegoro ping I* (Regent of Purworejo I) and *Mas Pateh Cokrojoyo*. The fourth line is written in Arabic letters and reads *Penghulu Ladraad Hajji Akhmad Badaruddin* and *Penghulu Hajji Muhammad Baedhowi*. The writing in the fifth

row is the year number in Javanese letters: *1762*. There is some mathematical content at the entrance, namely the shape of a square, a rectangle, and a circle. Both sides of the door have the same motif, so there is a concept of reflection.

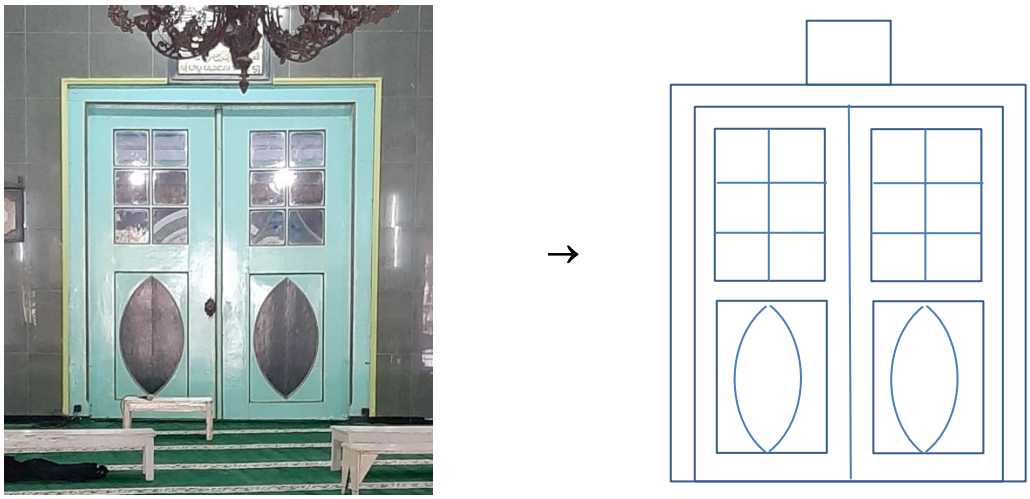

Figure 7. Main Prayer Room Entrance

In this *liwan* room, there is four *soko guru* made of teak wood from Pendowo Hamlet, Bragolan Village, Purwodadi District, Purworejo Regency. The dimensions of the four pillars are 54 cm x 54 cm, each with a height of 15 meters. *Soko guru* has a *purus* construction on the *umpak* stone as a key. In general, the bottom of this *purus*, the inner hole of the *umpak*, is first inserted with precious gold or silver to keep the *purus* that from teak wood will be porous. There are no complicated carvings in this pillar, only thick lines that are simple but impressively beautiful, elegant, and authoritative. At first, the *soko guru* was painted dark red with yellow stripes but later replaced with light green with yellow stripes (in Javanese traditional architecture it is known as *pare anom*). The *pananggaps' pillars* are made of red bricks with a size of 70 cm x 70 cm and consist of 2 pieces, all of which support the roof of the *pananggap*. Meanwhile, the *panitih* roof is directly supported by a wall section as thick as two bricks.

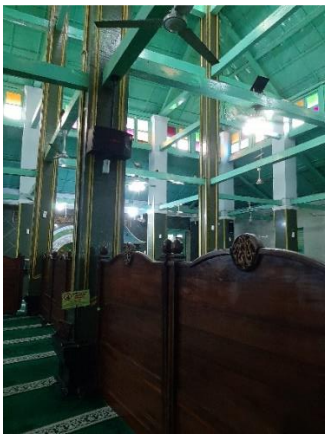

Figure 8. Soko guru

These four *soko guru* are located on a *lingga* made of *yoni* stone (stone paired with a *lingga* to worship Lord Shiva in Hinduism). *Lingga* is originally elliptical with a square bottom. *Lingga* symbolizes *Dewa Syiwa Nataraja*. As a pair, *lingga* is the *yoni*, a stone in the shape of a square (square) with a shower on one side. *Yoni* symbolizes *Dewi Uma Parwati*, consort of *Dewa Syiwa*. The *lingga* is mounted on top of the *yoni*. L*ingga* and *yoni* (left) were used as the main pillars of the Great Mosque of Purworejo.

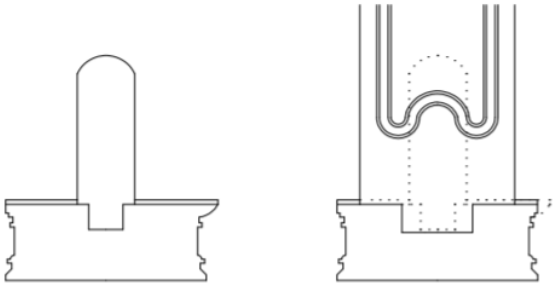

Figure 9. Main Prayer Room Entrance

The four *umpak* used all used *yoni* stones, which were still widely available in the Bagelen area, and their size was also large enough to be used as the base of the *soko guru*. The *yoni* stone used as the foundation for this mosque, the shower part, has been leveled. Because the pedestals used are not specially made, none of the four *umpak* are the same. There is some mathematical content on this main pillar, namely the number of main pillars and their thought poles. Table 3 describes the results of identifying the Main Prayer Room (*Liwan*) based on the classification of D'Ambrosio [7].

Table 3. Subject, classification, and Learning resources at Main Prayer Room (Liwan)

Figure	Learning Activity	Subject: Grade/ Basic Competences	D'Ambrosio Clasification
7	Classifying flat shapes contained in the entrance	Two Dimensional Shape	Classifying
	Determine the area of the inscription located above the door	Two Dimensional Shape	Measuring
	Determine the area of a rectangular glass	Three and Two Dimensional Shape	Measuring
	Count the number of squares of glass on the door.	Integer Operation	Counting
	Calculate the area of the black area at the entrance, which is shaped like a circle.	Two Dimensional Shape	Measuring
	If one of the doors is drawn with Cartesian coordinates, it can determine the coordinates of the interior parts of the other doors using the reflection principle.	Geometry Transformation	Measuring
8	Determine the number of main pillars (*soko guru*)	Integer Operation	Counting
	Determine the number of bricks that support the roof of the *pananggap* and the roof of the *panitih*	Three and Two Dimensional Shape	Measuring
	Determine the volume and surface area of the main pillar (*soko guru*)	Three and Two Dimensional Shape	Measuring

4. *Mihrab*

Mihrab is an outward indentation on the wall to the west and is right in the middle. This *mihrab* is intended as the Qibla direction during prayer and is a place for the imam when leading congregational prayers.

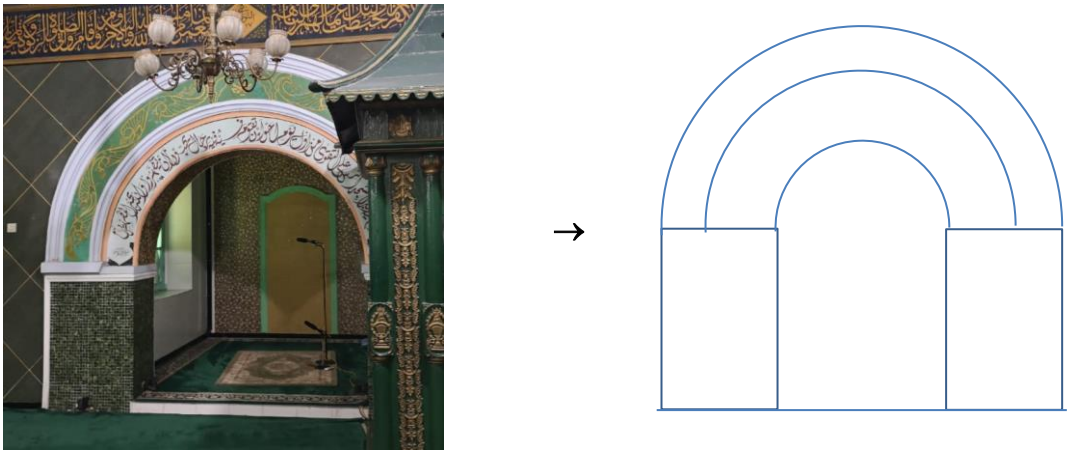

Figure 9. Main Prayer Room Entrance

Mihrab with a curved shape like this is called the *mihrab musyawaaf*. On the *mihrab* arch, an image resembles a branch or twig of a sugar apple tree complete with beautifully arranged fruit and leaves. The image is thought to be a *sangkalan memet*, which when read in Javanese, reads: *Pang Pinajang Srikaya Sagodonge*. These words have the following numerical meanings that are 1) *pang* is meaning branch symbolizing 6, 2) *pinajang* is meaning decorated symbolizing 2, 3) *srikaya* is meaning *srikaya* fruit symbolizing 3, and 4) *sagodonge* is meaning with the leaves symbolizing 1. When read backward, it will read the year 1326, which is indicates the year the *mihrab* was made, namely in 1326 H. There is some mathematical content on *mihrab* that is the concept of a circle, a rectangle, and a number. Table 2 describes the results of identifying the *mihrab* based on the classification of D'Ambrosio [7].

Table 3. Subject, classification, and Learning resources at the mihrab

Figure	Learning Activity	Subject: Grade/ Basic Competences	D'Ambrosio Clasification
9	Classify the forms contained in the mihrab	Two Dimensional Shape	Classifying
	Determine the surface area of the mihrab with the formula for the area of a circle or integral	Two Dimensional Shape dan Integral	Measuring
	Learning number by using Javanese number	Number	Counting

5. Porch

Inside this porch, there is *Bedug Pendowo*, which is the largest *bedug* in Indonesia. This *Bedug Pendowo* was made on the orders of Kanjeng Raden Adipati Cokronegoro I between 1834 AD - 1840 AD as a sign of the entry of prayer times for the congregation. Bedug Pendowo is made of teak wood from Pendowo Hamlet, Bregolan Village, Purwodadi District, Purworejo Regency with sizes, that is 1) bottom centerline (front) is 194 cm, 2) the centerline of the top (back) is 180 cm, 3) circumference of the bottom

circle (front) is 601 cm, 4) circumference of the top circle (back) is 564 cm, and 5) length is 292 cm.

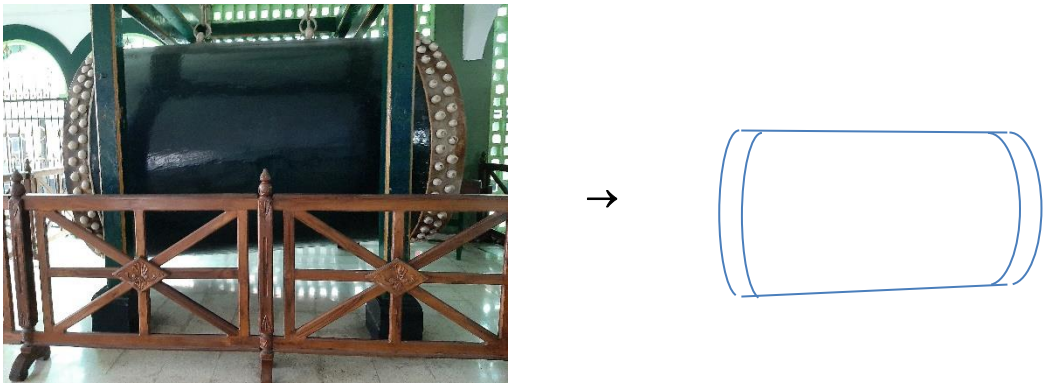

Figure 10. Bedug Pendowo

The leather used is from bull skin. This Bedug Pendowo is hung on a teak wood frame with a fairly large iron chain and is placed in the mosque's foyer. At first, this bedug was beaten every time the obligatory prayers entered, but only played on certain days. This bedug is shaped like a tubular shape. In addition, the fence that surrounds the bedug, as shown in figure 10, also has a mathematical context. In figure 10, there are several mathematical contexts, namely rectangles, diagonal planes, and axes of symmetry.

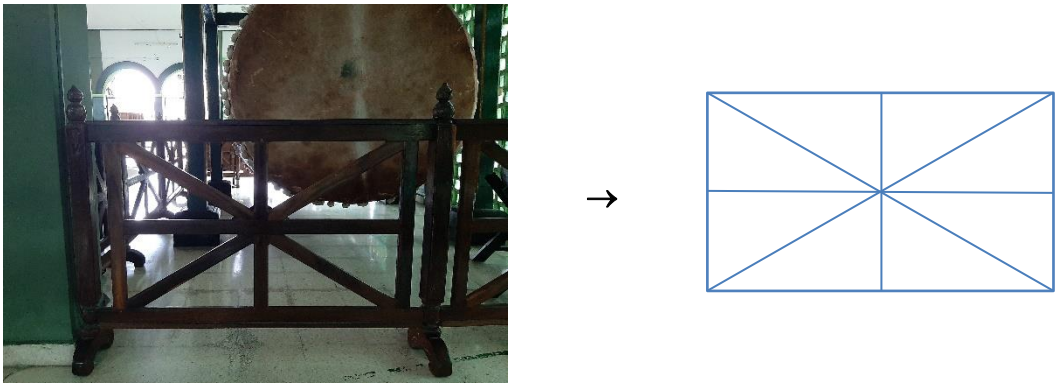

Figure 11. Bedug Pendowo's Fence

In the middle of the upper foyer, a square is divided into four parts consisting of several squares. This section can be used as a medium for learning numbers, especially for learning multiplication.

Figure 12. Bedug Pendowo's Fence

Table 4 describes the results of identifying the porch based on the classification of D'Ambrosio [7].

Table 4. Subject, classification, and Learning resources at the porch

Figure	Learning Activity	Subject: Grade/ Basic Competences	D'Ambrosio Clasification
10	Determine the volume and surface area of the drum	Three and Two Dimensional Shape	Measuring
	Determine the area of skin used to make the drum.	Three and Two Dimensional Shape	Measuring
	Determine the number of circle ornaments on the drum	Number Operation	Counting
11	Determine the type of triangle formed on the fence shape	Two Dimensional Shape	Classifying
	Determine the type of flat shape formed in the fence	Two Dimensional Shape	Classifying
	Determine the length of the wood used to make the fence	Two Dimensional Shape	Measuring
12	Determine the number of squares on the porch	Number Operation	Counting

B. Discussion

Based on the 2013 curriculum content standards analysis, learning resources at the Jami' Darul Mutaqqim Mosque can be identified as a learning source for students from elementary school, like number operation to class senior high school, like integral. It explains the alternative learning media that can be offered and enriched with cultural backgrounds, namely ethnomathematics. The mathematical concepts found in the Jami' Darul Mutaqqim Mosque building are number, number operation, three and two-dimensional shape, geometry transformational, and integral. Based on D'Ambrosio classification, some categories can be obtained from exploratory ethnomathematics: counting, measuring and classifying.

Several previous studies exploring mosques ([2]; [5]; [12]; [15]; [24]; [29]; [40]) found that many elements of mathematics. Mathematical elements are often found in every corner of mosque buildings [29]. As in the Jami' Al-Baitul Amien Mosque building in Jember, the mathematical concepts found are flat material, spatial structure, and reflection congruence, namely calculating the area and circumference of a circle, trapezoid area, tube blanket area, and determining reflection results [40]. In the other research, from identifying the Kota Gede Mataram Mosque are carvings (ornaments) on the walls, pavilion buildings, mosque roofs, and drums are closely related to geometric concepts, including building flat and building space [5]. Then, the other study also explains that the mathematical concepts that appear in the Mesjid Soko Tunggal are triangles, squares, rectangles, rhombuses, circles, and reflections [24]. It explains that mathematics is closely related to the daily life of students or society, so it is not difficult to learn mathematics if you present mathematical concepts correctly. Questions and explanations are made based on ethnomathematical identification of the shape of the building of the Jami' Darul Mutaqqim Mosque.

Activities in learning mathematics by applying ethnomathematics can further increase the interaction between teachers and students or students with other students ([9]; [10]). The linkage of culture with mathematics means that ethnomathematics can facilitate students to construct their mathematical knowledge and concepts ([18]; [34]). Applying ethnomathematics in mathematics learning can also be a means to motivate and stimulate students to be able to overcome boredom and can give new nuances to students in learning mathematics ([34]; [37]). Linking ethnomathematics with mathematical practice experie makes ethnomathematics close to students' social environment so that learning activities become more enjoyable ([17]; [20]; [36]; [39]). With this research, the components of ethnomathematics, formal mathematics, and their use in learning mathematics will be proven and identified. Learning that is integrated with ethnomathematics and is said to contribute to better education, namely in motivating, ethnomathematics plays a role in creating and encouraging value awareness [22], even the use of ethnomathematics by teachers results in effective mathematics learning [16].

CONCLUSION

Based on the results and discussion, it can be concluded that there are ethnomathematical values in the Jami' Darul Mutaqqim Mosque. Ethnomathematics appears in the shape of the parts of the mosque building. The parts of the mosque are 1) the adzan tower; 2) the mosque roof; 3) the main prayer room (*liwan*); 4) the mihrab; and 5) the porch. The mathematical concepts found are number, number operation, three and two-dimensional shape, geometry transformational, and integral. Variations, according to D'Ambrosio, are counting, measuring, and classifying. This research is still within the limits of exploration, so the researcher hopes that the results of this study can be developed further research. Therefore, the Jami' Darul Mutaqqim Mosque has elements of mathematics that can be used as a reference in the development of teaching materials in schools.

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