Ethnomathematics: exploration of a mosque building and its ornaments

T Purniati1*, Turmudi1, and D Suhaedi2

1Department of Mathematics Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
2Mathematics Program Study, Universitas Islam Bandung, Jl. Tamansari No. 1, Bandung 40116, Indonesia

*Corresponding author’s e-mail : tpurniati@upi.edu

Abstract. Ethnomathematics is a program that studies the cultural aspects of mathematics. This program presents mathematical concepts in a way related to the cultural background of students. This study aims to explore ethnomathematics aspects of a mosque building and its ornaments. This study used a qualitative approach to exploration methods. The techniques of collecting data were observation, documentation, and literature reviews. The research location was the Great Mosque of Cimahi which was determined using purposive sampling. The results of the study show that there are ethnomathematics aspects of the mosque building and its ornaments. The mathematical concepts of the mosque building and its ornaments are related to the concepts of geometry and algebra. Mathematical presentations related to mosque buildings and its ornaments are expected to help students to connect mathematics with the surrounding culture so that mathematics becomes more meaningful.

1. Introduction

Mathematics is generally seen as free from the culture [1]. So there is a view that mathematics education does not need to consider the growing diversity in the student population [2]. However, in fact, mathematics is made from many traditions that are rich, diverse, and historically different. This is in accordance with the opinion of D’Ambrosio, who emphasized that all people have developed unique and different mathematical knowledge that is incorporated into the culture. This can be seen in diverse group ways to compile, measure, use numbers and combine geometric shapes. Mathematical thinking is influenced by the diversity of the human environment, which includes language, religion, morals, economics, social, and political activities [3]. Thus, mathematics is a social and cultural product [4].

Educators (both school management and teachers) need to gain knowledge and develop respect for the diverse cultural traditions of each of their students so that they can apply the principle of cultural conformity in school and in class [1]. Teaching mathematics through cultural relevance and personal experience helps students to know more about reality, culture, society, environmental problems, and themselves which enables them to master mathematics better [5].

D’Ambrosio argues that the main purpose of mathematics education is to encourage the creation of new knowledge. To create new knowledge, we must look at society as a whole and its cultural dimensions [6]. Ethnomathematics is a program that combines mathematical ideas and procedures practiced by members of different cultural groups [7]. This program presents mathematical concepts in a way that is related to the cultural background of students, so as to enhance students’ ability to make...
connections that are meaningful and deepen their understanding of mathematics [5]. Ethnomathematics is a knowledge that is built by members of cultural groups that differ from time to time and across generations that live and are closely related to their own historical, social, cultural and natural environment [3]. Ethnomathematics offers a broader view of mathematics which includes ideas, ideas, procedures, processes, methods, and practices that are rooted in different cultural environments [8].

There are three root words derived from Greek in ethnomathematics, namely techne, mathema, and ethno. Techne means ways, art, and technique. Mathema means to understand, explain, and learn. Whereas, ethno means groups in the natural environment, social environment, and cultural environment [6]. Thus, ethnomathematics is described as art and technique (tics) developed by members from different cultural backgrounds (ethno) to explain, understand, and overcome their own social, cultural, environmental, political and economic environment (mathema) [9]. So the long phase becomes the tics of mathema in the ethno difference and the arrangement becomes ethnomathematics [10, 11].

Bishop proposed that the school mathematics curriculum should be designed in a way that is related to the ethnomathematics practice [12]. It is impossible to teach mathematics in a way that is insensitive to the student experience [13]. With the inclusion of cultural aspects in the mathematics curriculum, it will have long-term benefits for students 'mathematical achievements, these aspects contribute to the perception that mathematics is a part of our daily lives and can enhance students' ability to make connections which means [1].

There are several studies on ethnomathematics. Amit and Qouder [14] revealed aspects of mathematics in the daily activities of the Bedouin community in the Negev region of Israel, in measuring length and weight in the traditional way. Pradhan [15] revealed aspects of mathematics in wooden artifacts from Chundara, Nepal. Sharma and Orey [16] revealed aspects of mathematics in the artifact named dhol, which is a musical instrument from Rai's culture in Nepal. Shockey and Mitchell [17] revealed mathematical aspects of the construction of the Penobscot lodge from natives Americans. Trinick, Meaney and Fairhall [18] revealed the concept of symmetry in Rauru, a Māori meeting place located in Hamburg, Germany. These things show that the aspects of mathematics can be found in cultural practices [12].

One of the environments that close to student is mosque. A mosque is a place used by Muslims to perform the prayer, either alone or congregation [19]. Aside from being a place of prayer, the mosque also serves as a place to carry out all activities of Muslims, including religious education activities, recitation, and other social activities [20]. Mosque buildings and ornaments in Indonesia are influenced by various cultures, especially Indonesian culture, and Islamic culture. In addition, mosque buildings and ornaments are also related to mathematical concepts. So, mosque buildings and its ornaments can be used as an alternative media that can be used in mathematics learning.

2. Methods
This study aims to explore the ethnomathematics aspects of a mosque building and its ornaments. So, this study used a qualitative approach with exploration methods. Data collection techniques were observation, documentation, and literature review. The research location was the Great Mosque of Cimahi. Determination of this location used the purposive sampling.

3. Result and Discussion
Based on the results of observations and documentation on the building and ornaments of the Great Mosque of Cimahi, it was found that the building and ornaments of the mosque had ethnomathematics aspects. The mathematical concepts associated with the building and ornaments of the mosque are the concept of geometry and algebra. The following is the result of an exploration of ethnomathematics aspects of the building and ornaments of the Great Mosque of Cimahi.
| Ethnomathematics | Mathematical Concept |
|------------------|----------------------|
| The shape of the roof on the mosque’s tower can be associated with the concept of plane geometry (triangle and trapezium) and space geometry (rectangular pyramid). In addition, the ornament can be associated with the concept of plane geometry (square and rhombus). |
| ![Image](image1.png) |

| Ornaments on the mosque’s walls can be associated with the concept of plane geometry (rectangle and octagram) and transformation geometry (dilation). |
| ![Image](image2.png) |

| Ornaments on the mosque's fence can be associated with the concept of plane geometry (rhombus and circle). |
| ![Image](image3.png) |
The shape on the mosque’s pole can be associated with the concept of space geometry (rectangular prism). In addition, the ornament can be associated with the concept of plane geometry (octagram).

The shape of the lamp on the mosque’s pole can be associated with the concept of space geometry (cone).

The shape of the lamp on the mosque’s walls can be associated with the concept of space geometry (cylinder).

The shape of the lamp on the main room of the mosque can be associated with the concept of space geometry (sphere).

Ornaments on the mosque's door can be associated with the concept of transformation geometry (translation, reflection, rotation, and dilation).
Ornaments on the mosque's pole can be associated with the concept of transformation geometry (reflection and rotation).

Ornaments on the mosque's walls can be associated with the concept of algebra (frieze group). In these ornament patterns, there are translation and vertical reflection.

Ornaments on the mosque's walls can be associated with the concept of algebra (frieze group). In these ornament patterns, there are translation and vertical reflection.
In this ornament patterns, there are also translation and horizontal reflection.

In this ornament patterns, there are also translation, vertical reflection, and horizontal reflection.

Based on these results it was found that the building and ornaments of the Great Mosque of Cimahi were related to mathematical concepts, namely geometry concepts (plane geometry, space geometry, and transformation geometry) and algebra (frieze group). This is in accordance with D'Ambrosio's statement which emphasizes that everyone has developed mathematical knowledge that is incorporated into the culture [3]. Mathematics is everywhere and practiced by every culture [21]. Therefore, in teaching mathematics, teachers should begin learning by exploring informal mathematical knowledge obtained by students from the surrounding environment. Concrete things that relate to students' daily experiences can be used as an interesting media for learning mathematics [22].

4. Conclusion
The mathematical concepts that can be revealed from the building and ornaments at the Great Mosque of Cimahi are geometry concepts (plane geometry, space geometry, and transformation geometry) and algebra (frieze group). Through building and ornaments at the Great Mosque of Cimahi, it is expected that students will more easily learn mathematical concepts.

5. References
[1] Rosa M and Gavarrete M E 2016 Polysemic Interactions between Ethnomathematics and Culturally Relevant Pedagogy Current and Future Perspectives of Ethnomathematics as a Program ed Rosa M et al (Hamburg: Springer) p 23-30
[2] Wahyudin 2018 Etnomatematika dan Pendidikan Matematika Multikultural Prosiding Seminar Nasional Etnomatnesia ed Widodo S A (Yogyakarta: Universitas Sarjanawiyata Tamansiswa) p 1-19
[3] Rosa M and Gavarrete M E 2017 An Ethnomathematics Overview: An Introduction Ethnomathematics and its Diverse Approaches for Mathematics Education ed Rosa M et al (Hamburg: Springer) p 3-19
[4] Alangui W V and Rosa M 2016 Role of Ethnomathematics in Mathematics Education Current and Future Perspectives of Ethnomathematics as a Program (Hamburg: Springer)
[5] Rosa M and Shirley L 2016 Introduction Current and Future Perspectives of Ethnomathematics as a Program ed Rosa M et al (Hamburg: Springer) p 1-3
[6] D’Ambrosio U 2016 An Overview of History of Ethnomathematics Current and Future Perspectives of Ethnomathematics as a Program ed Rosa M et al (Hamburg: Springer) p 5-10
[7] Rosa M and Orey D C 2016a Six Dimensions of Ethnomathematics Current and Future Perspectives of Ethnomathematics as a Program (Hamburg: Springer) p 11-13
[8] Rosa M and Orey D C 2016b Innovative Approaches in Ethnomathematics Current and Future Perspectives of Ethnomathematics as a Program (Hamburg: Springer) p 18-23
[9] Rosa M and Orey D C 2013 Ethnomodeling as a Research Theoretical Framework on Ethnomathematics and Mathematical Modeling Journal of Urban Mathematics Education 6 2
[10] D’Ambrosio U 2018 The Program Ethnomathematics: Cognitive, Anthropological, Historic and Socio-Cultural Bases PNA 12 4
[11] Turmudi 2018 Kajian Etnomatematika: Belajar Matematika dengan Melibatkan Unsur Budaya. Prosiding Seminar Nasional Etnomatnesia ed Widodo S A (Yogyakarta: Universitas Sarjanawiyata Tamansiswa) p 38-53
[12] Shirley L and Palhares P 2016 Ethnomathematics and its Diverse Pedagogical Approaches Current and Future Perspectives of Ethnomathematics as a Program Hamburg: Springer)
[13] Orey D C 2017 The Critical-Reflective Dimension of Ethnomodelling Ethnomathematics and its Diverse Approaches for Mathematics Education ed Rosa M et al (Hamburg: Springer) p 329-354
[14] Amit M and Qouder F A 2017 Weaving Culture and Mathematics in the Classroom: The Case of Bedouin Ethnomathematics Ethnomathematics and its Diverse Approaches for Mathematics Education ed Rosa M et al (Hamburg: Springer) p 23-50
[15] Pradhan J B 2017 Mathematical Ideas in Chundara Culture: Unfolding a Nepalese Teaching and Learning System Ethnomathematics and its Diverse Approaches for Mathematics Education ed Rosa M et al (Hamburg: Springer) p 125-152
[16] Sharma T and Orey D C 2017 Meaningful Mathematics Through the Use of Cultural Artifacts Ethnomathematics and its Diverse Approaches for Mathematics Education ed Rosa M et al (Hamburg: Springer) p 153-182
[17] Shockey T and Mitchell J B 2017 An Ethnomodel of a Penobscot Lodge Ethnomathematics and its Diverse Approaches for Mathematics Education ed Rosa M et al (Hamburg: Springer) p 257-284
[18] Trinick T, Meaney T, and Fairhall U 2017 Cultural and Mathematical Symmetry in Māori Meeting Houses (Wharenui) Ethnomathematics and its Diverse Approaches for Mathematics Education ed Rosa M et al (Hamburg: Springer) p 235-256
[19] Muslim A 2004 Manajemen Pengelolaan Masjid Aplikasi Ilmu-ilmu Agama 5 2
[20] Auliyah R 2014 Studi Fenomenologi Peranan Manajemen Masjid At-Taqwa dalam Pemberdayaan Ekonomi Masyarakat Bangkalan Jurnal Studi Manajemen 8 1
[21] Brandt A and Chernoff E J 2015 The Importance of Ethnomathematics in the Math Class Ohio Journal of School Mathematics 71
[22] Marsigit et al 2018 Pengembangan Pembelajaran Matematika Berbasis Ethnomatematika. Prosiding Seminar Nasional Etnomatnescia (Yogyakarta: Universitas Sarjanawiyata Tamansiswa) p 20-38