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Ethnomathematics in Borobudur Temple and Its Relevance in Mathematics Education: A Literature Study

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Abstract: Ethnomathematics in Borobudur Temple and Its Relevance in Mathematics Education. **Objectives:** The purpose of this literature study is to reveal the forms of mathematical culture in temples in Indonesia, especially in the Borobudur Temple. **Methods:** The object of this study is the scientific literature on the theme of ethnomathematics and Borobudur Temple. The stages of this research are determining the research problem, finding and evaluating relevant literature, conducting data analysis, and compiling the results.The data analysis technique used was hermeneutics analysis. **Findings:** In this study, it has been revealed that Borobudur Temple is a building that has been designed with great mathematical techniques. There is a numbering system, so-called *watakwilangan* and *primbon* in Javanese culture that regard the number does not only refer to certain quantity, but also a character affecting human life. In addition, geometric shapes appear on the structure, both basic geometric shapes, and fractal shapes. **Conclusion:** There are unique mathematical concepts in the form of Javanese number systems, logic, and space configurations that can create a beautiful and persisting building.

Keywords: ethnomathematics, borobudur, culture, mathematics, education.

Abstrak: Etnomatematika pada Candi Borobudur dan Relevansinya pada Pendidikan Matematika. ***Tujuan:*** *Penelitian studi literatur ini bertujuan untuk mengungkap bentuk-bentuk matematika budaya pada candi di Indonesia, khususnya Candi Borobudur.* ***Metode:*** *Objek kajian ini adalah literature yang bertema etnomatematika dan candi Borobudur. Tahapan penelitian ini adalah penentukan masalah penelitian, mencari dan menilai literature yang relevan, melakukan analisis data dan menyusun hasil.* ***Temuan:*** *Pada penelitian ini terungkap bahwa Candi Borobudur adalah bangunan yang dirancang dengan teknik matematika yang tinggi. Sistem bilangan pada budaya jawa tidak hanya mewakili jumlah tertentu, tetapi juga suatu karakter yang mempengaruhi kehidupan manusia. Selain itu, bentuk geometris muncul pada bagunan itu, baik bentuk geometris dasar maupun bentuk fraktal.* ***Kesimpulan:*** *Terdapat konsep matematika yang unik baik berupa sistem bilangan jawa, logika dan konfigurasi ruang yang bisa membuat bangunan menjadi indah dan bertahan.*

Kata kunci: *etnomatematika, borobudur, budaya, pendidikan matematika*

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INTRODUCTION

A universal application and value-free view of mathematics makes mathematics be recognized as something independent from the cultural root, local context, and daily life. This understanding causes mathematics education be presented in abstract terms, and seemingly it does not touch the realm of application, so students find mathematical concepts is difficult to understand. Gilsdorf explained that a certain concept of mathematics is was generated from a certain culture (Gilsdorf, 2012). This kind of learning makes mathematics be difficult for students because the concepts do not originate or emerge from their own culture. Western mathematical concepts are incompatible with what is in the local culture.

On the other hand, local culture has its own mathematical concepts that have been used in local society. However, due to the dominance of Western education, local mathematical concepts were discarded and not recognized. As a result, the local mathematical concepts (ethnomathematics) will be marginalized and disappear because they are not considered a valid form of mathematics. Ethnomathematics helps to shape meta-awareness of the role of mathematics in society and culture so that the ethnomathematics program can reveal how traditional mathematics plays a role in its own culture (Rosa & Gavarrete, 2017, p. 3). Mathematical education requires a radical reform that enables cultural and critical aspects embedded in the philosophical ground of mathematics teaching (Nunez, 2015). Mathematics learning cannot be separated from the culture and historical context that has been shaped it. Mathematics education in Indonesia needs to deliver mathematical views that are inter-connected with the local culture and customs of students so that they can understand mathematics through understanding their own local culture.

Indonesian culture is vibrant and diverse; this cultural richness should be used as a learning medium. In the ethnomathematics view, there are various forms of local mathematics found in every culture, and Indonesian culture is no exception. Various mathematical activities and concepts such as measuring, calculating, and classifying may emerge in multiple aspects of Indonesian culture. For example, numerous temple building constructions in Central Java and Yogyakarta have unique patterns and sophisticated geometric shapes. Regarding the building, there are underlying patterns in the form of geometric shapes such as circles, triangles, squares, and rectangles. Furthermore, the Javanese temple pattern design signifies a form based on fractal geometry(Situngkir, 2018). These abundant Indonesian mathematical heritage should be a appreciated knowledge that enriches mathematics learning at school.

Marcia Ascher explained that mathematical ideas involve numbers, logic, or spatial configuration and, in particular, the combination or organization of these into systems or structures. (Ascher, 2017, p. 2). Ascher is a pioneer and a key thinker in ethnomathematics discourse. She has provided an elementary concept of mathematics as an anvil to trace local mathematics in non-western cultures. So, these primary concepts would guide ethnomathematics researchers to find indigenous mathematical concepts in a form that may be considered different from modern and formal mathematics.

Rosa and Gavarrete explain that the concept of ethnomathematics research can be understood as to how mathematics is made of many historically rich, diverse, and distinct traditions (how mathematical concepts are formed by rich, varied and diverse cultural traditions (Rosa & Gavarrete, 2017, p. 4). In this case, it is essential to emphasize that cultural diversity is vital in seeing how a mathematical concept is formed and

understood by humans being. This idea provides multicultural spectacles in understanding mathematics.

Rosa & Orey explained that ethnomathematics attempts to establish relations between mathematical ideas and daily activities embedded in local practices (emic) and academic conceptual frameworks (etic). Ethnomathematics are attempts to form relationships between mathematical ideas and procedures that exist in local practices and frameworks of academic conceptual (Rosa & Orey, 2016, p. 5). In this understanding, ethnomathematics is better understood as an attempt to explore how people understand mathematics in everyday life. Rosa and Orey have provided that the ethnomathematics is a way to comprehend other mathematical forms. Also, Rosa & Orey have put the ethnomathematics as a bridge for mathematics learners who have local mathematical concepts to understand formal mathematics, and vice versa (Rosa & Orey, 2016).

Ethnomathematics forms have occasionallydifferent philosophical foundations with formal mathematics. In the term of learning, It can be used as enrichment material to introduce a different kind of mathematics to students as Amit & Quoder stated that ethnomathematics seeks to establish relationships between mathematical and cultural content from learners and sometimes the appropriate curriculum that is in accordance with local needs and local culture. However, it may differ from planned teaching programs (Amit & Abu Qouder, 2017).

The ethnomathematics concept from D'Ambrosio takes the emphasis on openness and equality. Much further, according to D'Ambrosio, ethnomathematics is a way of celebrating diversity in the realm of mathematics. In addition to the issue of equality, ethnomathematics, in D'Ambrosio's view, is ubiquitous mathematics. Mathematics does not only appear in the cultures of the interior of local societies. Mathematics, in this case, ethnomathematics, may appear in every environment and everyday life.

D'Ambrosio saw that various forms of activities considered as non-academic and do not pertain to expert actually may contain elements of cultural mathematics. Many professions, such as farmers, traders, and laborers, have their concepts in dealing with problems, and they can carry out mathematical conceptualizations of the reality they understand. However, with a narrow view of mathematics and an understanding of academic mathematics as the "true "mathematics, the mathematical forms that emerge in daily life are excluded from criteria recognized as mathematics. As explained, there are mathematical notions of peoples that written history has hidden, frozen, or stolen. Including these ideas makes it clear that what is labeled "Western" mathematics is more accurately called "world mathematics" (Powell & Frankenstein, 1997, p. 8).

Various studies examine ethnomathematics and its role in mathematics education. Most of them, using ethnomathematics as a perspective to uncover how local mathematics exists in Indonesian culture. These studies show that Indonesian culture has many aspects of mathematics that need to be revealed. Imswatama & Lukman (2018) has conducted a study entitled "The effectiveness of mathematics teaching material based on ethnomathematics." In this study, it has been proven that ethnomathematics has a positive impact on students' ability to learn mathematics subjects.

Abi (2017) discussed how and what it looks like to integrate ethnomathematics into the mathematics curriculum and learning models. This study shows that ethnomathematics can bridge mathematics and daily life, which is easier to learn by students. Suwito & Trapsilasiwi (2016) has conducted a research aimed to develop

innovative learning tools that can foster and preserve culture through learning mathematics. Moreover, Muhtadi (2017) revealed various forms of Sundanese ethnomathematics, which are grouped into three activities, namely: estimating, measuring, and making patterns. In the three forms of ethnomathematics, there was concepts in the form of cubic (a unit to measure volume), brick (a unit to measure land area), and a lead-way pathway (swing model). Rani (2018) has conducted a study, "Ethnomathematics at Ratu Boko Temple as a Realistic Mathematics Learning." In his research, Rani argued that in the architecture of the Ratu Boko Temple building, several buildings have a mathematical relationship, namely flat geometry material such as triangles, squares, rectangles, trapezes, parallelograms, and circles. Rani concluded that ethnomathematics acts is a bridge between abstract mathematical concepts and reality or concrete objects in everyday life.

Research from Abi and Siwito & Trapsilasiwi has provided evidence that ethnomathematics exists in Indonesian culture and can simultaneously be used in school mathematics learning. The study from Muhtadi and Rani, in more detail, reviewed the concepts of ethnic mathematics that exist in Sundanese and Javanese cultures. Muhtadi and Rani described how the essential elements of mathematics emerge in different ideas in Sundanese and Javanese culture. Although Rani presents ethnomathematics in the Javanese culture of the Boko temple, it did not yet mention other more significant and iconic temples such as Borobudur. Although Abi and Siwito & Trapsilasiwi have discussed how ethnomathematics in Indonesia in the realm of learning, both have not yet explored ethnomathematics in Javanese culture for education interest. Based on the analysis of the existing literature, the study about ethnomathematics in Borobudur temple and its relevance to mathematics education is original and has never been done before.

On the various problems and theoretical studies above, this research discusses ethnomathematics. Ethnomathematics is basic mathematical concepts such as patterning, calculating, and predicting that exist in local cultures. The object of the study is the Borobudur Temple, its discourse, history, and culture written in academic literature. This temple is the largest in Indonesia and is considered one of the wonders of the world. This research explores ethnomathematics form in Borobudur Temple and its relevance to mathematics learning. Mathematics education in ethnomathematics perspective is mathematics education that empowers the knowledge and local wisdom of Indonesian culture to be synthesized into mathematics teaching. Indonesian culture explored is restricted to material and non-material aspects. Material cultural elements in the form of Borobudur temple architecture, while non-material culture is local knowledge of Javanese temple architecture. This study has served innovative knowledge that enriches mathematics education by providing reconciliation of local culture and modern mathematical concept. Most important thing is that the students can learn mathematics through their own culture.

METHODS

This research uses a qualitative approach, and the method devised was a literature study or literature review. A qualitative approach is a research concept that emphasizes the description of quality over quantity, as well as revealing the meaning of a phenomenon under study (Taylor, Bogdan, & DeVault, 2015). In this study, a qualitative approach is used to explain how mathematical forms and concepts exist in the construction of Borobudur Temple. A literaturestudy or literature review is a method

that scrutinizes and analyzing specific themes and discourses. The data and pieces of information studied are available on books, article journals, and documents relating to the research theme. According to Templier & Paré (2015),the stages of literature study methods are: formulating the research questions and objectives, searching the extant literature, screening for inclusion, assessing the quality of primary studies, extracting data, and analyzing data.

Research subject

The subject of this research was the discourse of Borobudur Temple, including Javanese culture and the architectural design of the Borobudur Temple. In the temple architecture design, it involves the shape, size, design, motifs, and philosophies contained therein have a mathematical concept.

Data collection

Data collection methods used in the form of literature review and documentation. The literature review was used to reveal the theories about ethnomathematics, the historical idea on Borobudur Temple, and Javanese culture that relates to the mathematical concept and the temple. The documentation method was carried out to examine various record sources related to the research subject, including reconstruction of Borobudur record and particular pictures portrayed the temple and its detail.

Data analysis

The data analysis method used was Hermeneutic analysis. This analysis delivers the possibilities of interpretations in thinking. In so doing, methods of hermeneutics analysis can uncover and present the structure of the meaning of lived experience (Ho & Leung, 2017). With this analysis, the mathematical concepts that exist in Javanese culture in the form of Borobudur Temple would reveal. In understanding Javanese mathematical phenomena, the hermeneutic method requires analysis of historical contexts and figures where the artifacts/temples were made; then, the current context is also presented in interpretation. By this, the phenomenon in the form of a temple would be understood in terms of history and present. What was shown in the interpretation was the historical context of Javanese mathematical culture, as well as the present context in the form of formal mathematics. In this way, the phenomenon of ethnomathematics in the Borobudur Temple could be well comprehended because it firmly roots in authenticity in the past and, at the same time, gives meaning to the present.

■ RESULTS AND DISCUSSION

The perspective used to uncover mathematical knowledge of these cultural artifacts is the ethnomathematics concept of Ascher and D'Ambrosio. In the understanding of ethnomathematics from Ascher, forms of mathematics outside formal mathematics are recognized as ethnomathematics. In local cultures, mathematical ideas do not always take the form of modern mathematics. Ascher mentioned that ethnomathematics in non-modern cultures could be seen in the concepts of numbers, logic, space configuration, and systematization, or pattern formation. Of course, the idea will be different from what is in modern mathematics. Therefore, it is necessary to have sufficient cultural horizons and strong historical knowledge in interpreting the forms of ethnomathematics in the Borobudur Temple.

Besides Ascher, the ethnomathematics concept used as a lens of thought was D'Ambrosio's ethnomathematics theory. Unlike Ascher, who saw ethnomathematics narrowly, D'Ambrosio comprehended it in a global and vast view. D'Ambroio stated that the formation, systematization, and use of local mathematical knowledge are an integral part. Therefore, D'Ambrosio gives three ideas as a continuous and

bound process of ethnomathematics, namely literacy, matheracy, and aristocracy.

In the first part, it will be discussed how the ethnomathematics concept of Borobudur Temple in the Ascher perspective, in the form of numbers, logic, space, and patterns. The numerical system in ancient Javanese culture is the numbers adopted from Indian culture, namely a ten-based number system. The logic that appears in the Borobudur Temple artifact is about the attachment and cause-effect between humans, symbols, and world realities. The space configuration in Borobudur Temple is in the form of fractal geometry, which imitates the natural form. The systematization process, in the Borobudur Temple, is the use of ethnomathematics to assembly a temple that is architecturally successful and contains spiritual meaning. The following discussion is the elaboration of each concept.

The Concept of Numbers

Borobudur Temple is a remarkable building and requires careful planning in its construction. Because this building is large and contains extraordinary details, there is certainly a concept of numbers that support its creation. The number of stupas in the Borobudur Temple is 73 units, with more detail is one main stupa, 32 stupas on the first circular terrace, 24 stupas on the second circular terrace, and 16 stupas on the third circular terrace. The number and level/terrace were neatly arranged and it systematically indicates that they already have an excellent numerical system and calculation technique. In an apparent view, the shape of Borobudur Temple, when it is seen from the side or top, it always looks symmetrical, although it is not entirely accurate. This symmetrical shape indicates that there are sophisticated measurements and calculations in its architecture.

In ancient Javanese culture, the concept of numbers adopted the Indian number system, which is a ten-based number. Brahmins and Pandita widely used this number in various activities, both scientific, worship, and daily. The concept of numbers in Javanese culture differs from modern number systems even though both of them are based on ten. From the perspective of Javanese culture, the symbol of numbers does not only indicate quantities but also symbolizes nature and character. In the Javanese tradition, this concept is called numerical character or *watakwilangan*. It means that a certain number does not only refer to an amount but also a particular character affecting human life and their destiny. This concept commonly appears in *Primbon*, a Javanese numerology, which used as guidance to everyday activity, including constructing a building. Each number symbolizes a particular character, such as 2 symbolizes men and 3 symbolizes women (Prabowo, 2010). Besides, numbers in Javanese cosmology are closely related to the reality they believe. Therefore, their numerical system had formed the concept of *primbon*. It is a calculation of quantification (the conversion of phenomena into numbers) of certain properties in daily life, which results as a guide to action. The measurement of Borobudur architecture was relied on this numerical concept. Its width and length reflect certain characters that supernaturally bless the society and human life.

In addition, numbers in Javanese cosmology do not only represent a certain amount but also objects or realities. All three are a different but mystically interconnected reality. In Javanese culture, a quantity is not only written in the form of numbers but also words. This concept is called *candrasengkala* or *suryasengkala*. For example, enunciating 1600 as a *saka* year can be written through the sentence "*sirna*

ilangkertaning bumi". The four realities are representative of the numbers. *Bumi* represents number 1, *kertaning* represents number 6, *ilang* represents number 0, and *sirna* represents number 0. This year is the moment of the vanishment of the Majapahit Kingdom. This description shows that there are three interconnected entities in the number system in Javanese culture, namely numbers, character, and reality.

In the measurement system, the Javanese tradition uses *tala*, hasta, and *depa* measurements. The size that often appears and widely used is *tala*. One *tala* is equivalent to the length of the tip of the head to the chin. There is also an opinion that the length of the tip of the middle finger to the base of the palm. The size of the *tala* was used to determine the length of various Javanese architectures. Unlike modern measurements that are standardized for their measurements, the Javanese culture measurement is relative to everyone. This is because the length of the head or the length of the hand is different for each person. This inaccuracy gave the impact to Borobudur shape and size. The shape and size of the Borobudur Temple look perfectly symmetrical, but it is not. In further examination, the size of the Borobudur Temple is not exactly symmetrical, but similar and close to (Situngkir, 2018). The size of each stone, the stupa's diameter, and size, as well as the projection of this temple, are not accurately the same.

Hokky Situngkir said that making Borobudur Temple is similar to making batik patterns. The concept of similarity in the pattern does not use a standard rule, but with precision relying on cognition or mind (Situngkir, 2018). Furthermore, the pattern of making the Borobudur Temple is like a mosaic arrangement which assembly existing original stonessize. So, it is unlike modern building construction, that makes the same brick size and then arrange them into a single building. Making Borobudur Temple was a different technique; it was done by resembling the rocks and following the original size of the stones. It is like putting together a puzzle or a mosaic painting. Because it usedmosaic techniques, the standard and precise measurement concepts such as in the modern world are not needed.

Logic

Logic is simply interpreted as reasoning for cause and effect on reality. In Javanese culture, especially in the construction of Borobudur Temple, the logic concept about cause and effect appears in the development of the architecture. Because they require a building that lasts forever, the architecture of the Borobudur Temple decides the most logical structure for this purpose. The basic structure that can be so durable is the structure of the pyramid, which is wide below and pointed at the top. This construction makes the temple building resistant to various natural disturbances such as storms, earthquakes, and floods.

One logical strategy at Borobudur Temple to defend from rainwater by making waterways (Munandar, 2018; Setyawan & Gunawan, 2018). Therefore, in Borobudur Temple, there is a drainage system. The function of waterways is to flow the rainwater from the top court to the bottom of the temple. Various strategies undertaken to achieve the objectives of the temple construction rely profoundly on logic. Therefore, the concept of cause and effect on the Borobudur Temple mega project was beneficial. In addition to philosophical and religious reasons, the shape of the temple, location, and additional structures are logical strategies in the architecture of the Borobudur Temple.

Space Configuration

The concept of space or geometry in the Borobudur Temple is very complicated; this is

because Borobudur does not only contain the concept of Euclidian geometry, but there is also the concept of fractal geometry (Situngkir, 2018). If we look at the building of Borobudur Temple, we will see square, rectangular, circular, and beam shapes. These various forms fall into the category of Euclidian geometry. Square and circle-like shapes can be seen in the Borobudur structure in the following image.

Figure 1. Combination of angular shapes and curves

Nevertheless, if traced further, there are very complicated ornaments, and various shapes are similar to each other to form regular patterns. The concepts of similarity and pattern formation are the basis for forming fractal geometry patterns. The fractal pattern is a geometrical shape that is similar to itself but appears on different scales. The similarity could be exact, but in a particular case, it is quasi-exact. The following picture is one example of various kinds of a fractal patterns.

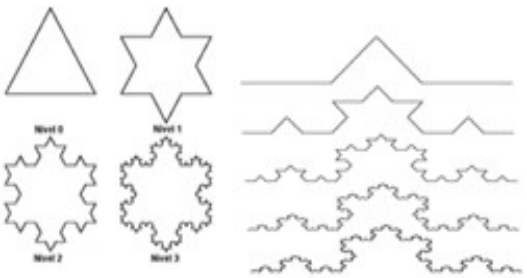
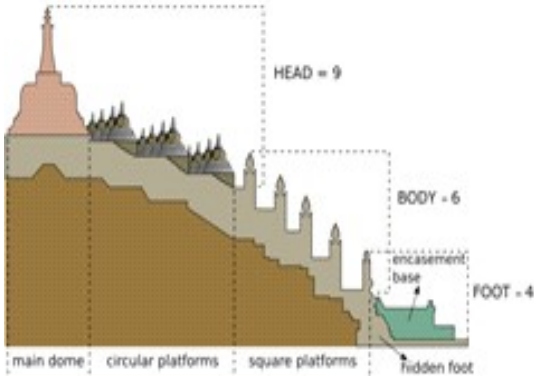


Figure 2. Fractal Pattern

The self-similarity geometrical patterns prevalently exist in Borobudur architecture. The form of stupas and ornaments were generated in a fractal pattern. Pattern shapes that are similar to each other can be seen in the following image.

(a)



(b)

Figure 3. (a) real; (b) illustration pictures of fractal patterns in Borobudur (Situngkir, 2018)

Another exciting thing is that, although they have similar and patterned shapes, they do not have an accurate similar size (Situngkir, 2018). This form is in accordance with the fractals structure in natural shape, like the existing patterns in the conch shell, flowers, and leaves in plants. The various forms in nature are symmetrical and resemble each other, but it is not the same. The formation of Borobudur Temple is also possible to follow the foundation of such fractal geometry.

The measurement of *tala* and *hasta* is not standardized in length. Then the mosaics stone structure has shaped the figure of Borobudur Temple into a beautiful fractal dimension, not precise but orderly patterned.

Systematization

At Borobudur Temple, there are at least four forms of extension between stones. The extension styles are called birds, notches, shafts and holes, and grooves, and tongues stone extension (Puspitasari, Setyawan, & Rini, 2016). Mastery over the shape and space allows them to make building structures composed of stone without cement and adhesive, which relies on the stone extension technique. The photo and name of the extension stone technique, according to Puspitasari, Setyawan, & Rini, are as follows.

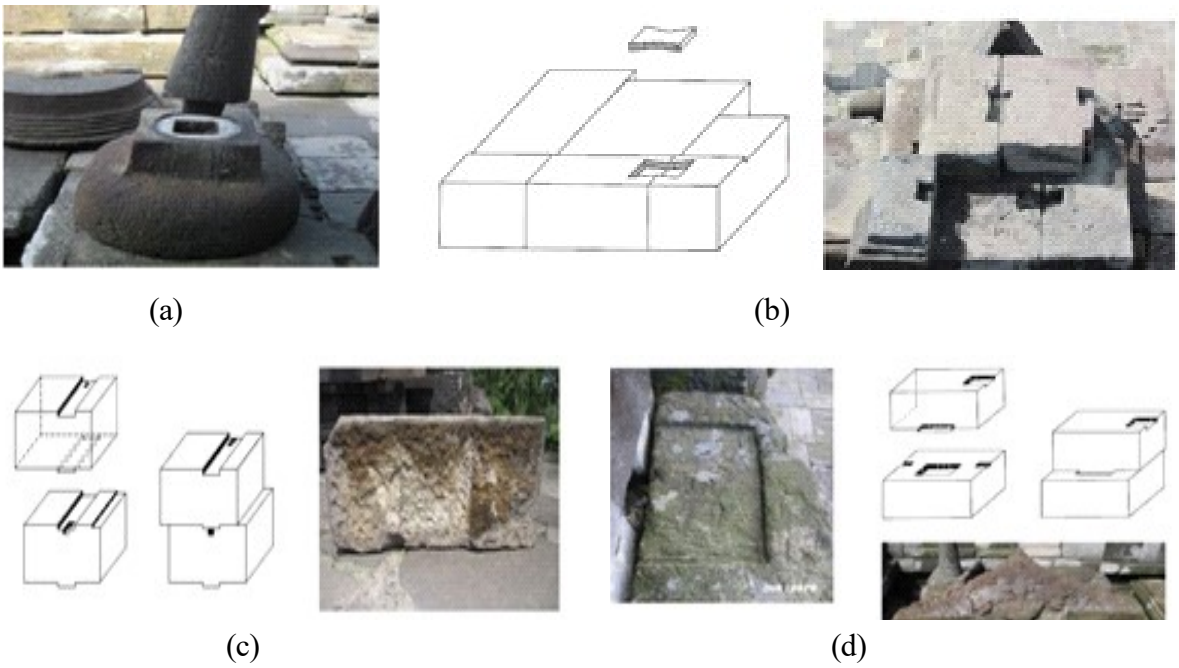


Figure 4. (a) shaft and hole extension; (b) bird tail extension; (c) grooves and tongue extension; (d) notch extension (Puspitasari, Setyawan, & Rini,2016)

The various forms of the connection allow for the preparation of a large number of aids but remain robust and sturdy. Form the pictures above, it can be concluded that Javanese culture had recognized the geometrical form such as square, rectangle, cone, and spherical shape. Furthermore, they had utilized those geometrical formations to create intelligently capable devices enabling them to resemble stones firmlywithout epoxy cement.

Fractal Geometry in Borobudur

To perceive Javanese cultural ethnomathematics knowledge in Borobudur temples, we cannot merely lay on modern mathematical knowledge. Every culture and era has its own mathematical method that is appropriate for its people. Therefore, the form of ethnomathematics in temples in Indonesia cannot be seen through the concept of modern mathematics and Euclidean geometry. There must

be another understanding of geometry that can explain the mathematical phenomena in the Borobudur temple. In Indonesian culture, Situngkir explained that the geometry used was not geometry provided with rulers and protractors (Situngkir, 2018). Geometry concepts in various artifacts, both batik, and temple, are not based on the basic form of Euclid's geometry. Indonesian culture understands geometric shapes, such as natural forms. Therefore, understanding of geometry in Indonesian culture cannot be reduced to Euclidian geometry. What is in nature is far more complicated than that. However, it is much more irregular. The boundary between sea and land is not a line; mountains are not cones, clouds are not curved lines (Situngkir, 2018, p. xxi).

There is a 4: 6: 9 length ratio for the overall size of the legs, body, and head of the temple, both vertically and horizontally (can be seen at figure. 3.b). The height and width of the temple parts called "feet," "body," and "head" roughly meet numerical comparisons of 4 to 6 and 9 (Situngkir, 2018, p. 52). This comparison does not only show the size and choice of architectural techniques but also an expression of art and beauty. In nature, many similar similarities appear. Therefore, the Borobudur Temple building is a building that is in harmony with nature's design, or in other words, its construction mimics how nature has been made. This is an unusual method of mathematics known by modern society (Situngkir, 2018, p. 58).

Literacy Process

In ancient Javanese culture and society, there had been a robust literacy process. Literacy is not only meant as the ability to read and write but the ability to capture natural phenomena and interpret them as concepts of ideas. When looking at the architecture of the Borobudur Temple, both history and cultural point of view of Java, various concepts play a role. Many concepts embody as numbers, the logic of causation, understanding of form, and space.

Matheracy Process

The process of matheracy is the formation of existing understandings, symbols, and ideas into a unity in the form of theories that have narratives. Borobudur Temple is proof of mind ingenuity and spiritual elegance. Both are united into a mega structure that lasted for thousands of years. Various sites in the Borobudur Temple have their own meaning.

Technocracy Process

The process of aristocracy is the utilization of existing knowledge for practical purposes. From searching history books, it is found that there were many obstacles in the construction of Borobudur Temple. However, due to the mastery of concepts and good mathematical knowledge, these difficulties could be overcome. A variety of existing knowledge allowed the construction of an extraordinary Borobudur Temple.

Borobudur Ethnomathematics in Mathematics Learning

From the above study, it can be seen that the concept of ethnomathematics in Borobudur Temple is in the form of numbers, logic, space configuration, systematization, and fractal geometry. In terms of the process, there are also processes of literacy, matheracy, and technocracy. Various ethnomathematics concepts are very relevant for learning mathematics.

In the case of Borobudur Temple, the use of ethnomathematics concepts is not only limited to the introduction of various basic geometric shapes and the number of stupas, statues, or height and width of buildings. Ethnomathematics is much further than that. With the ethnomathematics process, the students are expected to be able to learn how a certain number system, how Indonesian culture understood the abstraction process that produces geometric

shapes, and how that kind of knowledge was used to build monumental buildings and had solved various real problems.

In geometry, there is a process of abstraction, namely the formation of ideal ideas such as points, lines, and geometric shapes from real reality. This process emerged in Greek culture. In Indonesian culture, especially Javanese, there is also a process of abstraction like that which gives rise to forms that are classified as fractal geometry. It is a form having characteristics of symmetry or self-resembling and repeatedly forming patterns. This form appears in the building of the Borobudur Temple. In addition, the logic and connection system on the stone temple can be used as a learning process of technocracy. Namely, students are taught how the mastery of geometry can be used to build temples.

Ethnomathematics learning is both reinforcements inward and outward exploration. Strengthening inward is taking ethnomathematics knowledge to sharpen mathematical concepts that already exist and firmly established. The concept of geometry in Borobudur temple is able to enrich the knowledge of the school mathematics material. On the other hand, the use of ethnomathematics also aims to explore cultural reality. This means that students are taught to explore the knowledge existing in real life. It also leads students to expand their mathematical understanding by acclaiming local mathematical knowledge and also to develop critically and meta-cognition (Herawaty, 2018). Widada (2019) has proved that the mathematical problem-solving abilities of students after being given ethnomathematics with outdoor learning models were higher than before being given the learning models. So, ethnomathematics is suitable for the student to increase their problem-solving ability in a real-life situation.

A knowledge building is not generated from a culturally void space, but it constructed by a series of adaptations of various elements ranging from antediluvian cultures to hitherto existing cultures. Mathematical education must be harmonized and suitable for the particular student coming from various cultural backgrounds (Knijnik & Wanderer, 2015). So, it is the importance of paying attention to cultural and social relevance, and then it focuses on students' interests as one of the aspects of relevance (Kazima, 2013). It is vital to enable the teacher to development of opulent mathematical ideas within a context that was familiar to the students and the community (Civil, 2010). Ethnomathematics is always providing vast perspective, soit can be said that being inclusive and accepting the presence of "The Other" is the spirit of ethnomathematics.

■ CONCLUSIONS

Ethnomathematics is an inclusive mathematical concept. Understanding ethnomathematics provides awareness that there are other forms of formal and modern mathematics that we learn in school. Also, ethnomathematics describes the awareness that mathematical concepts are something that is interconnected with the cultural context in which mathematics is formed. Thus, mathematics is not an abstract concept that is separated from real life. Mathematics, in the view of ethnomathematics, is thought that originates from the struggle of life. Therefore, to develop existing mathematical knowledge, it is necessary to explore how mathematical concepts exist in culture and social life.

In the perspective of D'Ambrosian, Borobudur Temple is a building that contains symbols and concepts of spirituality. This shows that Javanese culture at that time had an influential

literacy, namely the ability to form ideas in symbols and concepts of world understanding. The shape, symbol, and size, as well as its architecture, are a world understanding of ancient Javanese culture and Buddhism. The process of matheracy or the formation of mathematical concepts (in the form of symbols or ideas) can be perceived in the architectural concept of Borobudur Temple. The symmetrical shape and structure of the fractal pattern, as well as the various symbols and their interpretation at each site in the Borobudur temple, has proven that they can narrate their mathematical concepts. In the process of technocracy, Indonesian culture has shown its reliability with the establishment of the Borobudur Temple. Technocracy is the process of using mathematical knowledge for practical purposes. With the monumental Borobudur is a Temple building which is symmetrical, sturdy, and resistant to adverse natural effects, as well as calculations of the location and availability of resources. So, it can be concluded that the Borobudur Temple is the result of technocracy in ethnomathematics knowledge. The concept of Borobudur Temple is supported by the number system, spiritual philosophy, location determination, and architectural design to be able to realize the Borobudur Temple building, which has survived for centuries. That vast knowledge is a vibrant learning resource which generates joyful and engaging culture-based mathematics lesson.

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