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SOJIWAN TEMPLE AND PLAOSAN TEMPLE: SOME GEOMETRICAL FEATURES

Faisa Nirbita Mahmudah, Universitas Negeri Yogyakarta, Indonesia
e-mail: faisanirbita44@gmail.com (corresponding author)

Abstract: Cultural objects around learners can become real contexts for building awareness of and studying mathematics. The present study is aimed at exploring and identifying ethnomathematical values which are contained in the building structures and reliefs of *Sojiwan* Temple and *Plaosan* Temple, specifically in the matetrials of geometry and measurements. The study is descriptive qualitative research. Data sources were observations, interviews, documentations, and literary study. Results show that the two temples have a similarity in that they contain four concept domains in the materials of geometry and measurements that can be studied through ethnomathematics; namely the materials of characteristics, circumferences and areas of flat shapes, volumes and areas of space shapes (flat sides and curve), congruency and similarity that can be integrated in the temple structure buildings, and geometric transformations that can be integrated in the reliefs on the temples. Ethnomathematics learning based on these two temples can be used to help learners' achievement of understanding of the material concepts and cultivation of characters.

Keywords: Ethnomatematics, Plaosan Temple, Sojiwan Temple, geometry

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INTRODUCTION

Results of the research studies by Mahmudah (2018) and Wati & Murtiyasa (2016) stated that learners still had low reasoning abilities and creativities in order to answer mathematics test items related to factual contexts. Similarly, Simalango, Darmawijoyo, & Aisyah (2018), in the results of their study, also revealed that the majority of the students still found it difficult to complete mathematics test items related to daily-life problems. Lack of knowledge and experiences concerning the application of mathematics learning in factual conrexts becomes one of the factors for these conditions. Therefore, efforts are needed of the integration of mathematics learning into

the use of real phenomena which are found around the learners so that it will help them in understanding the subject content materials.

As a matter of facts, factual problems or phenomena in and around the environments of the learners can be used as sources of knowledge for people (D'Ambrosio, 2007). Knowledge about factual phenomena can be developed by finding explanation, understanding, and completion paying attention to the surrounding conditions and historical, cultural, and social geographical influences (Risdiyanti & Prahmana, 2020). One of the ways that can be done is by developing knowledge by paying attention to the phenomena of the environmental cultures, especial which are related to mathematics learning. Culture-based mathematics can help students to elevate their interests on mathematics so that they will be in a better position to see that mathematics is not merely limited to learning in the classroom, but it also has an important role in the real world. This is related to ethnomathematics (Brandt & Chernoff, 2015).

D'Ambrioso (2016) explained that ethnomathematics is linguistically derived from three-word roots in Greek; namely *ethno* which means nature group or socioculture, *mathema* meaning explain and learn, and thic which means way, art, technique. Therefore, ethnomatemathematics can be undertood as a program to dig into and study about knowledge in mathematics by way and technique of sociocultural or cultural group members (Risdiyanti & Prahmana, 2020). With that, the use of ethnomathematics can be implemented in mathematics learning by making use of various cultural contexts that can be found in the surrounding environments.

Mathematics learning by making use of factual contexts in a cultural environment puts the learners as the subject who learns so that every learner has a chance to learn and act through cultures (Marsigit *et al*, 2018). The use of cultural conrexts in mathematics learning is in congruence with the cultural goal stipulated by the mathematical sciences education board-national research council which places mathematics as a process to develop cultures (Wijaya, 2011). In this case, the use of cultures in mathematics learning is not only useful for learners in studying material concepts, but is also used to develop and preserve cultures.

In Indonesia, cultures are widely varied; various regions have their specific characteristics. Cultural outcomes in the society can be distingushed into two: material cultures and immaterial cultures. Material cultures are cultural outcomes which are concrete such as houses, temples, weapons, clothes, and others. Meanwhile, immaterial cultures are those which are oriented to spiritual objects that are inhertited to the

succeeding generations such as traditional customs, languages, folk stories, folk songs, traditional games, etc. (Pudji *et al*, 2019).

One of the cultral outcomes in Indonesia is the temple. The *Sojiwan* temple and Plaosan temple are two temples that lie in the aera of Klaten, Middle Java, but they are also close to the Prambanan temple of Sleman, Yogyakarta. This mathematics learning in the integration of the ethnomathetics based on the *Sojiwan* Temple and *Plaosan* Temple is a preliminary step in realizing learning which uses cultural contexts in the form of culture. This is supported by research results that state that culture-based mathematics learning can be utilized in the constructing of mathematical concepts in learners through the initial perspectives that learners have acquired through their culturl environmental conditions (Richardo, 2016: 122). In this relation, mathematics learning that is integrated to these two temples can be conducted by, first of all, identifying the ethnomathematical objects that are found in the two temples. Exploring in details the ethnomathematics values that can be found on the reliefs and structures of *Sojiwan* Temple and *Plaosan* Temple can generate ideas for mathematics learning. The present study is aimed at exploring and identifying the ethnomathematics values contained in the reliefs and structures of *Sojiwan* Temple and *Plaosan* Temple in the implementation of mathematics learning and integration of its ethnomathematics values.

METHOD

The study is descriptive qualitative research looking at phenomena or events in details to find patterns in the phenomena (Lambert & Lambert, 2012). The study used the descriptive approach to research to analyze and describe an object by way of field explorations (Yusanto, 2019). The study was conducted in *Sojiwan* Temple and *Plaosan* Temple (North and South) situated at Prambanan District, Klaten Regency, Middle Java. Data collected for the study were elicited by way of literary study and field exploration. Data were obtained by direct observations on the two temples, interviews with the temple custodians, and photos of temple reliefs and structures. Meanwhile, the document data were obtained from books containing mathematics concepts and objects of the temple buildings. Data validity was appraised by triangulation, a process of examining the data as an unseparable part of the study which qualified the data as valid evidences for making a conclusion (Darmayasa, Wahyudin, & Mulyana, 2020). Data were analyzed by way of five stages: data tabulation, data reduction, data codification, data interpretation, and making conclusion.

RESULTS AND DISCUSSION

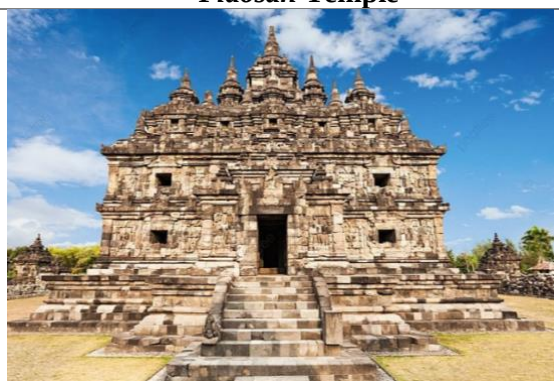
The *Sojiwan* Temple is a temple of the Buddhist religion marked by the existence of a dome, as head of the temple (*arupadhatu*), at the top of the building. The *Sojiwan* Temple consists of the main or mother building and one dome on the side. The structure of the building is divided into three parts: foot, body, and roof of the temple (Trisnayanti, 2015). Tuyu & Herwindo (2021) reveal that Buddhist and Hindu both have three main sections with almost the same names. They are the head of the temple or *arupadhatu* (Buddhist) or *svarloka* (Hindu), body of the temple or *rupadhatu* (Buddhst) or *Bhuvarloka* (Hindu), and foot of the temple or *kamadhatu* (Buddhist) or *Bhurloka* (Hindu). Based on the results of the interviews with a temple custodian, the Plaosan Temple is a Hindu and Buddhist temple with the same characteristic of having a dome on top of the building. It is told that Plaosan Temple was a wedding gift for Rakai Pikatan who was a Hindu and Pramodhawardani who was a Buddhist, bestowed by father of Rakai Pikatan as a place for worship. Plaosan Temple consists of the North Temple and the South Temple separated by a provincial highway. The North Temple consists of two main buildings: The Male Temple and the Female Temple, surrounded by small-size accompanist temples.

Studies on *Sojiwan* Temple and *Plaosan* Temple have been done by previous researchers with some similarities and differences in the findings. Jati, Mastur, & Asikin (2019) conducted their study on *Plaosan* Temple, *Sojiwan* Temple, and *Waseso* Tower as objects of their objects of ethnomathematics explorations for the learning of the concepts of areas and circumferences of flat shapes, giving examples of shapes on temples, and one test item concerning circles. Kurniati & Widagsa (2022) conducted their study on *Plaosan* Temple exploring the mathematics values found on the temple. Results of this study showed that there were objects in the temple that could be used as materalis for the flat shapes triangles and rectangles, Pythagoras theorm and congruency among flat shapes, space shapes with flat sides, and space shapes with curve sides.

Discussion in the two previous studies is more focused on the explanation of artefacts that can be used in mathematics learning and then it is continued with the Bruner's phases that can be applied staring from the enactive phase, iconic phase, and up to the symbolic phase. The present study, however, although exploring the same temple objects on the contents of geometry and assessment, also includes the discussion of the activities and strategies related to the temple objects in learning that is integrated in ethnomathematics.

Based on the results of the exploration, observation, documentation, and literary reviews, it can be seen that the two temples of *Sojiwan* and *Plaosan* have similarities and differerebces. These can be seen in the Table 1.

Tabel 1. Similarities and Differences between *Sojiwan* Temple and *Plaosan* Temple

Parts	*Sojiwan* Temple	*Plaosan* Temple
	 Source: SuryoDJB	 Source: pngtree
	Similarities	
Main building	Both of the main buildings are cuboids	
Stairs	Stairs up 10 steps constructed of stone cuboids	
Floor	Both have a base floor from stone in the shape of cuboids, plain without motifs or reliefs.	
	Differences	
Side wall	Temple walls are simpler and narrative; there are many reliefs telling about the stories of the *Jataka* and other animals teaching about moral values.	Temple walls are more detailed; containing many reliefs focusing on the character Buddha, gods and godesses, and community activities.
Roof	Roof has 3 storeys with the dome at the top. However, the whole section forms a square pyramid.	Roof has 3 storeys with the dome at the top, but the whole section forms a retangular pyramid.
Relief	contains 20 reliefs telling about fabels (and fauna) with Buddha teaching.	contains reliefs of humans, flaura, and fauna telling about Buddha teaching and people's perspectives. Reliefs of fauna has a lot of the application of translation concepts.

There are various building strutures and reliefs in the two temples that can be integrated into mathematics learning, especially the ones related to the topics of geometry. In general, there are four divisions of geometry and measurement in mathematics learning that can be learned through the building strutures and reliefs of the temples; namely: characteristics of the concepts of circumferences and areas of flat shapes; characteristics, volumes, and areas of surfaces of space shapes; similarity and congruency; geometric transformation.

Learning integration characterstics, concepts of circumferences and areas of flat shapes

The building structures of the two temples can be integrated on the concepts of the characteristics, circumferences, and areas of flat shapes with objects in the shapes of triangles, squares, rectanles, and trapezoids. The following is a Figure 1 of the stairs of *Sojiwan* Temple in the form of a triangle and an accompanist temple showing three shapes of a triangle, trapezoid, and rectangle.

Figure 1. Stairs of *Sojiwan* temple and an accompanist temple of *Plaosan*

The temple structure shown in the Figure 1 can be an object in mathematics learning in the topic materials of the characteristics of flat shapes, starting from the characteristics of flat shapes related to sides ad angle points, and the areas and circumferences of the flat shapes. This is in line with a study conducted by Hardiarti (2017) that there are concepts of flat shapes in mathematics that can be studied through the building structure of the Muaro Jambi Temple. Besides, there are structures of the temple building that can be integrated into mathematics learning concerning combinations of flat shapes, as shown in the following Figure 2.

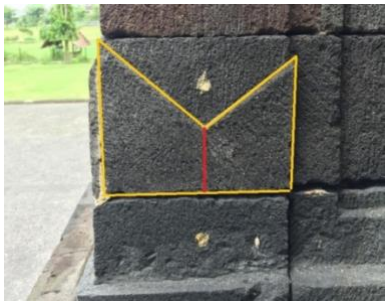


Figure 2. Stone motifs on the wall of *Sojiwan* Temple

Concept learning cannot only be integrated concerning areas and circumferences of triangles, rectangles, and trapezoids on their flat shapes, but it can also be applied with the concepts of areas and circumferences of the combined shapes. In line with this, Irsyad, Sujadi, & Setiana (2020) stated that the concepts of the learning of circumferences and areas of combined shapes can be learned through the building structures of a temple. In the concepts of the combined flat shapes on these stone motifs, a number of possibilities can be suggested of the arrangements of these combined shapes on the building structure

of the temple. This can offer opportunities for learners' interesting learning activities and training their creativities in building strategies in solving problems. This is in agreement with the proposition that the application of ethnomathematics as a pedagocical undertaking can generate fun, active involvement in the learning process, and improvement of creativities in mathematics instruction (Rosa & Orey, 2015).

Learning integration characteristics, volumes and areas of space shape surfaces

Figure 3. Main building of *Plaosan* Temple

As shown in the following Figure 3, the main building of the *Plaosan* Temple resembles a cuboid on the body part and rectangle pyramid on the head. The representation of these cuboid and pyramid shapes as space shapes with flat sides on the building structure of the temple can be integrated in mathematics learning of the junior high-school level. The temple object can be integrated in studying the characteristics of space shapes with flat sides such as ribs, angle points, and sides and also in studying the concepts of surface areas and volumes. Besides for space shapes with flat sides, the building structure of the temple can also be integrated for the material space shapes with curve sides, such as the dome of the *Sojiwan* temple.

Figure 4. Dome of *Sojiwan* Temple

In principles, the head part (*Svarloka*) of *Plaosan* Temple is an acculturation between Buddhist and Hindu temples. This can be seen from Figure 4, combination of the dome shape (looking like a tube) which is a specific characteristic of the Buddhist temple and accompanists (looking like a crown) which is a secific characteristic of the Hindu religion.

The dome in the tube shape can be used as an object of ethomathematics learning in the topic of space shapes with curve sides, i.e. the characteristics of a tube, and volumes and surface areas for the SMP junior high school level. The ideas of using the building structures of a temple in the learning of this space shape is in line with the results of the study by Nursyeli & Puspitasari (2021) that show that the building structure of the temple of Cangkuang Leles in Garut, West Java can be integrated and used in geometry learning, one of which being space shape topic materials.

Learning inregration of the concepts of congruency and similarity

Figure 5. Foot part of the main gate of *Sojiwan* Temple

The structure of the foot part of the main gate of the temple in Figure 5 has the shape of a straight trapezoid on the right and left which have similarities in the shape and size of the sides and have the same angles; therefore, can become an object for the learning integration of the topic of congruency. Further, one of the structures in the other temple can be used in studying the concept of similarities, i.e. as follows:

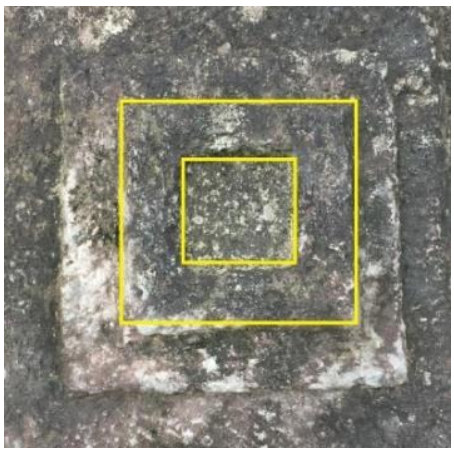


Figure 6. Stone structure of *Sojiwan* Temple

In Figure 6, there are two square shapes, large and small. The smaller square is a keyhole to fasten among stones in the building of the temple, which is usually called a 'knock'. The angles which are congruent with the square shapes of the structure are the same in size and the matching sides have the same ratios. This finding can, therefore, give the opportunity to learn the basic concepts of congruency and similarity for the learners. This is in line with results of the study done by Setiawan, Wahyu, & Sunardi (2018) that show that the concept materials of congruency and similarity can be learned from culture-based materials, one of which being related to the temples of Kurung and Meru in the *Pura* building of Giri Semeru Agung, Bali. Concerning the concept materials of congruency and similarity contained in the structures of temple buildings, this material can be included into the mathematics lesson for students of semester two, Year IX.

Learning integration concepts geometric transformation

Figure 7. Reliefs on the *Plaosan* accompanist temple

Reliefs on Figure 7 can be integrated into the concepts of geometric transformation. Reliefs on the crown shape of the *Plaosan* accompanist temple show the concept of reflection or mirroring when it is cut along the central line; this can be an example of reflection towards the *y* axis. This finding of the integtration of the concept of geometric transformation with this cultural object is relevant with the study by Mulyani & Nataliasari (2020); although they find it in a motif of the Sukapura batik cloth, while this one is on the relief of a temple. Besides, there is also an integrated concept of translation, or shifting, found on *Sojiwan* Temple on the relief in the shape of a rhombus, as shown in the Figure 8.

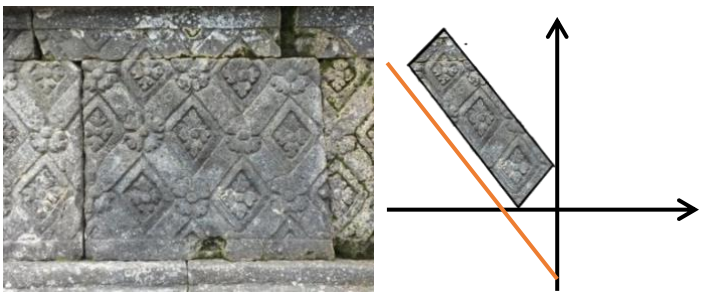


Figure 8. Relief on *Plaosan* Temple (Male)

Furthermore, eksploration on objects on these two temples is not only limited to identifying relations of materials that are matching and that can be used for the learning of material concepts, but it can also be used in learning activities for giving understanding of new concepts as well as giving enrichment to understanding concepts that have been learned before. In the practice, therefore, these objects need to be explored by teachers before giving the instructional activities to the learners in class. Teachers need to have lesson designs that guide the learners in mathematics learning that is related to the use of these objects.

In the learning activities, the learners can be guided to find for themselves whatever materials are related to the temple objects by making use of the prior knowledge they have acquired in previous classes. This is in congruence with one of the currilar trivia, i.e. literacy, where learners are encouraged to have the ability of integrating the cultural contexts in the school with the cultural contexts in the community through cultural dynamics that enable them to interchange between academic knowledge and local knowledge (D'Ambrosio, 1999).

There are two lines of activities that can be carried out to make use of temple objects as a way to understand or contemplate on mathematics material concepts that are related to geometry and measurement. In actuality, learning activities can be done outdoor by asking the learners to directly explore these temple objects. This is in line with what is clarified by Rianasari & Sulistyani (2017) that by ourdoor learning outside of class, learners are able to learn from actual activities and objects so that they are able to connect the materials to the contexts of daily life.

The first step of the ethnomathematics-based learning activities that the teacher can adopt is for the teacher to explain, first of all, the conceptual knowledge and, subsequently, the learners are asked to explore the factual knowledge about everything that is related to the temple. For the material characteristics of space shapes with flat sides, the teacher explains first the definitions of ribs, angle points, and sides. After that, the learners are asked to find the parts of ribs, angle points, and sides on the temple building. This activity gives the opportunities to learners to estimate, recognize, and probe into the objects more deeply and integrate them with mathematics. This shows that the learners' mathematics abilities and literacy are cultivated and, with that, learners will be able to use, translate, and model cultural artefacts from events and objects in the daily life into codes or symbols. In other words, learners are able to find mathematics in their own cultures (Prahmana, *et al*., 2023).

The second ethnomathematics-based learning activities can be started with the teacher showing the factual knowledge first and the learners are asked to find definitions or knowldge about the concepts related to the material being studied. For the materials congruency and similarity, the teacher can show the learners examples of buildings in the *Plaosan* or *Sojiwan* Temple that represents shapes that are congruent or similar. And then, the learners are asked to try to define what are meant by being shapes that are congrount or similar. In this case, the teacher may give guides or hints of making comparisons of lengths and angles and provide it with examples from the temple buildings.

In the two strategies, learners have an important role in the instructional activities and the teacher functions as a facilitator that backs up and scaffolds the learners in running their own learning to achieve the goals of the learning-teaching processes. In both the examples, all learners have received and acquired preliminary knowledge about the related materials in the previous classes. However, the materials in the geometric transformation are new for them. Understanding of the new mathematical terms, such as translation and reflection, must be scrutinized first before the teacher asks the learners to conduct any calculation. Sugiatno & Husna (2020) revealed that mastery of these mathematical vocabulary terms can help learners in their success in mathematics learning. It is, therefore, important for learners to study these new mathematics vocabulary items, one of which strategies is proposed by Marzano. Marzano (2004) stating six steps in this vocabulary learning; namely: describing, re-presenting, drawing, discussing, revision and review, and gaming. The first three steps are used for introducing these new vocabulary words to the learners; and the three remaining steps are used for giving repeated exposures of the new words for the learners to review and memorize.

The first Marzanos step in learning new vocabulary is giving description or explanation about the new vocabulary items; in this case, for example, describing or explaining what are translation and reflection. The second step cosists in asking the learners to rewrite the description or explanation about the new vocabulary in their own words. In the third step, the teacher asks the learners to draw a picture, symbol, or graph which represents the understanding of the words translation and reflection. In the fourth and fifth steps, the learners conduct discussions among themselves concerning the results of their results and, with the help of the teacher, make revisions and completion. In the last step, the teacher lets the learners play games which give them opportunities to complete their efforts of understanding the new vocabulary words. In this occasion, the teacher can use a ‘frayer board’ as shown in the example Table 2.

Table 2. 'Frayer board' mathematical vocabulary

My definition (containing definitions of mathematics vocabulary words which learners will fill in using their own words	**Characteristics** (containing characteristics of intended vocabulary words, such as reflection, so that the result of reflecting has the same shape and measurement)
containing mathematical vocabulary words that will be learned, such as: reflection	
Examples that are found (containing examples of the intended vocabulary words that are found in the temple area, such as reliefs on the building of *Sojiwan* Temple	**Pictures** (contining pictures of the examples that are written)

The learning process does not only mean how learners acquire new concepts, but it also includes re-inforcement of the mastery of the material being learned. The activity that can be given to the learners is giving them the opportunities to complete problems related to the materials. The learners can also be asked to identify objects related to the previous lessons which can be related to objects in temples. In the scope of gometric materals and measurement, some of which are related to areas and circumferences of flat shapes (two-dimensional) and areas and volumes of space shapes (three-dimensional), learners can be asked to identify, for example, which physical parts of the temple buildings show areas, circumferences, areas of surfaces, volumes, etc. This task may be relatedd to the levels of understanding and analyzing in the Bloom's taxonomy of the educational objectives.

When the learners have been able to understanding the concepts, they can be asked to apply their material concepts by measuring areas, circumferences, surface areas, and volumes on the temple objects. By conducting these ethnomathematics-based activities in these direct manners, learners will be able to give meaning to the purposes and results of studying the temple objects which become the domains of their mathematics learning which makes it easier for them to understand material concepts, give them wider perspectives on the mathematical values that are found in their local cultures, and make their activities as fun learning (Surat, 2018).

From the foregoing discussions, it can be seen that there are many objects in the environments of *Sojiwan* and *Plaosan* Temples that can be integrated and implemented to understand material concepts and strengthen its mastery in the setting of mathematics learning and the activities related to it. The use of ethnomathematical objects in this mathematics learning can enrich the concept application and accommodate learners' understanding by trying to make use of ethnomathematical objects that can be found around their cultural environments (Hardiarti, 2017). The superiority of using cultural objects in mathematics learning is not only directed towards learners' concept mastery, but it can also be used for character development by appreciating their cultural values.

In the line of learners' character development, and the effort to use culture-based mathematics learning, Wahyuni, Tias, & Sani (2013), in their study, emphasized that mathematics learning which is integrated in cultural contexts, or ethnomathematics, can help learners to understand concepts and develop national characters. This is aligned with what is pronounced by Wijaya (2011) that the development of national cultures and characters must be done in an integrated way in the process of education and learning which do not severe learners from their social environments. Closely related to this, the school must give the opportunities for the learners to dig into and reflect the moral values that are contained in the cultures that they learn in the contexts of mathematics learning (Risdiyanti & Prahmana, 2020). Therefore, ethnomathematics learning shows that mathematics learning based on cultures is able to accommodate the occurence of transfer of values as well as transfer of knowledge which are very valuable for learners. .

This ethnomathematics learning through cultural objects in the forms temples can be directy explored and captured by learners by getting them to visit the temple or designing instruction that is active and attractive and putting up relevant materials and significant characters and moral vaues for the learners. This has been stipulated in the national educational curriculum which emphasizes the implementation of moral values and characters so that learners are able to learn and reflect these moral values and characters which are contained in their cultures (Risdiyanti & Prahmana, 2020). Therefore, learners are not only directed to learn and settle their material concepts in their learning, but they are also directed to culttivate their cultures and participate in appreciating and preserving the Indonesian cultures.

Through the presentation and dicussion of the results of the study, it can be seen that many objects and activities around the structure buildings and reliefs of *Sojiwan* Temple and *Plaosan* Temple can be integrated in mathematics learning based on cultures. The many advantages that can be gained from this undertaking include understanding of material concepts, nurturance and cultivation of character education, and development of opportunities and creativities for learners. Considering the significances of the results of the study. The researchers propose that there be further research on the practice of mathematics learning based on the cultural objects and activities around *Sojiwan* Temple and *Plaosan* Temple. Besides, it is suggested that further exploration be done on the two temples to study more deeply about the meanings that are contained in parts and reliefs of the temple buildings and, more importantly, to explore further the possibilities of cultural and character values in order to contribute to the enrichment of the Indonesian education.

CONCLUSION

The objects and reliefs on the building structures of *Sojiwan* Temple and *Plaosan* Temple can be developed and integrated into ethnomathematics learning especially in the materials of geometry and measurement. Four domains have been taken as research topics and subjected to the research analyses; these are circumferences and areas of flat shapes, volumes and areas of space shapes (flat sides and curve), congruency and similarity, and geometric transformations. Ethnomathematics learning that is portrayed in the study is directed towards three goals of understanding and mastery of relevant material concepts, nurturance and development of character education through appreciation and preservation of the national cultures, and giving practices for instruction and learners which improve learners' creative thinking and make learning effective and fun. It is still expected that further research be done looking into further influences and implications of the application of ethnomathematics on *Sojiwan* Temple and *Plaosan* Temple.

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