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Mathematics Teaching Materials Based on the Ethnomathematics of Shiva Temple by Applying the "Tri-N" Teaching

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ABSTRACT

Education as a process of cultural transformation is a cultural inheritance from one generation to the next. Ethnomathematics can bridge the gap between culture and learning mathematics. One of the cultural elements to be integrated into mathematics learning is to use one of the cultural sites in Yogyakarta, namely the Shiva Temple. This is done to increase students' interest in culture through learning mathematics. Various cultural elements that can be studied at the Shiva Temple include buildings, architecture, ornaments, statues, etc. Besides being based on the ethnomathematics of Shiva Temple, the approach that can be used is Tamansiswa's teachings, namely Niteni, Nirokke, and Nambahi (3N). To facilitate students in learning the material for building flat sides, it is necessary to have interesting, fun, and culturally related teaching materials. Therefore, this study aims to describe the ethnomathematics-based teaching materials of Shiva Temple by applying the teachings of Niteni, Nirokke, Nambahi. This research is a qualitative descriptive study. The data were obtained through direct observation, interviews with the Prambanan temple tourism park manager, documentation, and literature study. The results obtained are the design of teaching materials that contain a summary of the material and practice questions regarding the shape of the flat side space in which there are many pictures of ornaments, and statues found in the Shiva Temple and written with the application of the teachings of Niteni, Nirokke, Nambahi.

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1. INTRODUCTION

Mathematics is one of the basic sciences that plays an essential role in growing critical, logical, and systematic thinking (Ernest, 1991)(Rahayu, Istiqomah, Purnami, & Agustito, 2017). Learning mathematics trains compiling and looking for relationships between concepts and structures (Setyansah & Apriandi, 2019). By having good mathematical skills, students are expected to solve a problem both in mathematics and other fields in everyday life.

Mathematics is a human activity (Freudenthal, 1991), attached to inseparable human activities (Andriani & Marsigit, 2020) (Zaenuri, Teguh, & Nurkaromah, 2017). Learning mathematics must provide opportunities for students to build their knowledge. In making their knowledge, students must be directly involved in concrete experiences by relating them to real-world problems (Gravemeijer, 1994)(Isoda, 2010)(Lestari, Mulyono, & Minarni, 2018).

Regarding the real-world context, Indonesia has a variety of cultures that can be integrated into learning. Education is a process of cultural transformation where education can be interpreted as a cultural inheritance from one generation to the next. Mathematics learning cannot be separated from the culture and historical context that shape it (Bishop, 1990). Mathematics education in Indonesia needs to present a mathematical view connected to culture so that students can understand mathematics by understanding their own local culture. Thus, integrating mathematics and culture can foster students' ability to develop cultural heritage by using basic mathematical thinking skills. Mathematical knowledge from social interactions in which relevant ideas, facts, concepts, principles, and skills are acquired due to the cultural context (Rosa & Orey, 2010). Some scholars have developed a pedagogy theory through the direct relationship between culture and school subject matter (Gay, 2000) (D'Ambrosio, 1990).

Culture-based mathematics learning is contextual learning closely related to culture. It allows teachers and students to participate actively based on the culture they already know to obtain optimal learning outcomes (Pannen, 2005). Various activities and mathematical concepts such as measuring, counting and classifying appear in various aspects of Indonesian culture. For example, in building a temple or traditional house, there are basic patterns in geometric shapes such as circles, triangles, squares and long rectangles. These various Indonesian mathematical concepts should be able to become knowledge that enriches mathematics learning (Kurniawan & Hidayati, 2019). Ethnomathematics can bridge the gap between culture and learning mathematics. Ethnomathematics is a form of culture-based education in the context of mathematics. Ethnomathematics states that ethnomathematics is analogous to a lens to view understanding mathematics as a cultural product or a cultural product (D'Ambrosio, 2006).

Adopting ethnomathematics into mathematics learning activities is possible (Zhang & Zhang, 2010) because mathematical knowledge is obtained from within and outside the structured system of learning mathematics (Orey & Rosa, 2010). According to François (2012), the expansion of ethnomathematics by the cultural diversity of students and with the practice of mathematics in their daily lives brings mathematics closer to the student environment because ethnomathematics is implicitly a program or activity that delivers values in mathematics and mathematics education.

Learning by constructing meaningful experiences both inside and outside the classroom that focuses on culture has increased and deepened the understanding of prospective teachers in teaching mathematics with various cultures Bonner (2010). Massarwe et al. (2012) stated that students' knowledge of geometry increased, and they understood the importance of ethnomathematical learning activities related to students and other cultures.

Ethnomathematics is very important in learning activities for prospective teachers, both in-class activities and activities in the field. When in the field/school, prospective teachers can immediately apply what they have learned in learning activities with their students who come from a variety of different cultural backgrounds (Harding-DeKam, 2007). The differences in cultural experiences that exist have inspired Duranczyk & Higbee in their research. Duranczyk & Higbee (2012) has integrated multi-cultural learning design and its application in students' mathematical thinking.

Ethnomathematics helps to form meta-awareness of the role of mathematics in society and culture (Rosa & Gavarrete, 2017). This activity is, of course, to accommodate the role of ethnomathematics in teaching mathematics. To remember, mathematics teachers must know their role as facilitators in the learning process and not as sources and introductions of knowledge. This can be done by utilizing students' knowledge of ethnomathematics in learning, and this will encourage the development of students' basic conceptual knowledge. In addition, this activity also allows students to develop expanded problem-solving strategies, thus making mathematics a meaningful and reflective lesson (Matang, 2002).

Studying cultural elements to be integrated into learning is better using the existing culture in the surrounding environment. One of the cultural sites that are very appropriate for reference in ethnomathematical education in the Special Region of Yogyakarta is the Shiva Temple, the largest temple in the Prambanan Temple complex. Hindu temples, in general, emphasize the worship of the god Shiva, although, in Hindu belief, the concept of Trimurti is known (Sedyawati et al., 2013). The Trimurti concept emphasizes the Shiva figure as a center of worship, a role model, and a leader for ascetics (Riyani, 2015). Various cultural elements that can be studied at the Shiva Temple include buildings, architecture, ornaments, statues, etc.

Besides being based on the ethnomathematics of the Shiva Temple, an approach to learning mathematics is also needed. One approach that can be used is the teachings of Tamansiswa Niteni, Nirokke, Nambahi (3N) (Boentarsano et al., 2016). In the 3N teaching, there are three stages, namely the Niteni stage, the Nirokke stage, then the Nambahi stage. Each step does not precede each other because Nambahi is the final process that will produce complete knowledge and skills. It is hoped that at the Niteni stage, students can seek clarity from mathematical objects or materials through careful and in-depth observations. From the Nirokke stage, students can imitate mathematical objects or materials that have been observed. Then at the Nambahi stage, students can try to be creative in solving a mathematical problem with the knowledge that has been obtained from the Niteni and Nirokke stages (Suparlan, 2015)(Rahayu et al., 2017)(Ardianti, Harini, & Ayuningtyas, 2020).

One of the characteristics of learning is that it can create a safe and fun learning atmosphere for students and foster students' attention and motivation in learning. However, the reality in the field is different from what mathematics learning should be. Based on observations and interviews in the field, it is obtained that the material on the flat side is one of the materials that is difficult for students to understand. Students find it challenging to understand the material because students are still challenging to visualize the shape of the flat side space. Students also do not have the motivation to learn to build a flat side space. This could be because the delivery of the flat-sided building material was less attractive.

With these problems, so that students do not feel bored and are more motivated to learn mathematics, teachers need to innovate in learning mathematics by facilitating students to learn and search for mathematical concepts with their abilities. One way that can be taken is by providing teaching materials that can be used to study the material for building flat sides with cultural links, namely the Shiva Temple site. The teaching materials are in the form of teaching materials based on the ethnomathematics of Shiva Temple.

To facilitate students in learning the material for flat-sided building, teaching materials are needed that are interesting, fun, and related to culture. Therefore, it will be described the ethnomathematics-based teaching materials of Shiva Temple by applying the teachings of Niteni, Nirokke, Nambahi.

2. METHODS

This research is a type of qualitative descriptive research. This research was conducted at the Prambanan Temple complex in July 2020. The subjects of this study were the Shiva Temple and the Prambanan temple tourism park manager. Data collection techniques used are observation, interviews, documentation, and literature study. Observations were made to obtain information about the Shiva Temple directly at the research site, interviews were conducted to obtain information about the history of the Shiva temple from the manager of the Prambanan temple tourism park, documentation was used

to take pictures of the Shiva temple, and literature studies were used to obtain information about the history of the Shiva temple.

The data analysis technique uses an interactive model that is carried out interactively and continues until it is complete so that the data is saturated. This technique contains three main steps: data reduction, data presentation, and concluding. The triangulation method is used to check the validity of the data.

3. FINDINGS AND DISCUSSION

Based on the results of observations, documentation, interviews, and literature studies, data regarding the form and structure of the Shiva temple were obtained, and data about one of the teachings of Tamansiswa, namely Niteni, Nirokke, and Nambahi.

Shiva Temple is a temple with a base area of 43.46 meters x 42.60 meters and a height of 47 meters which is the largest and most important temple in the Prambanan Temple complex (Sedyawati et al., 2013). Named Shiva Temple because in it there is a Shiva Mahadewa statue which is a giant statue. This building consists of three parts vertically: the legs that describe the underworld, which is a place for humans, the body, the middle world where humans have left the world, and the head, which depicts the gods' upper world.

The four entrances to the Shiva Temple correspond to the four cardinal directions. The main door faces east with the largest entrance staircase. On the right and left stand two giant statues of guards carrying a mace, a manifestation of Shiva. Inside the temple, four rooms face the four wind directions and surround the largest room in the middle. A corridor bordered by a fence surrounds the base of the temple's foot. On the inner wall of the ledge, there is a relief of the Ramayana story, which can be followed by walking in a clockwise direction starting from the main door. The decorations on the outer walls are creatures with the body of a bird with a human head, a giant head whose tongue is in the form of a mythological pair, and other heavenly creatures. The roof of the temple is multi-level with a complex arrangement.

Inside the Shiva Temple, there are several statues, namely (1) the Shiva Mahadewa statue, which is Lord Shiva who is known as the destroyer of nature, (2) the Supreme Guru Shiva statue who is a hermit and depicts a priest, (3) the Ganesha statue in the form of a human with the head of an elephant. 4-handed who is sitting where this statue is a child of Shiva, (4) the Durga statue in the form of an 8-handed woman holding various weapons where this statue is one aspect of Shiva's wife.

Parts of has a mathematical aspect so that it can be related to mathematical materials. Ethnomathematics objects that will be used in teaching materials are buildings and ornaments found in Shiva Temple in the form of buildings, statues, and temple ornaments. The ethnomathematical objects can be seen in Table 1 below:

Table 1. Mathematical Objects in Shiva Temple

No	Ethnomathematics	Concept	Implementation
1.		Rectangle Cube	Calculating the area and perimeter of a rectangle Calculating the surface area and volume of a cube

Figure 1. Stairs at Shiva Temple

2.	 **Figure 2.** Ornaments on Shiva Temple	Cylinders Cube Rectangle	Calculating the area and perimeter of a rectangle Calculating the surface area and volume of cube and cylinders
3.	 **Figure 3.** Ornaments on Shiva Temple	Cube Rectangle Square	Calculating the area and perimeter of rectangles and squares Calculating the surface area and volume of cube
4.	 **Figure 4.** Arca Siwa Mahadewa	Rectangle Cube	Calculating the area and perimeter of a rectangle Calculating the surface area and volume of a cube

One of Tamansiswa's teachings that can be used in learning mathematics is Niteni, Nirokke, Nambahi (Boentarsano et al., 2016). First, Niteni can be interpreted as a process of observing, paying attention, and remembering the flat face three-dimensional objects material presented in the teaching materials. By observing, paying attention, and remembering, students are expected to capture the meaning of the material presented. Second, Nirokke can be interpreted as a process of imitating the steps or ways of working on the sample questions given. And the third is Nambahi which means to add (develop). In the process Nambahi, students' innovation and creativity in working on questions will be tested (Suparlan, 2015)(Rahayu et al., 2017)(Ardianti et al., 2020). Through various kinds of questions, it is hoped that students will imitate working on the exemplified questions and process different questions. The following is an example of the content of teaching materials based on the ethnomathematics of the Shiva Temple by applying the teachings of Niteni, Nirokke, Nambahi to the material for building flat sides.

Determining the Surface Area of Cube

Basic Competence

Determining the surface area and volume of cubes, cubes, prisms, and pyramids

Yuk Niteni

Pay attention following figure!

Figure 1

Look at the stairs and ornaments of the Shiva Temple in Figure 1!

The stairs and the ornaments of the Shiva Temple are in the form of a cube.

To calculate the surface area of the cube, do the following steps:

Make a miniature replica of the pole using asturo paper.

Slice some of the ribs on the cube-shaped shape so that when it is opened and laid down on a flat plane, it will form a plane figure to obtain what is called a cube net.

Then measure and calculate the area

The surface area of the cube is the sum of the total area of the sides of the cube. Two areas of opposite sides are the same in shape and size.

Example Problem

Given a cube with a size of 6 cm x 5 cm x 4 cm. The surface area of the cube is.....

Solution:

Given: The with length 6 cm, width 5 cm, and height 4 cm

Ask: What is the surface area of the cube?

Answer:

The surface area of the cube = 2(lw+lh+wh)

= 2(6.5+6.4+5.4)

= 2(30+24+20)

= 2(74)

= 148

So, the surface area of the cube is 148 cm.

Yuk Nirokke

It is known that the cube has a size of 10 cm x 8 cm x 5 cm. The surface area of the cube is.....

Solution:

Given: .....

Ask: .....

Answer:

The surface area of the cube = ...

= .....

= .....

So, ...

It is known that the cube is 20 cm x 15 cm x 10 cm. The surface area of the cube is...

Yuk Nambahi

It is known that the base area of a cube is 112 cm2, the length of the cube is 14 cm, and the height of the cube is 5 cm. The surface area of the cube is.....

An iron safe that is 3 m long, 2 m wide, and 1 m high are to be painted. If each m2 painted is Rp 7.500,00, then the cost of painting the outside of the entire safe is.....

A cube has a diagonal of 17 cm, a width of 9 cm, and 12 cm. The surface area of the cube is...

The design of mathematics teaching materials based on Shiva Temple ethnomathematics by applying Niteni, Nirokke, and Nambahi summarize the material and practice questions regarding flat shapes and spatial shapes. In the teaching materials, there are pictures of ornaments, objects, and buildings of Shiva Temple, which are real visualizations of various forms of flat and spatial shapes. It is expected that students can do Niteni by studying a summary of the material and discussing sample questions. After students get Niteni, students can carry out the Nirokke process by doing practice questions. Furthermore, in Nambahi, students work on more complex questions.

Ethnomathematical-based teaching materials can facilitate students in constructing student knowledge (Dahlan & Permatasari, 2018). In this teaching material, students are required to find and build their knowledge by conducting experiments using real objects such as paper, rulers, and scissors. Students are required to find the concept of the surface area of a block. With this activity, students not only gain knowledge about the concept of the surface area of a block from books but based on direct observations and experiments.

According to (Arisetyawan, Suryadi, Herman, & Rahmat, 2014), the approach to learning mathematics from a cultural point of view aims to build a bridge between students' background knowledge and formal mathematics teaching in schools. This is important for students learning mathematics because it connects what will be learned with previous knowledge and can increase their motivation (Sawatzki, Downton, & Cheeseman, 2019). The results of this ethnomathematical study have the potential to provide a connection between mathematics and culture. Learning mathematics adapted to cultural knowledge, initial experience, and students' frame of reference will make mathematics closer and more meaningful to students (Clark Orey & Rosa, 2020).

4. CONCLUSION

Based on the research that has been done, it is obtained the design of ethnomathematical teaching materials based on Shiva Temple by applying the teachings of Niteni, Nirokke, Nambahi to the flat-sided geometry material. This teaching material can be used as a reference for teachers to teach flat-sided geometry material, which is expected to help students understand the material more easily and get to know one of the cultures in Indonesia. Students can develop cultural heritage by using basic mathematical thinking skills. This study only describes the design of teaching materials. Therefore, further research is needed to develop these teaching materials to be suitable for use in learning mathematics.

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