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Using the Ornaments of Historical Mosque to Learn Two-Dimensional Shapes

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Abstract

Teaching geometric shapes is one of the basic issues of early childhood mathematics and it far more important in the early childhood period than most people realize. They form ideas about common shapes – such as circles, squares, triangles, and rectangles – from the toys, books, television programmes they come in contact with everyday. Often, elementary students learn geometric properties of two dimensional shapes as empty verbal statements to be memorized, without any chance to experience it meaningfully. Considering the important of that domain, we designed a study to examine how young children introduce two-dimensional shapes by observing the ornaments of historical mosque which is located by the Kuin River, Banjarmasin, South Kalimantan.

The research methodology that we use in this study is a design research. There are three phases of conducting a design research: preliminary design, teaching experiment, and retrospective analysis. In this research, a sequence of instructional activities is designed and developed based on the hypothesis of students' thinking processes. This research was conducted in grade 1 on SD Islam Sabilal Muhtadin, Banjarmasin.

The result of the teaching experiment showed that the ornaments of historical mosque could help them in bridging the gap between informal knowledge and formal mathematics so that they could use it to see the shapes and also provides opportunities to the students to experience and to develop the concepts meaningfully while using the contextual situation. However, the students find difficulties when they had to draw the shapes based on their characteristics.

Keywords: ornaments of historical mosque, two-dimensional shape, design research.

1. Introduction

Teaching geometric shapes is one of the basic issues of early childhood mathematics and it far more important in the early childhood period than most people realize (Aktas & Aslan, 2010: 255). For example, geometric shapes are used to teach and learn arithmetical concepts, and knowledge of informal geometry is required to teach and learn writing as well. Some studies have shown that young children form ideas and concepts about shapes before they enter school (Clements & Sarama, 2000; Clements, 2001; Yin, 2003: 71). They form ideas about common shapes – such as circles, squares, triangles, and rectangles – from the toys, books, television programmes they come in contact with everyday (Hannibal, 1999: 354). It is thus not surprising that they have many ideas about these common shapes by the time they start formal schooling. However, teachers often do not ask children to extend their ideas (Clements & Sarama, 2000: 482) and what is known from Battista (2001; Rizkianto, 2013; 161), elementary students learn geometric properties of shapes as empty verbal statements to be memorized, without any chance to experience it meaningfully.

Aforementioned issues in the teaching and learning of geometric properties background this research to design instructional activities for learning geometric shapes. Introducing to plane geometry is one of the basic competencies for first grade elementary school student on Indonesian recent curriculum, Curriculum 2013. Moreover, one of the characteristics of the Curriculum 2013 is school as part of a

community that provides a planned learning experience in which students apply what is learned in school to the community and utilizes the community as a learning resource (Tim Kemdikbud, 2013). So in this research, we formulate the research question as: How young children introduce two-dimensional shapes those are rectangle and square by observing the ornaments of historical mosque.

2. Theoretical Background

We used some theoretical backgrounds to underpin this project, those were: Describing and classifying two dimensional shape – as concepts behind our research goals; children's levels of understanding about shapes – as a basic of our analysis and evaluation of the research; Realistic Mathematics Education (RME) – as an approach of mathematical lesson.

2.1 Describing and classifying two dimensional shape

Studying geometric properties of two-dimensional shapes provides a grand opportunity to emphasize the process goals of geometry. Children need to be able to describe properties of two dimensional shapes to see how two or more shapes are alike and different according to geometric properties. Describing and classifying are processes that extend over time as we add new and more complex properties (Reys, et al, 1984; 227).

In examining the two dimensional shapes we often focus on the sides or vertices (one-dimensional). We build these one-dimensional concepts as they occur naturally within a two-dimensional context. While we have an intuitive feel about the difference between shapes, we need ways to describe that difference. By considering the properties of shapes we can develop that ability. There are many ways of describing a geometric shape: the number of sides, the number of corners, or its name.

Often we teach children the names of the geometric shapes but do not build the discriminating power that the children need in order to use the names with meaning. In the beginning activities you should build on the children's own vocabulary, adding new words as appropriate. Although the name of the shapes can be used, they need not be formally introduced until children have done activities like these.

2.2 Children's Levels of Understanding about Shapes

As children develop, they think of shapes differently. At the *prerecognition* level, children perceive shapes but are unable to identify and distinguish among many shapes. They often draw the same irregular curve when copying circles, squares, or triangles. At the next, *visual* level, children identify shapes according to their appearance (Clements & Battista, 1992; Clements & Sarama, 2000: 482). For example, they might say that a shape "is a rectangle because it looks like a door." At the *descriptive* level, children recognize and can characterize shape by their properties. For instance, a student might think of a rectangle as being a figure that has two pairs as equal sides and all right angles. Because progress in children's levels of thinking depends of their education, children may achieve thid level in the intermediate grades or not until college.

Children at different levels think about shapes in different ways, and they construe such words as square with different meanings. To the prerecognition thinker, square may mean only a prototypical, horizontal square. To the visual thinker, squares might mean a variety of shapes that "look like a perfect box" no matter which way they are

rotated. To a descriptive thinker, a square should be a closed figure with four equal sides and four right angles. But even to this child, the square has no relationship to the class of rectangles, as it does for thinker at higher levels. This levels can help us understand how children think about shapes. We might remaind ourselves to ask what children see when they view a shapes. When we say "square," they might seem to agree with us for many prototypical cases but still mean something very different. The levels can also the teachers in providing appropriate learning opportunities for children.

2.3 Realistic Mathematics Education (RME)

Freudenthal (1991, Kamaliyah et al, 2011: 196) has an idea that mathematics as a human activity. It means that the students can experience mathematics when they are solving a meaningful problem. It became a principle of Realistic Mathematic Education (RME) that was developed in the Netherlands. In RME, students are given many opportunities to think and construct their own understanding. Treffer (1987; Zulkardi, 2002; Haris & Ilma, 2011: 58) defined five tenets for RME, namely:

1. Phenomenological exploration or the use of context
   The instructional activities started from informal or situation that is experientially real for students to the basis of formal concept.
2. Using models and symbols for progressive mathematization
   It used models and symbols as transition from a concrete context to formal knowledge.
3. Using students' own contribution and production
   Students were free to construct and describe their ideas and strategies in solving the problem. This opportunity will force the students to be a greater initiative when they construct and produce their own solution.
4. Interactivity
   Learning process of students is not a solo activity but it occurs in a social context.
5. Intertwinement
   A variety of mathematics topic integrated in instructional activity.

Starting with a contextual situation about the ornament of historical mosque in our region, this activity was designed following the path of Hypothetical Learning Trajectory (HLT). We will go further about our HLT in the next section. There are three components in context that allow students to mathematize the given situation (Fosnot and Dolk, 2001; Mariana, 2010: 55):

1. The potential to model the situation must be built in.
2. The situation needs to allow students to realize what they are doing.
3. The situation prompts learners to ask question, notice patterns, wonder, and ask "why and what if".

3. Method

3.1 participants

The participants were 29 first-grade students of SD Islam Sabilal Muhtadin, Banjarmasin, Indonesia. Three students participated in a pilot experiment aiming to investigate students' pre-existing knowledge and to try out the initial design in order to make some adjustments to the initial Hypothetical Learning Trajectory (HLT). The other 29 students participated in the teaching experiment. The group of three students and the group of 29 students were from different classes.

3.2 Research Design

The research methodology that we use in this study is a design research. The aim of design research is to develop a local instructional theory through collaboration of teacher and researcher in teaching and learning process (Gravemeijer & Eerde, 2009; Haris; 2011: 59). Bruner (in Drijvers, 2003; Putra, 2011: 290) said that the main objective of design research is understanding and not explaining. This objective implies that understanding how the learning process is done in a classroom activity is a core of design research.

There are three phases of conducting a design research. (Gravemeijer, 2004; Bustang, 2013: 61): developing preliminary design, conducting teaching experiment, and carrying out the retrospective analysis. In the preliminary design, we formulate a hypothetical learning trajectory consisting three components: learning goals for students, mathematical activities, and hypothesis about the process of the students' learning (Simon, 1995; Simon & Tzur, 2004; Putra, 2011: 290). In the teaching experiment, we test the instructional activities and improve the conjectured learning trajectory. During this phase, we collect data such as classroom observation, students' interview, field note, and students' worksheet. Those data are analyzed in the retrospective analysis phase.

3.3 The Instructional Design

As the main goal of this study, we designed activities for the children to support them on describing and classifying the two dimensional shape by observing the ornaments of historical mosque, Sultan Suriansyah, that located in Banjarmasin, South Kalimantan. Furthermore, the task would be challenging for them to arrange the paper model of the ornaments. However, in the middle of the task we asked them to record their arrangement on a piece of paper. This task was provided to examine their ability of symbolizing real situations. Of course, the guidance of teachers is more given for these young children.

Teacher can choose the appropriate activities as foundation to stimulate students in thinking and constructing mathematics. In this process, the teacher should anticipate what students mental activities emerge with seeing the learning goal. This envisions or anticipation was called as hypothetical learning trajectory (Simon, 1995; Wijaya, 2008; Haris & Ilma, 2011: 59). HLT is proposed as a term to identify and describe relevant aspects associated with a mathematics lesson plan, including: A description of the students' mathematical goals, the mathematical activities (including the tasks or problems, that students will work on to achieve the goals), and a hypothetical path that describes the students learning process (Revina et al, 2011: 131). The learning activity is designed to support young children in describing and classifying two-dimensional shapes those are rectangle, square, triangle, and circle by observing the ornaments of historical mosque.

In this study, we used some tool that can support children's mathematical thinking. The tools, activity, and our expectation are explained in the following table.

Table 1: Overview of the Proposed Role of Tools in the Instructional Sequence

Tool	Activity	Expectation
Pictures of the ornaments of historical mosque	Observing the shapes of the ornaments	Realizing the shapes which are different
Paper model of the ornaments and grid paper	Arranging the ornaments using the model on grid paper	Arranging the paper based on the pictures just in line
Pencil and grid paper	Drawing the shape of the ornaments on grid paper	Determining the right drawing of the ornaments on grid paper

The activities would be conducted in a frame of these following three sections:

1. Bringing the contextual situation
2. Arranging the ornaments using the model
3. Drawing the shapes in the right size.

Furthermore, we explain each section and its relation with the goal and the activities.

Table 2: Overview of the HLT in the instructional sequence

Sections	What the teacher shoul do	The goal of the activity
Bringing the contextual situation	▪ Show the slide of the mosque picture ▪ Discuss the following questions: have you ever go to the mosque? when you go to the mosque? what we do in the mosque? ▪ Ask students to observe the ornaments on the mosque's wall which are different in shape. ▪ Give the chance for students to tell the difference of the shapes	To involve children in the problem by bringing contextual situation about the historical mosque that located in their environment
Arranging the ornaments using the model	▪ Give students the model of the ornaments of the mosque. ▪ Ask students to stick the ornaments nicely on grid paper 1 x 1 cm based on the pictures. ▪ Ask students to find the ornaments those are different ▪ Ask them to classify the ornaments those are different in shape and size using the model ▪ Give chance to the students to tell their findings.	To help describing and classifying the shapes using concret object Give them chance to look for many different shapes of the ornaments.
Drawing the shapes on the right size.	▪ Ask students to observe their work on the previous activity. ▪ Ask them to make drawing of the ornaments by looking at the line on grid paper	To strengthen children's awareness of the difference among rectangle, square, triangle, and circle.

	▪ Discuss their picture in order to distinguish the rectangle, square, triangle, and circle	To help children Realize the properties of rectangle, square that has four sides and four corners, triangle has three sides and three corners, circle has one side and no corner.

4. Result and Discussion

4.1 Observing the Shapes of the Ornaments

To involve children in the problem by bringing contextual situation, the teacher showed the pictures of Sultan Suriansyah Mosque as in Figure 1. The teacher invited students to start thinking about the questions: *what building there is in the picture, do you ever go to there, and what are you doing in it*. All students know that the building is a mosque by reading the nameplate, namely Historical Mosque Sultan Suriansyah which is located in Kuin Utara, Banjarmasin. However, just a little part of them said that they ever go to the mosque. It seemed that the first graders have not too familiar with their region. Students may have gone there but they forget because the mosque is also one of the tourist destinations. In answering the last question, students said that we pray and read the Qur'an in the mosque.

Figure 2. The ornaments on the wall

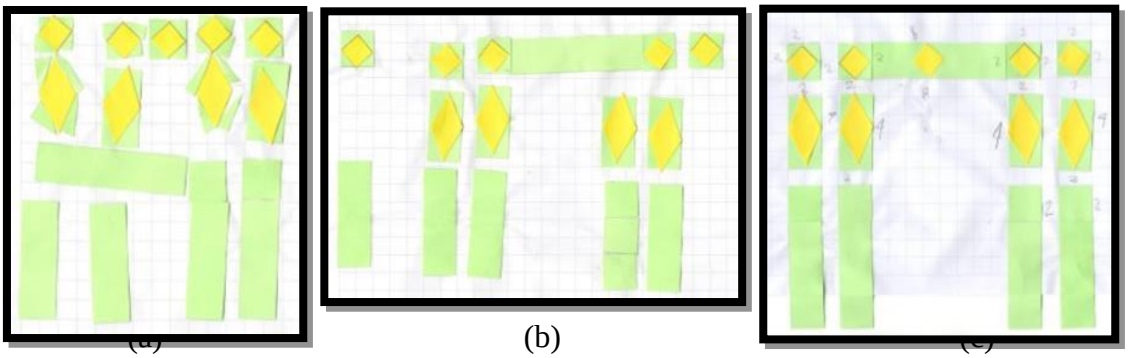
Next, teacher showed the pictures containing ornaments on the wall (Figure 2) and invited students to observe the form of decoration. Students were led to discover different forms among the ornaments. Teacher asked students to tell the ornaments which are same and which are different. Children conceived the shapes of the ornaments

as a whole and not as a sum of its parts and identified shapes according to their appearance. They said that the ornaments were different because the ornaments do not look the same. It means that the students at the visual level of van Hiele's theory.

4.2 Arranging the Ornaments Using the Model on Grid Paper

Students divided into 8 groups consist of 3-4 children. Each group was given paper model of the ornaments, grid paper, and glue to arrange the model based on the structured ornaments on the pictures. It was a big challenge for the first grade elementary school students to work in group because they still have big individualism. After the teacher gave the tools for group discussion where each group got one package, some students still confuse why they did not get the glue for each of them, for example. So, the teacher explained that they had to use the tools with their group (Figure 3).

Figure 3. The students worked in group



(b)

Figure 4. The works of three groups when arranging the ornaments

Some of the group's works are in Figure 4. Figure 4a shows that the group put the ornaments in the wrong structured. They just focused on the yellow paper and did not pay attention to the green paper. So that they put the longest green paper in the middle of the door and we cannot go through the door. It seemed that the group did not notice to the same form between the paper and the ornaments on the picture. The group was at the *prerecognition* level, in which children perceive shapes but are unable to identify and distinguish among many shapes. There was different thing on this group compared with other groups, that is, the group made the green paper surrounding the yellow paper by cutting the corner of the rectangular green paper in triangular form then paste the cutting in the side of yellow paper. While other groups paste the green paper first, then paste on it the yellow one.

Figure 4b shows the right arrangement but there are the structured ornaments placed less appropriate, that is not parallel to the ornaments on the top. There are three groups that arrange the ornament with a bit error like this. Most of groups' work was as shown in Figure 4c. They arranged the ornament with the right structure. So the group was at visual level. At *visual* level, children identify shapes according to their appearance. They could recognize the shapes on the picture, find the paper model of the shapes, and arrange them correctly on grid paper. Children were able to classify two dimensional shapes to see how two or more shapes are alike and different according to geometric properties.

4.3 Drawing the Shape of the Ornaments on Grid Paper

The next activity is drawing the shapes on the right size (Figure 5) and the students worked individually. The first grade students of elementary school have limited ability in drawing two-dimensional shapes in the right form and size. Even though they use a ruler they still have difficulties in making the lines of a mutually parallel. So we help them with grid paper and also from the previous activity, they had already known the the ornaments' sizes on grid paper. From the drawing, we can see how the student visualise the ornaments of historical mosque. Although most of students' drawing are correct, it leaves us some doubt on how the students interpret the shapes. We consider that the activity given presumably affect on the way students interpret and visualise the ornaments.

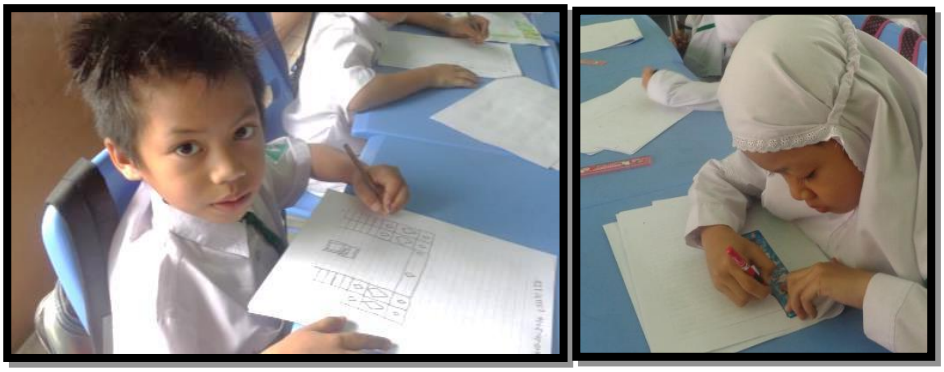
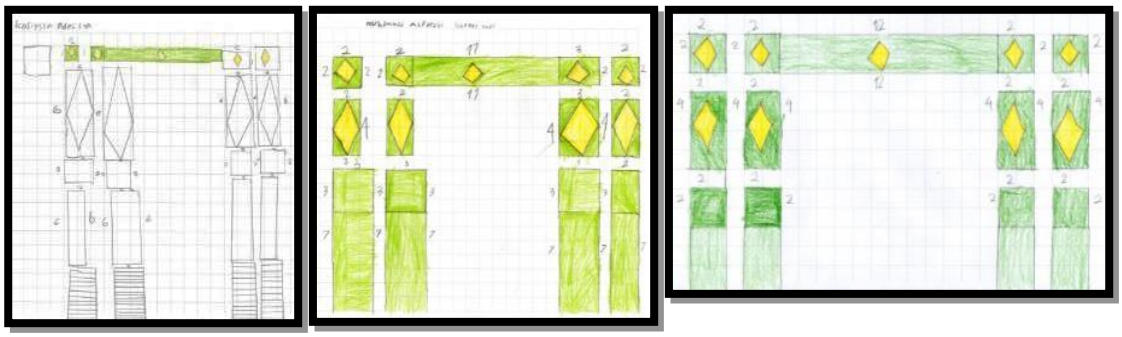


Figure 5. The students drew the ornaments on grid paper

Most students drew the ornaments in the wrong size and the shapes were not drawn exactly on the line of grid paper (Figure 6a). They did not notice their work when using grid paper and the model of the ornaments in previous activity whereas they can count the grid in order to draw the ornament in the right size. To get more insight on this drawing we conduct an unstructured interview with of the students who draw the ornaments in the wrong size. Yet, we cannot get clarification because the students did not give the clear answer why she drew in that way. She just kept silent at that time. It means that these students are at *prerecognition* level. On Figure 6b, students drew the ornaments with a bit error of size but the shapes (rectangle and square) were drawn on the line of grid paper. Figure 6c shows the correct drawing of the ornaments. They drew the ornaments in the right shapes, which is for rectangles and squares, and in the right size in which some rectangles have the horizontal side in the same length with the squares' side, also the vertical side of the longest rectangular green paper have the same length with the squares' side. It seemed that in Figure 6b and 6c students were at visual

level where children judge and operate on shapes according to their appearance in previous activity.



(a) (b) (c)

Figure 6. The students' work when drawing the ornaments

5. CONCLUSION

Learning two-dimensional shapes using the ornaments of historical mosque and PMRI approach could engage and motivate the first grade elementary school students. By providing the activity stick the ornament using the model from the paper, the students tried to introduce the shapes that are important for learning plane geometry. Moreover, the ornaments of historical mosque could help them in bridging the gap between informal knowledge and formal mathematics so that they could use it to see the shapes. However, the students find difficulties when they had to draw the shapes based on their characteristics.

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