SUPPORTING STUDENTS' UNDERSTANDING OF THE VOLUME OF CUBE AND CUBOID USING RUBRIK'S CUBE

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Abstract

Geometry is a lesson which emphasizes the student's ability to identify characteristics , the elements , and determine the volume in problem solving. This study was conducted to help 8th grade students understand the volume of cubes and cuboid by using rubik's cube. This study involved junior high school students of YPI Tunas Bangsa Palembang. The research approach used in this study is design research that consists of three stages: preliminary, design experiments, and retrospective analysis. A series of learning activities was designed and developed based on Indonesian Realistic Mathematics Education (PMRI) approach. The activities in this study begins with two experiments, the first experiment the students were asked to put rubik's cube into a box until it is full. The second experiment, the students were asked to put rubik's cube into a box should merely has representative length, width and height. After that the students were asked to compare the number of rubik's cube used in the first and second experiment . Through the whole experiments that have been conducted, it can be said that the students can understand the concept of volume of cubes and cuboid. The results showed that the series of learning activities has improved students' understanding of the volume of cube and cuboid.

Key Words : *volume, cube, cuboid, rubik's cube, PMRI, design research .*

INTRODUCTION

According to Van de Walle (2008) volume and capacity is the term for the size of three-dimensional objects. Furthermore, Van de Walle (2008) disclosed that the term of the volume can not only be used to refer to the capacity of the container, but also can be used to geometry. Two types of units that can be used to measure the volume and capacity are a solid unit and container. In the solid unit block of wood that can be filled repeatedly into a container that is being measured (Van de Walle, 2008). In this study, the rubik's cube was used as a solid unit, Tran (2005) said that a rubik's cube consist of 6 sides with nine pieces on each side. Some research about the volume of geometry stated that this issue is still a difficult thing, among others: So far, according to Heruman (2008) students are rarely, if ever, invited to seek and find the formula of the volume of a certain geometrical object by their own. If the students can find the formula by them selves, the learning will be more meaningful and it make students get more deep understanding.

Zulkardi (2006) revealed that the mathematical approach in Indonesia are still using the traditional approach that emphasizes on the training process. This learning process less enable students to learn such that it leads to a lack of information. One approach that is in accordance with the demands of the curriculum is Indonesian Realistic Mathematics Education (PMRI). The implementation of PMRI approach in Indonesia has been

conducted since 2001 (Zulkardi, 2009). PMRI approach refers to Freudenthal's idea that mathematics must be connected to reality and mathematics as human activity (Zulkardi & Putri, 2010). The research question is *how can rubik's cube support students' understanding of the volume of cube and cuboid.*

THEORITICAL FRAMEWORKS

1. Rubik's Cube

Tran (2005) stated that the rubik's cube is a cube consisting of 6 sides with 9 individual pieces on each. Arizpe, Dwyer, & Stevens (2009) states games are naturally motivating and fun, games facilitate individualization of assessment and instruction, and games make the abstract more concrete. Arizpe, Dwyer, & Stevens (2009) also concluded that playing mathematics games could enhance students' spatial abilities and algebraic reasoning.

2. The Use of Rubik's Cube the Volume of Learning Cubes and Cuboids

This research focus on determining the volume of cubes and cuboid. The rubik's cube is used to fill a box of a cube or cuboid. In accordance to the opinion of Van de Walle (2008) two types of units that can be used to measure the volume and capacity is a solid unit and container. In the solid unit, a block of wood that can be used to repeatedly fill a container that is being measured (Van de Walle, 2008). Furthermore Van de Walle (2008) said another type of the model is probably the plastic bottles and cups of liquid medicine, plastic jars and containers of any size, cubic wooden with the same size, peanuts, etc.

The box at first is filled with the rubik's cube until it is full, after that students will calculate the number of rubik's cube that put into the box. From the experiments, students will understand that the volume of the cube and the cuboid are related to the number of the rubik's cube that put into the box until it is full. For a small box, students may be able to put the entire rubik's cube into the box until it is full. Howefer, for a large box, students will have difficulty because of the limited number of the rubik's cube. Then, in the second experiment, students are told to put the rubik's cube into the box with a certain rule. The rubik's cube that is put only represent each, dimension of the box : the length, the width and the height. So that, students understand that the volume of a cube and cuboid is obtained from the representation of the rubik's cube put into the box until it is full. Based on this activity, students understand that the formula of the volume of cuboid or cubes is p. l. t, and because every sides on the cube has the same size, then the volume of the cube is s x s x s (the side x the side x the side).

3. Pendidikan Matematika Realistik Indonesia (PMRI)

RME is rooted in a theoretical view of Freudenthal about mathematics as a human activity (Gravemeijer, 1994) .

Gravemeijer (1994) mentions that there are three very important principles in designing mathematical learning approach based on RME.

a. Guided Reinvention (Rediscovering be guided)
   This principle is guided to rediscover the provision of opportunity for students to build and rediscover the ideas and concepts of mathematics.
b. Didactical Phenomenology (didactic phenomenon)
   This principle emphasizes a learning phenomena in which the educational stress the importance of contextual issues to introduction of topics of mathematics to the students. Bakker (2004) said that an incident / event / activity mathematical concept is an analysis of concepts related to the rules of incident / event / activity.
c. Self-Developed Models (model development itself)
   Gravemeijer (1994) states that there are four levels of modeling that arise from situational level to a formal level, the level of situational, referential level, the level of general and formal level.

METHODOLOGY

This study uses design research as the research approach. There are three stages in the design research (Gravemeijer & Cobb, 2006), namely:

1. Preparing for the experiment
   At this stage, a series of activities that includes a conjecture of students' thinking developed by researchers through hypothetical learning trajectory. Hypothetical Learning Trajectory (HLT) is a hypothesis or conjecture how developing students' thinking and understanding in a learning activity which in this study we use the approach of Indonesian Realistic Mathematics Education (PMRI) focused on the topic of the volume of cubes and cuboid.
2. Pilot Experiment
   Pilot experiment is conducted to test HLT that has been designed. The trial at this stage committed against six students who do not come from a class that will be used for the next teaching experiment. These six selected students have different abilities consist of two high-ability students, two middle-ability students and two low-ability students.
3. Teaching Experiment
   Teaching Experiment is aimed to test the design of hypothetical learning trajectory (HLT) that have been tested in pilot stage experiments and revised it. At this stage the HLT is the main guideline to focus on the learning process.
4. Restrospective Analysis
   At this stage of restrospective analysis, the data obtained in the experiment teaching stage in the analysis and the results of the analysis are used to design the next learning activity. Analysis at this stage aims to determine how the students can

generalize the activities in the material volume cubes and cuboid that have been designed to answer the research question.

This research was conducted in the second semester of the academic year 2014 / 2015. The subjects were six students from class VIII.2 for the pilot experiment and forty-four students from classes teaching stage VIII.1 to experiment. This study was conducted in SMP YPI Tunas Bangsa Palembang involving teachers of mathematics courses as a model teacher to teach the material volume cubes and cuboid.

RESULTS AND DISCUSSION

RESULTS

Learning trajectory includes activity of construct rubik's cube. In this activity the students made two experiments. The first experiment the students enter rubik's cube into the box until it is full and the second experiment rubik's cube students entering into the box only representative length, width and height, after which students compare the number of rubik's cube on the first and second trial.

Figure 1: Each Group Performs the Experiment

Each group received a different box. The first group received a cube box, while the second group received the cuboid box. Both groups are working based on the general instructions in LAS and based box that has been taken. After students perform the first experiments and solve its the problems, then continued with the second trial. It aims to make students understand that the volume of the cube and the cuboid is obtained from filling up the whole box full or filling representatives size.

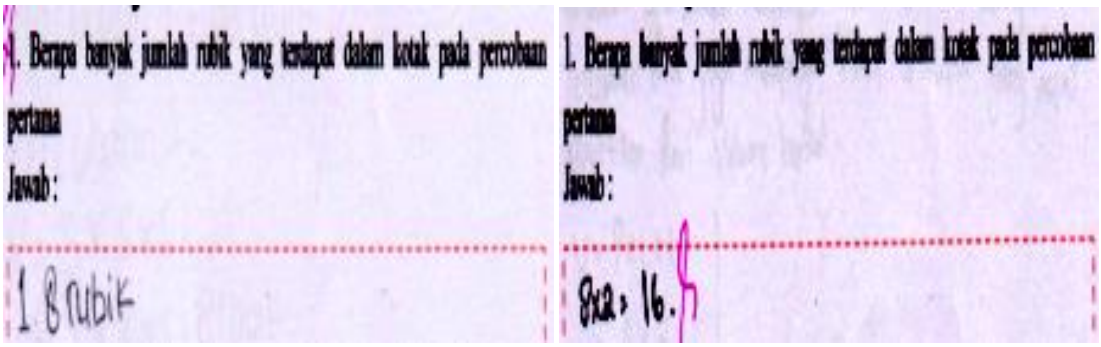

Figure 2: Group Answers No 1

The image to the left is the first group who took waking cube, there are eight rubik's cube. While the right image is a second group who took waking cuboid, there are sixteen rubik's cube.

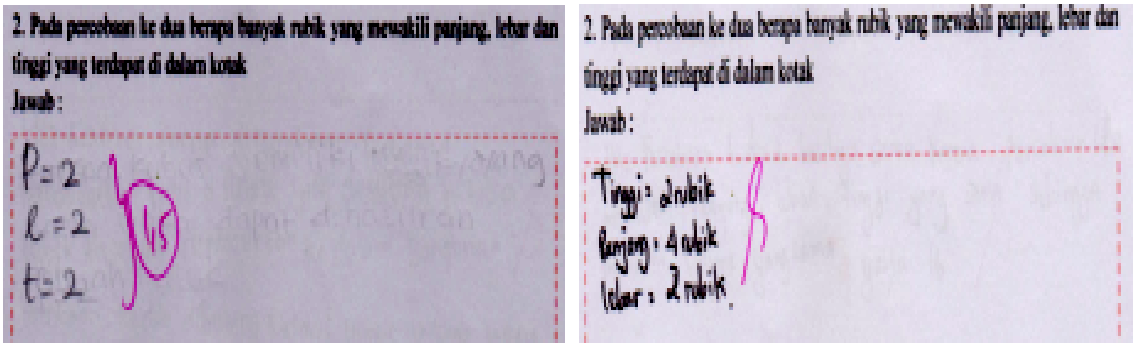

Figure 3: Group Answers No 2

The first group was written all of representatives size there are 2 rubik' cube, the length there are 2 rubik's cube, width there are 2 rubik's cube, and height there are 2 rubik's cube . The second group was written, the length there are 4 rubik's cube, width there are 2 rubik's cube, and height there are 2 rubik's cube. Visible differences in the number rubik's cube on each group according to the wake that they take, see figure 2 and 3.

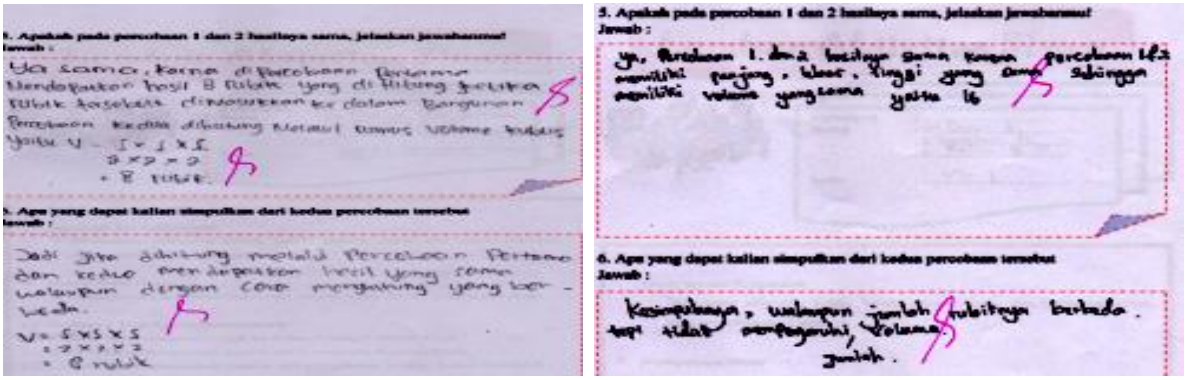

Figure 4: Group Answers No 5 & 6

Figure 4 is a group answer to question no 5 and 6. Where the question is whether the first experiment and the second result is the same, explain your answer. Both groups explain why according to the analysis of each groups. The first group wrote, in the first experiment is obtained by summing rubik's cube contained in the box, while the second experiment used the formula side times side times side. s . s. s = 2. 2. 2 = 8 rubik's cube, so the results obtained from the two experiment was 8 rubik's cube. The second group wrote, in the experiments 1 and 2 the same result because the experiments 1 and 2 have a length, width and height are equal. So it has the same volume that was 16 rubik's cube and although the number of different rubik's cube but was not affect the volume.

Based on the above six questions, students can understand the concept of volume cubes and cuboid. At the end of the activities, each group presented the results of the working group . When presenting the group can give and share information, so that both groups can understand the volume of the cube and the cuboid simultaneously .

At the end of the meeting the teachers distributed to each student's individual exercise . The following are several alternative answers of students :

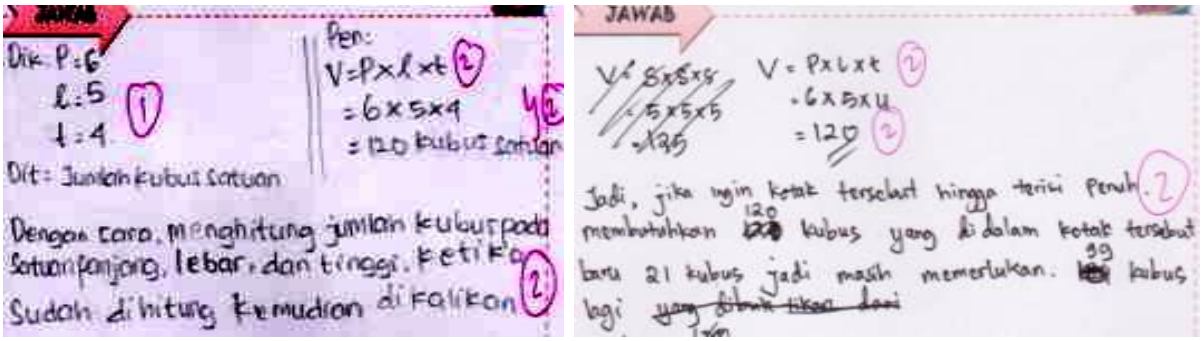

Figure 5: Several alternatives student answer

In figure 3, almost half of the students answer the question by using the same alternative answers. They answer the question by using the formula of the volume of cuboid of newly learned . Most students can answer the questions correctly. Such as Fitria answer p . l . t = 6 . 5. 4 = 120 unit rubik's cube and she put forward his reasons, namely by calculating the size of the cuboid and then calculate its volume. While Rakha by calculating the volume of the cuboid p . l . t = 6 . 5. 4 = 120 unit rubik's cube and then calculates the unit cube that is in the cuboid so that the cuboid requires ninety - nine unit cube again in order to fully charged.

DISCUSSION

In this activity there are 6 issues consisted of two experiments, in which the first trial rubik's cube enter into the box until it is full and then counted the number of rubik's cube that can occupy the box. Then in the second trial rubik's cube put back into the box, but with the proviso that the rubik's cube is entered only represent the length, width and height only. Through two trials are expected students are able to understand the concept of volume cubes and cuboid. Each group took a different first box, first group took waking cube and second group took waking cuboid. By analyzing different wake it is expected that each group is able to understand the concept of volume cubes and cuboid. Finally group 1 understand that the actual volume of the cube also has the same formula with a cuboid that is length times width times the height, because every rib on the cube has the same length, the formula of the volume of the cube into the side times side times side. When the group presentations, each group sharing and exchange - exchange of information, so that each group can understand the concept of volume cubes and cuboid.

Overall activity helps students understand the concept of volume figures with flat sides, especially the volume of cubes and cuboid, the students really explain invited directly involved in finding the volume of cubes and cuboid. As long as the student is only the formula given directly by the teacher so that students do not understand the concept of the volume of the cube and the cuboid.

CONCLUSION

Based on the results and discussion that has been described, Rubik's cube has an important role in understanding the volume of cubes and blocks of learning in VIII grade YPI Tunas Bangsa Junior High School Palembang. Activity experienced by students through two experiments. The first students to enter rubik's cube into the box until it is full , then the students enter rubik's cube on condition only the length, width and height. After the students to compare the first and second trial, through comparison of both experiments showed that it turns out to find the volume of a cube and cuboid obtained by using two ways, namely by inserting up to a full or by entering Rubik's cube only representative. Activities include two students who passed the experiment students were invited directly involved to find a concept, so that students can understand the material volume of cubes and cuboid well and learning becomes meaningful and students can conclude that in fact the volume of the cube and the cuboid is the same. Overall activity helps students understand the concept of volume figures with flat sides, especially the volume of cubes and cuboid, the students really explain invited directly involved in finding the volume of cubes and cuboid. As long as the student is only the formula given directly by the teacher so that students do not understand the concept of the volume of the cube and the cuboid.

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