Analysis of spatial ability of class VIII students Institute Indonesia Yogyakarta Problem Based Learning on topic of cuboids and cubes

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Abstract. The goals of this research were (1) to describe implementation of learning about cuboids and cube nets by using problem based learning (PBL), (2) to describe the spatial ability (spatial representation) of students by using problem based learning about cuboids and cubes nets. The type of research is design research. The research subjects were 28 grade VIII SMP Institute Indonesia Yogyakarta. Data was collected using field notes, documentation and results/answer of LKS 1, LKS 2. The data analysis technique used is qualitative descriptive. The research was conducted in March 2019. The research about the learning process by using problem based learning. The results of the research show that the learning design made in this research is good and the spatial ability of grade VIII students SMP Institut Indonesia Yogyakarta in making cuboids and cubes nets have fulfilled the first indicator (1). This is indicated by the majority of students able to describe cuboids and cubes nets. In addition, some students have not fulfilled the second indicator about identifying cuboids and cubes nets.

1. Introduction

Based on the results of observations on March 4 and March 8, 2019 in class VIII of the SMP Indonesia Institute of Yogyakarta, the conventional learning process was obtained. Learning that is carried out is still using the lecture method and educators have not been able to condition the class. In addition, education does not use learning media. This encourages students to look passive and not eager to participate in learning activities. From the discussion above, mathematics learning that is applied is less successful because educators need to dictate the steps to solving problems so that students are less creative in reproducing problems. Based on the above problems, the researcher conducted a study by applying a problem-based learning model to the cube nets and looking at the spatial abilities of students. In addition to problem solving skills, punishment and proof, communication, and mathematical connections, NCTM has one of the standard mathematical processes in school is the ability to represent mathematical ideas, including images, tables, graphics, numbers, symbols and others. Space building material is a part of geometry that emphasizes the ability of participants to understand abilities, not, and determine the area and volume in solving problems. In the middle class, participants discussed the relationship of drawing, measuring, visualizing, comparing, changing and classifying geometric objects [4].

Research that is relevant to the problem described by researchers is the research conducted by [1] on Learning Design in Surface Area Materials and Cubes and Beams Volume by Using Realistic Mathematics Learning Approaches. The results showed that based on the final test of 21 students there were 5 students who were unable to reach the first indicator of spatial ability, and 3 students were
unable to reach the third indicator of spatial ability, and 11 students who were unable to reach the fourth indicator of spatial ability. In addition, the research relevant to this study is Experimentation of Cooperative Learning Models of Think Pair Share (TPS), Group Investigation (GI), and Problem Based Learning (PBL) in Space Build subject matter in terms of Spatial Ability of Grade VII Se Surakarta City 2014/2015. The results showed that in groups of students with high, medium or low spatial abilities, students who were subjected to PBL learning provided better learning achievement than students who were subjected to the GI and TPS models.

Based on the background described above, the researcher raises the following problems (1) How is the implementation of learning for the topic of nets and cubes using problem-based learning? (2) What is the spatial ability (spatial representation) of class VIII SMP Yogyakarta Indonesian Institute by using problem-based learning on the topic of cube and beam nets.

2. Spatial Ability and Problem Based Learning

2.1. Spatial ability
Spatial ability [1] is the ability to capture the world of space appropriately or in other words the ability to visualize images, which includes the ability to recognize shapes and objects precisely, make changes to an object in his mind and recognize these changes, describe a thing or objects in the mind and change them in real form. According to [1], the indicator of mathematical spatial ability is the ability of students to imagine the shape or position of a geometric object that is viewed from a certain point of view, states the position between elements of a space construct, constructs and represents geometric models drawn on a flat plane, guess and determine the actual size of the visual stimulus of an object.

The spatial ability in this research is the ability to manipulate and rotate mentally an image into another arrangement and the ability to imagine the shape of an object inside a solid object from a different perspective in solving geometry problems related to the web of cubes and beams. Indicator of spatial ability as follows:

a) Describe the forms of cube and beam networks
b) Identify the shape of the cube and beam networks

| Phase | Indicator | Educator's Behavior |
|-------|-----------|---------------------|
| 1     | Student orientation on the problem | Explain the purpose of learning, explain the logistics needed, and motivate students to be involved in problem solving activities |
| 2     | Organizing students to learn | Helping students define and organize learning tasks related to the problem. |
| 3     | Guiding individual or group experience | Encourage students to gather useful and appropriate information, carry out experiments to get explanations and problem solving. |
| 4     | Develop and present the work | Helping students in planning and preparing suitable works such as reports and helping students to share assignments with another friend. |
| 5     | Analyze and evaluate the problem solving process | Helping students to reflect and evaluate the investigations and processes that students use. |
2.2. Problem Based Mathematics Learning References
Moffit (Ministry of National Education, 2002: 12) suggests that problem-based learning is a learning approach that uses real-world problems as a context for students to learn about critical thinking and problem solving skills and to acquire knowledge and concepts that are essential to the subject matter.

Ibrahim and Nur (2000) in [6] suggest that PBM is one of the learning approaches used to stimulate high-level thinking of students in situations that are oriented to real-world problems, including learning how to learn.

Ibrahim and Nur (2000) in [6] propose the steps of PBM in the following table 1.

3. Research Methods
The method of this research is descriptive qualitative research. This study aims to (1) describe the implementation of learning for the topic of cube and beam webs using problem-based learning (2) describe the spatial abilities (spatial representation) of class VIII SMP Yogyakarta Indonesian Institute using learning based problems on the topic of the cube and beam webs. The research subjects were class VIII students of the SMP Indonesia Institute of Yogyakarta. The number of class VIII students is 28 students. The method of data collection is the documentation and implementation of learning in the classroom. Before carrying out this research the researcher first observes the learning process in the classroom. The need to carry out this observation is to find learning problems that occur in the learning process. Data analysis techniques used are reducing data, presenting data and drawing conclusions.

4. Results and Discussion
The learning objectives as stated in HLT are: describing the learning implementation for the topic of the cube and beam webs using problem-based learning (2) describing the spatial abilities (spatial representation) of class VIII SMP Yogyakarta Indonesian Institute by using problem-based learning on net topics cubes and beams according to the problem-based learning syntax according to Ibrahim and Nur and adapted to the learning objectives above.

1. Analysis of HLT implementation
The following are the results of the analysis of HLT implementation in the learning process:

Meeting 1:

a. Student orientation on problems
At this stage the teacher explains the purpose of the learning: so that students (PD) can make a network of cubes. After that the educator (P) explains in general the process to be undertaken, namely the educator will provide problems and students will be divided into groups to solve the problem. Educators provide apperception by asking if there are questions from the material learned before. Through question and answer students are reminded again about the properties of square and rectangle

P  Does anyone still remember, what is meant by square and rectangle?
P D  All students answer simultaneously
P  Please answer one
P D 1  If a square means all sides are equal and if rectangular, the opposite side is the same. After that educators provide confirmation relating to the meaning of square and rectangle and their properties.

b. Organizing students to study
At this stage educators divide students into groups consisting of 4 students in one group. Then the Educator distributes LKS 1 related to the network of cubes and asks students to complete the problems given in LKS 1.
Next educator asks students to work in groups. Educators convey rules that must be done in groups, namely the process of discussion is only carried out in groups and may not discuss between groups. If there are questions, the group is asked to ask the educator directly. Educators ask students to look at the problems listed in LKS 1.

c. Guiding individual / group experiences
At this stage educators monitor the course of the discussion by going around to help students who have difficulty giving support. Initially most groups did not understand the problems that existed in LKS 1 so that educators gave support, i.e.

\begin{align*}
P & \quad \text{What image is displayed in front?} \\
PD & \quad \text{Kubus, Sis} \\
P & \quad \text{What building forms the cube?} \\
PD & \quad \text{Square} \\
P & \quad \text{How many square pieces do you need to form a cube?} \\
P & \quad \text{Six, Sis}
\end{align*}

Educators provide illustrations in front of the class by opening the built cube. The educator goes around and another group asks:

\begin{align*}
PD & \quad \text{Are these two images different?} \\
P & \quad \text{What makes the two images different?} \\
PD & \quad \text{The shape is different, Sis} \\
P & \quad \text{What happens if one image is rotated to the left?} \\
PD & \quad \text{The shape is the same as picture 2} \\
P & \quad \text{When is the same, is the picture said differently?} \\
PD & \quad \text{Same, Sis}
\end{align*}

Most students have been able to identify the shape of the cube nets based on the cube building provided by the educator. Most students have been able to describe the nets of cubes. Based on Figure 1 and Figure 2, it can be seen that in one form of cube nets, the location of the base and lid of a cube are made different. But in its implementation, students have not been able to produce all forms of cubes and beams.

d. Develop and present the work
At this stage the educator asks 4 groups who are willing to present the results of their work in front of the class. Each group explains how to make cube nets and how many cubes can be made.
e. Analyze and evaluate the problem solving process

At this stage educators invite students to evaluate what is learned. Educators guide the analysis and evaluation process in accordance with the learning objectives to be achieved. Educators open the process of analysis and evaluation by asking students to review the answers and presentations of the four groups. Then educators ask questions to students like the following.

\[ P \quad \text{What have you learned?} \]
\[ PD \quad \text{Make cube nets} \]
\[ P \quad \text{What conclusions can be drawn from the answers to the presentation? How many nets can be done?} \]
\[ PD \quad \text{seven.} \]
\[ PD \quad \text{eight} \]
\[ PD \quad \text{nine} \]

Because all PBM steps occur in the learning process, it is concluded that the implementation of learning on the topic of making a network of cubes using compiled PBM is of good quality.

Based on the work and presentation of the students, educators appreciate the work of students, then confirm that there are 11 forms of cube nets.

Meeting 2.
a. Student orientation on problems

At this stage educators explain the learning objectives so that students are: so that students can make webs of beams. After that educators generally explain the process that will be undertaken, namely educators will provide problems and students will be divided into groups to solve these problems. Educators provide apperception by asking if there are questions from the material previously studied. Through question and answer students are reminded again about what is a rectangle.

\[ P \quad \text{Does anyone still remember, what is meant by rectangles and rectangular properties?} \]
\[ PD \quad \text{All students answer simultaneously} \]
\[ P \quad \text{Please answer one} \]
\[ PD \quad \text{Rectangular the opposite side is the same} \]
\[ P \quad \text{What about the angle?} \]
\[ PD \quad \text{is ten degrees} \]

b. Organizing students to study

At this stage educators divide students into groups consisting of 4 students in one group. Then the educator distributes LKS 2 related to beam networks and asks students to solve the problems given in the LKS 2. Next the educator asks students to work in groups. Educators convey rules that must be done in groups, namely the process of discussion is only carried out in groups and may not discuss between groups. If there are questions,
the group is asked to ask the educator directly. Educators ask students to look at the problems listed in LKS 2.

c. Guiding individual / group experience
At this stage educators monitor the course of the discussion by going around to help students who have difficulty giving support.

According to you, what net are you drawing?
P D doesn’t know, Sis
P What image is displayed in front?
P D beam, Sis
P What does make up the beam?
P D Square and rectangular
P How many pieces does it take to form a cube?
P D six, Sis

Educators provide illustrations in front of the class by opening a beam that has been made by the researcher.

d. Develop and present the work
At this stage Educators ask 3 groups who are willing to present the results of their work in front of the class. Each group explains the ways to make beam nets and how many nets can be made.

This group presents the results of his work by explaining ways to make beam webs. The group found that there were 6 beam webs that could be made

e. Analyze and evaluate the problem solving process
At this stage educators invite students to evaluate what is learned. Educators guide the analysis and evaluation process in accordance with the learning objectives to be achieved. Educators open the process of analysis and evaluation by asking students to review the answers and presentations of the four groups. Then educators ask questions to students like the following.

What have you learned?
P D beam webs
What conclusions can be drawn from the answers to the presentation? How many nets can be done?
P D 1 five
P D 2 six
P D 3 seven
Because all PBM steps occur in the learning process, it is concluded that the implementation of learning on the topic of making beam nets using PBM arranged has good quality. Based on the work and presentation of the students, educators appreciate the work of the students, then confirm that there are 54 forms of cube nets.

2. Student Spatial Analysis (Representation) Ability.

Learning objectives such as those listed in HLT are describing the spatial ability (representation of spatial) of students by using problem-based learning on the topic of cube and beam nets. To find out whether the goal is achieved or not, the researcher establishes the Indicator: (1) Describes the forms of cube and beam networks, (2) Identifies the shape of the cube and beam networks.

**Problem 1 (Shape of cuboidS Nets)**

**Table 2. Student answer group**

| No. | Many Groups                                                                 | Picture |
|-----|-----------------------------------------------------------------------------|---------|
| 1.  | There is one group that answers this                                         |         |
|     | Discussion:                                                                 |         |
|     | 1. Students describe the nets of cubes formed from 6 square pieces measuring 2 cm × 2 cm. |         |
|     | 2. Students write that there are 6 beam webs that can be formed              |         |
| 2.  | There were 4 groups who answered this                                        |         |
|     | Discussion:                                                                 |         |
|     | 1. Students describe the nets of cubes formed from 6 square pieces measuring 2 cm × 2 cm. |         |
|     | 2. Students write that there are 7 beam networks that can be formed.         |         |
| 3.  | There were 2 groups who answered this                                        |         |
|     | Discussion:                                                                 |         |
|     | 1. Students describe the nets of cubes formed from 6 square pieces with a size of 1 cm × 1 cm. |         |
|     | 2. Students write that there are 8 beam networks that can be formed.         |         |
Based on the results in table 2 above specifically for points 1 and 2, the indicators of the spatial ability of students have been fulfilled but not yet related to the maximum students have not been thought about and discussed all the related needs of wire mesh net design

Problem 2 (Shape of cubes)

Table 3. Student answer group

| No. | Many Groups | Picture |
|-----|-------------|---------|
| 1.  | There were 4 groups who answered this Discussion: Students describe beam nets with sizes $p = 2 \text{ cm}$, $l = 1 \text{ cm}$, $t = 1 \text{ cm}$. There are 7 nets formed. |
| 2.  | There were 2 groups who answered this Discussion: Students describe beam nets with sizes $p = 3 \text{ cm}$, $l = 2 \text{ cm}$, $t = 2 \text{ cm}$. There are 5 nets formed. |
| 3.  | There is one group that answers this Discussion: Students describe beam nets with sizes $p = 3 \text{ cm}$, $l = 2 \text{ cm}$, $t = 2 \text{ cm}$. There are 6 nets formed. |

Based on the results in table 3 above, it can be seen that the indicator (1) is fulfilled while the indicator (2) is not fulfilled so that the indicators of students' spatial abilities have not been fulfilled and have not been maximized because the students have not described and written down all possible forms of beam networks.

5. Conclusion

Based on the analysis of the process of implementing learning using a problem-based learning model it can be seen that the steps of problem-based learning that have been designed have emerged in practice in the field. So, it can be said that the learning design designed in this study is good.

Based on the analysis of the learning process it can be concluded that the spatial ability of students in making nets of cubes and beams is still not maximal. This is indicated by all students who have met the indicators of spatial ability in making webs of cubes while all students do not fulfill the second indicator in making webs of beams. In this case the students have not been able to make all the possibilities of the cube and beam nets.

Reference

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