Analyzing mathematical creative thinking ability on sample space materials grade VIII SMP Kanisius Pakem

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Abstract. This study aimed to describe the learning process using problem-based learning for a sample space material and creative thinking ability while solving the problem. The subject of this study is 16 grade VIII students of SMP Kanisius Pakem. The instrument used in this study were observation sheet, Hypothetical Learning Trajectory (HLT) and the student’s worksheet. The type of this research is design research. The result then can be classified, represented, and the conclusion can be drawn by comparing the result from the Student’s Worksheet and indicators of mathematical creative thinking ability. The result of this study were using problem based learning is the mathematical creative thinking does not require student’s answer to be correct, but more importantly that they have displayed some indicators of mathematical creative thinking while solving the problem.

Keywords Problem Based Learning, Mathematical Creative Thinking, Hypothesis Learning Trajectory, Design Research

1. Introduction

1.1. Background

SMP Kanisius Pakem located at Pakembinangung, Sleman. The ability of students of SMP Kanisius Pakem shows an average academic abilities, especially in mathematics. This known through the test also based on the teacher interview. From the observation in class, we found that the way students learn were affected by the lack of seriousness, lack of interested in reading book, and low motivation in study. In terms of problem-solving abilities, students have a tendency to follow the teacher without try to find the other one. Therefore, the teacher found it difficult to take a big step in teaching mathematics. NCTM claims that students must learn mathematics with understanding, actively build new knowledge from previous experience (NCTM, 2000: 20 in JhonA.van de Walle, 2011: 3). This principle is based on the basic idea that learning mathematics with understanding is important. Studying requires not only numeracy skills but also requires the ability to think and reason mathematically to solve a new problem and learn new ideas [1].

One of the learning models that can be used to develop students' abilities in mathematical creative thinking ability is MEA (Model Eliciting Activities). Viewed from the stages of learning from MEA which can be used in this discussion, it begins with given the mathematical problems, then students identify problems related to real life and state them in the exact form possible. Then students make a mathematical representation of the specific components of the problem given. In the next stage, students analyze the model to find a solution. The final part is that with the solution students discover
the context of mathematical material. Problem Based Learning is one alternative in a learning method that is able to make students become active in creative thinking, this can also make students look for other ways to answer problems and understand the concepts of related lessons.

1.2. Research Question
The research question of this study are how problem-based learning is implemented in learning sample space material and how is student’s mathematical creative thinking ability on sample space material using problem based learning.

1.3. Research Purpose
The research purpose of this study is to answer the research question above, that is to describe the learning process for sample space material by using problem-based learning to determine mathematical creative thinking ability on students of the sample space material.

2. Literature Review

2.1. Problem Based Learning
Problem Based Learning (PBL) is one of the learning models centered on the learner by confronting the learners with the various problems they face in their lives. PBL model is a learning model that presents learning material from making problems as a starting point for discussions that will be analyzed and synthesized to find solutions or answers by students. Problems can be submitted or given by teachers to students, from students with teachers, or from students themselves, who then made the discussion and sought to solve it as a student learning activity [7].

The main purpose of PBL is to combine cognitive and metacognitive processes in teaching and learning (Mathews - Aydinli, 2007). In other words, students realize directly how the thought process until they can understand and provide solutions to a problem.

Usman (2010) states that problem-solving is one of the competencies that are the focus of mathematics learning. According to Polya (Wardhani, dkk, 2010) strategy in problem-solving consists of four steps, namely understanding the problem, making a problem-solving plan, implementing a problem-solving plan, and making a review of the implementation of the problem-solving plan [8]. The problem-based learning step can be seen in table 1 [1,5]:

| Stages of Problem Based Learning | Description |
|----------------------------------|-------------|
| Phase 1                          | Student Orientation to the Problem |
| Phase 2                          | Preparing Students for Learning    |
| Phase 3                          | Helping Independent Research in Groups |
| Phase 4                          | Develop and Presentation Work      |
| Phase 5                          | Analyzing and Evaluating the Problem-Solving Process |

2.2. Creative Thinking Ability
Based on [9, 10, 11,12] already been confirm that Creative Thinking is a process that combines logical and divergent thinking. Think divergent is used to find ideas to solve problems, where as logical thinking is used to verify these ideas into a creative solution. Where creative thinking is marked by the characteristics of thinking fluency, flexibility, originality, and elaboration. Indicators of creative thinking can be seen in table 2 [6]:

| Stages of Problem Based Learning | Description |
|----------------------------------|-------------|
| Phase 1                          | Student Orientation to the Problem |
| Phase 2                          | Preparing Students for Learning    |
| Phase 3                          | Helping Independent Research in Groups |
| Phase 4                          | Develop and Presentation Work      |
| Phase 5                          | Analyzing and Evaluating the Problem-Solving Process |
3. Methodology

The type of this research is design research. Gravemeijer & Van Eerde in Prabhana (2017), stated that research design is a research method that aims to develop Local Instruction Theory (LIT) in collaboration with researchers and educators to improve the quality of learning. Design Research includes systematic learning starting from designing, developing and evaluating all interventions related to education such as programs, learning processes, learning environments, teaching materials, learning products, and learning systems [13]. The subject of this study is 16 grade VIII students of SMP Kanisius Pakem. The instrument used in this study were observation sheet, Hypothetical Learning Trajectory (HLT) and the student’s worksheet. The result then can be classified, represented, and the conclusion can be drawn by comparing the result from the Student’s Worksheet and indicators of mathematical creative thinking ability.

4. Discussion

4.1. The Implementation of Problem Based Learning in Sample Spece Material

| Table 3. implementation of Problem Based Learning |
|-----------------------------------------------|
| **Stages of Problem Based Learning** | **Description** |
| Phase 1: Student Orientation to the Problem | In this phase, the teacher gives a guide that contains questions from real problems related to the sample room material. The question of the real problem given is about the game of monopoly. The students were asked to describe a game of monopoly. Throwing dice on monopoly is used as an introduction to the topic of the sample room. "Who has played monopoly before?" "How do you play it?" "If the dice is thrown once, what number of dice can appear?" |
The students answered that the possibility of dice that could appear was 1,2,3,4,5,6

Phase 2: Preparing Students for Learning

In this phase the teacher divides the students in a balanced group, where later each group will be given a problem, then students in the group are asked to analyze and answer these problems, at this stage the teacher goes around while looking at the discussion process and helping students to get a picture of the problem imagined. The teacher also provokes students to use several alternatives from several ways and answers that might occur.

Phase 3: Helping Independent Research in Groups

In this phase the teacher divides the students into groups, where each group is given a problem, then students in the group are asked to analyze and answer these problems, at this stage the teacher goes around while looking at the discussion process and helping students to get an overview of the imagined problem. The teacher also provokes students to use several alternatives from several ways and answers that might occur.

The problems given are:
First Problem: Clara has 5 pieces of clothes in red, green, blue, yellow, and orange. She also has 3 pants in black, brown, silver. How many pairs of clothes and pants can Clara wear?

Second Problem: A student who lives in Kidul village is going to school. In order to get to school, the student can pass two lines. The first route is to pass through the village of Wetan and the second route is through the village of Kulon. To reach Wetan village from Kidul village there are three routes that can be passed. To reach Kulon village from Kidul village there are two routes. From Wetan village to school there are four routes that can be passed. From the village of Kulon there are three paths to get to school. How many paths can the student go through to go to school from his home?
Phase 4: Develop and Presentation Result

In this phase students present the findings of the problem given. 4 groups that were previously divided presented their findings from the problem given.

- For the first problem, 2 of the 4 groups have similar answers, namely there are 3 pairs of clothes and pants that can be paired. While the other 2 groups also had the same answer, 15 pairs of clothes and pants, but one of the two groups forgot to write 3 other possibilities, so their answers were initially 12. After further confirmation, it turned out that on the "scrawl" paper they had written 15 pairs, but forgot to write it on the answer sheet for the presentation.

- For the second problem, 2 groups have the same answer which is 18 paths that can be taken where to get the 18 lines the strategy used there is a similar numbering and then sorted, some also make a diagram. While the other 2 groups also gave a number on the route, but did not reach the number 18 ways.

Phase 5: Analyzing and Evaluating the Problem-Solving Process

In this phase, the teacher assists students in drawing conclusions about the teaching and learning process. The conclusions taken are related to some of the results obtained by each group. Then the teacher gives confirmation of the understanding of sample space from the table above we can know about each phase while we teach PBL, that will help for our next research if we still do PBL on class.

4.2. Description of Student's Mathematical Creative Thinking Ability

In the first problem, there were two groups who answered many ways to pair clothes and pants in 3 ways. This is based on the question where there are 5 pairs of clothes and 3 pants so that the number of pairs of clothes and pants that students think of is one shirt with exactly one pant. 2 other clothes are not needed to make a pair as shown in Figure 1:

![Figure 1. Student's Answers Problem 1](image)
Based on the indicators of mathematical creative thinking in the students' answers, some indicators that are fulfilled are aspects of flexibility because by monitoring the answers presented, it can be seen that students' thinking is still able to move to certain thoughts because the students' answers can still change third they find another view, then besides that the aspect of authenticity is also fulfilled because in the answer the students spontaneously express opinions such as those presented in the picture without thinking of others. The conclusion, in this case, is that mathematical creative thinking processes are not required by students' answers to be correct, but rather several indicators that cause children's thinking processes to solve problems are defined as the process of creative thinking in mathematics. Still in the first problem, with answers different from the other groups as in Figure 2.

Figure 2. Student's Answers Problem 1

Figure 2 presented can be seen as this group can present problems in the form of sequential pairs, which in the process of sorting pairs also at least make the modeling of real problems that occur in everyday life with the problems presented by the problem. So this group can easily make a mathematical form of the solution regarding 5 x 3 because there are 5 available clothes paired with 3 available pants.

Based on some mathematical creative thinking indicators in the answers above, the indicators that are fulfilled are authenticity because in the process students get these results without looking at them from the guidebook or looking at other groups, and making unusual mathematical forms, then elaboration aspects namely this group is able detailing the things that detail the things in the questions given.

The conclusion of this is that the learning that occurs with the problems given and is new, does not rule out the possibility that children will become more critical thinking than usual.

One other form of thinking from the first problem is in Figure 3 below:

Figure 3. Students Make Pairs of Clothes and Pants
It can be seen from Figure 3 that groups of students are able to present data in pairs with one another, this is seen in the work of student groups. In this case, the mathematical creative thinking indicator that occurs is authenticity because in group work it is seen how to show partners that occur in a new way with the previous group, then elaboration because the group has been able to specify other things.

On the second problem solving the four groups initially experienced problems in laying out the village position which was influenced by giving the village name to the question. The group tends to want to adjust the position of the village with the direction of the wind, so that each group has problems with the location of Kidul, Kulon, Wetan, and school. This was previously unpredictable in the HLT, but then with a little naming assistance directed by the teacher, the group understood the position at least mentioned villages. In the second problem, there were three groups with almost the same answers and one group that answered differently. One other form of thinking from the second problem is in Figure 4 below.

![Figure 4. Student's Answers Problem 2](image)

The understanding of the three groups presenting in the picture above has the same understanding, namely the word "alternative path" is interpreted as the fastest route that can be taken from the village where it came to school, so they make the numbering and form of the road according to their wishes, so that the lane appears the shortest also according to them, this happens because they understand the questions based on their imagination where in their daily lives there must be a faster route to go than the other paths.

Based on some indicators of mathematical creative thinking in the answers above, the indicators that are fulfilled are flexibility because the work process of the students above is able to produce many possible answers, which later the group's answers are no longer rigid, then aspects of authenticity because the group finds new ways which are not previously predicted there will be an answer like that, then fluency where in the process of getting answers like the picture above we need a number of supporting questions to develop a model of a problem, then an elaboration aspect which in the preparation of a solution model requires details such as the position of the initial village, description from the shape of the model, many lines at each intersection.

The conclusion of the analysis above is that mathematical creative thinking is also influenced by the influence of the language used in the problems that occur. There is also one group that answers differently is the last group, answering as in Figure 5 below:
In Figure 5, it can be seen that the group has been able to respond to the problem with a model that is better than the previous group, in the answer from this group it is presented that no longer uses the fastest road but some possible paths, but unfortunately in this answer the numbering is not optimal so that making conclusions on solutions does not look good, but broadly speaking the group has been able to display creative thinking patterns in the presentation, this is concluded through several indicators of mathematical creative thinking that are fulfilled namely the aspect of flexibility occurs when groups are not rigid in making numbers which will milk if sequencing sequentially is more accurate, then aspen the authenticity of the group in getting the answer does not imitate the method described earlier, the group gets the answer with their own thinking process, then the fluency aspect occurs when the group data collection makes several questions that must be answered when the model is completed, and the last is the elaboration aspect, this is shown when the group makes a model and solution of the problem presented by detailing many paths, numbering paths, initial village position, and destination, then sorting partner that can occur

The conclusion of this is that mathematical creative thinking processes are also able to form when there are questions that must be answered and found in the solution of the available questions.

5. Conclusion

The result of this study was using problem-based learning for a sample space lesson such as the beginning teacher give real problem as opening, then make a group to solve given problem, the student makes some presentation to show their result, last teacher help student to get the conclusion of sample space material. The second result shows that student has different mathematical creative thinking abilities which can be evident from their worksheet, and through their learning style four different indicators are used to determine if the student has display mathematical creative thinking ability when analysis their worksheets. From the first problem, the student has fulfilled three out of four indicators of mathematical creative thinking ability. The second problem the student has fulfilled all four indicators of mathematical creative thinking ability. The mathematical creative thinking does not require the answer to be correct, but more importantly that they have displayed some indicators of mathematical creative thinking while solving the problem.

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