Analysis of problem solving ability through problem based learning in triangle perimeter of 7th grade in Kanisius Kalasan junior high school

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Abstract. This study aims to design problem-based learning in the triangle perimeter material and analyze problem-solving ability in triangle perimeter material of 7th Grade in Kanisius Kalasan Junior High School. Students of 7th Grade in Kanisius Kalasan do not get any opportunity to develop problem solving ability because the teacher still use conventional methods. According to the National Council of Teacher of Mathematics (2000) the development of problem solving abilities is one of the goals in the process of learning mathematics, it is an aspect that can make students develop mathematical thinking skills. The type of research used in this study is design research. The subjects of this study were 22 students of class 7B in Kanisius Kalasan. The research instrument in this study was a test sheet. The results of research related to the learning process show that the stages of the process that occur were as follows: (1) the orientation phase of students about the problem regarding of triangle perimeter, (2) organizing learners to learn related to the topic of triangle perimeter, (3) guiding individual/group experience on the process of learning triangle perimeter, (4) developing and presenting the work obtained from the discussion group, and (5) conclude the results of the learning process that has been done. The following results below were obtained based on students problem solving abilities: there are 14 students who were qualified within 4 out of 5 indicators, namely students can identify the elements that were known, asked, and the adequacy of the elements needed, students could form mathematical problems or develop mathematical models, students can apply strategies to solve various problems within or outside mathematics, and students can use mathematics significantly and there are 8 students who qualified within 2 out of 5 indicators namely students can identify the elements that are known, asked, and the adequacy of elements needed and students can use mathematics meaningfully.

1. Introduction
Kanisius Kalasan Junior High School is a school located in Krajan, Kringinan, Tirtomartani, Kalasan, Sleman Regency, and Special Region of Yogyakarta. Based on observations that researchers conducted in Kanisius Kalasan Junior High School, teachers still use conventional methods, learning is still teacher-centered and has not applied any other methods or strategies in the learning process. The teacher does not apply interesting methods or strategies for learning, therefore students become less enthusiastic in following the learning process. The teacher does not initiate teaching by conveying learning and apprehension goals, so students do not get any clear direction in the learning process. Students are required to follow what is explained by the teacher in learning and students are not given the opportunity to develop thinking skills. Based on observations made on the students, it appears that students have a tendency to only be able to work on the same questions as the examples given previously by the teacher. In the learning process students pay less attention to the teacher during the
lectures, so there are students who rarely use mathematical thinking skills to solve problems. Therefore, teachers need to design learning methods that can motivate students to use their thinking skills to solve problems. One such learning approach is "Problem Based Learning (PBL)". This learning approach is focused on the problems presented by the teacher and students solve the problem with all their knowledge and skills from various sources that can be obtained.

Problem-Based Learning (PBL) is an innovative learning model that can provide active learning conditions to students. [2] Problem-Based Learning (PBL) is a learning model that involves students to solve a problem through the stages of the scientific method so that students can learn knowledge related to the problem and also have the skills to solve problems. In addition, PBL requires a variety of intelligences to confront real-world challenges, the ability to deal with anything new in existing complexity [7]. PBL is a learning model with a student learning approach to authentic problems so students can develop their own knowledge, develop higher skills and inquiry, empower students and increase self-confidence [4]. [6] PBL has the following characteristics: (1) learning starts with a problem, (2) ensures that the problem given relates to the real world of students, (3) organizes lessons around problems, not around disciplines, (4) provides great responsibility to students in shaping and running directly their own learning process, (5) using small groups, and (6) requiring students to demonstrate what they have learned in the form of a product or performance. In the problem-based learning process, there are several stages used as follows [8]:

| Stage Performed | Teacher Activity |
|-----------------|------------------|
| Step 1: Students orientation to the problem. | Explain the purpose of learning, explain the logistics needed, and motivate students to be involved in problem solving activities. |
| Step 2: Organizing students to learn. | Helping students to define and organize learning tasks related to the problem. |
| Step 3: Guiding individual/group experiences. | Encourage students to gather appropriate information, carry out experiments to get explanations and problem solving. |
| Step 4: Develop and present the work. | Helping students in planning and preparing suitable works such as reports and helping them with various tasks with their friends. |
| Step 5: Analyze and evaluate the problem solving process. | Helping students to reflect or evaluate their investigations and the processes they use. |

Problem solving is one of the goals in the learning process in terms of curriculum aspects. The importance of problem solving in learning is also conveyed by the National Council of Teacher of Mathematics (NCTM). According to NCTM [5] the process of mathematical thinking in mathematics learning includes five main standard competencies namely problem solving ability, reasoning ability, connection ability, communication ability and representation ability. The lower ability in these five competencies will result in the low quality of human resources, which is shown in how low problem solving abilities. This is because all this time the current learning process has not provided any opportunities for students to develop their ability to solve problems. Mathematical problem solving abilities are measured using several indicators. According to NCTM [5] indicators for measuring students' mathematical problem solving abilities include: 1) Students can identify the elements that are known, asked, and the adequacy of the elements needed, 2) Students can formulate mathematical problems or develop mathematical models, 3) Students can apply strategies to solve various problems (similar and new problems) within or outside mathematics, 4) Students can explain the results according to the original problem, and 5) Students can use mathematics meaningfully.

To find the perimeter of a triangle, must first know the length of the three sides of the triangle because the circumference of the triangle is the sum of the lengths of the three sides that make up the triangle [1]. Finding the perimeter of a triangle means finding the distance around the triangle. The simplest way to find the perimeter of a triangle is to add up all the lengths of the sides, but if you don't know the entire length of the sides, you need to calculate them first. [1] If ΔABC has sides a, b, and c, then the perimeter of a triangle is $K = a + b + c$. 

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1. [1]
Based on one of the results of a similar study, Yuli [9] who investigated a Problem Based Learning method, offered a form of learning that involved students actively in learning. Problem Based Learning is a method based on authentic problems so that students can compile their own knowledge and foster higher skills development. The addition of giving structured assignments supports PBL learning. Through structured assignments student learning activities will increase. Students obtain this knowledge directly through their own experience. Every student has the opportunity to present his own abilities. Thus, Problem Based Learning accompanied by the provision of structured assignments can develop students’ mathematical problem solving abilities.

According to Hesti and Ririn [3] to improve students’ problem solving skills, it needs to be supported by the correct learning method. One of the lessons to improve problem solving skills is using Problem Based Learning. PBL is a method that use real-world problems as a context for students to learn about critical thinking and solving skills, to acquire essential knowledge and concepts. So that PBL models use real world problems as a context for students to have active learning, critical thinking, and intellectually skilled in problem solving. Based on the background of the problem, this research problem can be formulated as follows: (1) How is the process of learning triangle perimeter material and triangle area with the Problem Based Learning model in grade 7B Kanisius Kalasan Junior High School? (2) How is the problem solving ability of students grade 7B Kanisius Kalasan Junior High School on triangle perimeter?

2. Research Method

The type of research used of design research. This research designed to design learning, namely problem-based learning and analyze students’ problem solving ability in triangle perimeter material. Prahmana [7] defines design research is an appropriate research method for developing a solution (solving) complex problems in educational practice as well as for developing or validating a theory about the learning process, as well as the learning environment. Prahmana [7] suggests there are several stages in design research. The stage is the Preliminary Design stage, the Design Experiment stage, and the Retrospective Analysis stage. The subjects in this study were 22 students of grade 7B Kanisius Kalasan Junior High School. Researchers conducted research at Kanisius Kalasan Junior High School in March 2019. Data collection techniques used in this study were observation, interviews, documentation, field notes, and tests. The research instrument used a test sheet.

3. Research Results and Discussion

3.1. Preliminary Design

In this stage the researcher designs taught method that would be used to teach triangle perimeter with Problem Based Learning method. The development of the Hypothetical Learning Trajectory (HLT) in each learned activity was the most important part in designed learning activities of students. Design learning was a concept map that would be passed by students during the learning process. Learning activities and student thinking results are hypothesized in HLT.

3.2. Design Experiment

3.2.1. Stage of orientation of students to problems. At this stage, educators gave a problem. Then the educator asked the students related to the concept of perimeter and the type of triangle based on sides. Students suggest there are three types of triangles based on sides namely isosceles triangle, equilateral triangle, and scalene triangle. Students also suggest that perimeter means went around or passed all sides. The problem gave is as follows:

*Mr. Tono has rope 48m long, the rope is used to confine his triangle-shaped fish pond, Mr. Tono wants to measure the length of each side of the pond. What is Mr. Tono’s likelihood of the length of each side of the pond? Describe how the shape of Mr. Tono’s fish pond string might have formed!*
3.2.2. Stage of organizing students to learn. At this stage educators divided students into 5 groups, with 3 groups consisted of 5 people and 2 groups consisted of 4 people. Then educators asked students to pay attention to the problem gave.

3.2.3. Stage guiding individual or group investigations. At this stage, educators acted as facilitators to help students to gather information and organize understood of the concept of around the triangle based on the problems gave.

![Figure 1 & Figure 2](image1.jpg)

**Figure 1 & Figure 2.** Educators guided investigations

3.2.4. The stage of developing and presenting results. At this stage, the educator asked each group to wrote down the answer on the answer sheet provided.

Then the educator asked one group to present the results of the group worked while the other groups pay attention. The followed presentation of the results of the discussions conducted in the group.

![Figure 3](image2.jpg)

**Figure 3.** Students presented the results of the answers
Figure 4. Answers gave by one of group

From the problems gave, three groups answered that there were three possible forms of Mr. Tono's pool while the other two groups answered that there were two possible forms of Mr. Tono's pool. The five groups answered that the length of the pool of Pak Tono's pool was the length of the entire rope around the pool divided by three because the shape of the pool was triangular, so they answered that the length of each pool of Mr. Tono's pool was 48 m: 3 = 16 m, the length of each side of Mr. Tono's pool the same is 16 m so that the possible shape of the pond of Tono is an equilateral triangle. Then the five groups also found the possibility of the two forms of Mr. Tono's pool being an isosceles triangle. Three groups answered the possibility that the length of each side of Mr. Tono's pond was 17 m, 17 m and 14 m. The length of these sides was based on the possibility of the length of each side of the previous pool, which is 16 m. The two sides of the previous 16 m pool were added with 1 m and the other side was reduced by 2 m, while the other two groups answered the possibility that the length of each side of Mr.Tono's pond was 18 m, 18 m and 12 m obtained from both sides of the pond 16 m 2 m is added and the other side is reduced by 4 m. One group determines the length of each side of Mr.Tono's pool by reducing the length of one side of an isosceles triangle that has been obtained previously, which is 14 m - 1 = 13 m, the length of one side remains 17 m while the overall rope is 48 m, then the length of one side others are 48-13-17 = 18 m. One group determines the length of each side of Mr. Tono's pool by reducing the length of one side of the isosceles triangle that was previously obtained, which is 18 m - 2 = 16 m, the length of one side is 18 m while the whole rope is 48 m, the length of one side others are 48-16-18 = 14 m. One other group only described the form of Mr. Tono's pool but did not determine the length of each pool. Based on the students' answers, it can be concluded that students can solve the problem by applied the formula perimeter the triangle.

3.2.5. Analyzing and Evaluating the Problem Solving Process. At this stage educators help students to reflect or evaluate the investigation process that they did. Educators direct students to compare the results of their group work with groups that present their work in front of the class. Educators asked students how the different answers exist. Then the educator asked how the steps to solve the problem gave and the students together conclude that there are three possible forms of Mr. Tono's pool. At the conclusion of the students also concluded to calculate the perimeter of a triangle is the side added side added side or the number of three sides, while for equilateral triangle the perimeter formula was three times the side. After students can deduce the learning process that has been run, the teacher gave an
appreciation and conditions the class returns to normal and invites students to close the lesson by prayed.

3.3. Retrospective Analysis
Based on the learning outcomes obtained by students, then the followed an analysis of problem solving from students as follows:

**Question analysis:**
Novi has three triangular pillowcases with a length of 40 cm each. To beautify the three pillowcases, Novi wanted to sew the lace around the pillowcase. Price of lace Rp. 4,000.00 per meter. Draw a sketch of the pillowcase that Novi has and calculate by length of the lace and the cost of the lace that Novi needs to buy!

Student 1 answer:

![Figure 5. Student 1 Answer](image)

Based on the students' answers in Figure 1, procedurally it is correct because students drew sketches of triangular pillowcases owned by Novi then count first around their sockets with the formula triangle perimeter, so that the final result is obtained, but the final result is not clearly stated. Student answers based on indicators of problem solving abilities according to NCTM:

1. Students can identify the elements that are known, asked, and the adequacy of the elements needed. Judged from the results of student work for elements known to students write correctly the length of the side was 40 cm which is indicated by writing the perimeter of the same side with the side + side + side and can wrote the price of lace Rp. 4,000.00/m. For the element in question, it can be seen from the way students answer by searched first perimeter the triangle then multiplying it with the price of lace.

2. Students can formulate mathematical problems or develop mathematical models. Judged from the work, students can write mathematical models, namely students wrote down the process of solving problems gave from the beginning to find the final results.

3. Students can apply strategies to solve various problems (similar and new problems) within or outside mathematics. Judged from the work of students, students can find the costs needed to bought lace based on the perimeter of 3 known pillowcases.

4. Students can explain the results accorded to the original problem. At work the student did not finished or wrote conclusions from the problem gave, so that in the student answer this indicator is not fulfilled.

5. Students can use mathematics meaningfully. In the work of these students can use the mathematical knowledge they had to apply to solve problems.
Student 2 answer:

![Image](image.png)

**Figure 6. Student 2 Answer**

Based on the students' answers in Figure 2, students drew a sketch of a triangular pillowcase owned by Novi and then calculate the perimeter of the triangle with the formula triangle perimeter, but the student did not multiply the 3 pillowcases asked. Students seem unable to interpret the problem and are unable to re-examine the answers they are worked on. Student answers based on indicators of problem solving abilities according to NCTM:

1. Students can identify the elements that are known, asked, and the adequacy of the elements needed. Judged from the results of student work for elements known to students write correctly the length of the side was 40 cm which is indicated by writing the perimeter of the same side with the side + side + side and can wrote the price of lace Rp. 4,000.00/m. For the element in question, it can be seen from the way students answer by searched first perimeter the triangle then multiplying it with the price of lace.

2. Students can formulate mathematical problems or develop mathematical models. Judged from the work, students can write mathematical models, namely students wrote down the process of solving problems gave from the beginning to find the final results.

3. Students can apply strategies to solve various problems (similar and new problems) within or outside mathematics. Judged from the work of students, students cannot find the cost needed to buy lace based on the perimeter of 3 known pillowcases.

4. Students can explain the results accorded to the original problem. At work the student did not explain or wrote conclusions of the problems given, so that in the student answer this indicator is not fulfilled.

5. Students can use mathematics meaningfully. In the work of these students can used the mathematical knowledge they had to apply to solve problems.

**4. Conclusion**

Based on the results of research of class 7B in Kanisius Kalasan Junior High School, the following conclusions are obtained:

1. Design learning through Problem Based Learning that is well designed can help students solve problems by applying the concept of triangle perimeter.

2. Problem solving skills of students of 7B in Kanisius Kalasan based on indicators of problem solving ability according to NCTM there are 14 students who are qualified within 4 out of 5 indicators, namely students can identify the elements that are known, asked, and the adequacy of the elements needed, students can form mathematical problems or develop mathematical models, students can apply strategies to solve various problems within or outside mathematics, and students can use mathematics significantly and there are 8 students who qualified within 2 out of 5 indicators namely students can identify the elements that are known, asked, and the adequacy of elements needed and students can use mathematics meaningfully.
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