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Analysis of Problem-Solving Skills of Seventh Grade Students of Indonesia Institute of Yogyakarta Junior High School in Triangle Materials after the Implementation of Problem-Based Learning Model

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Abstract: The objectives of this study were (1) to describe the learning steps of triangular material using a problem-based learning model (2) to describe the problem-solving skills of class VII students of the Yogyakarta Institute of Indonesia Junior High School in triangular material, after learning using problem-based learning. This type of research is design research. The research instruments used were field notes and learning outcomes test sheets. Field notes are used to describe the steps of problem-based learning while the learning outcomes test sheet is used to see students' problem-solving skills according to NCTM. Method of collecting data is in the form of documentation and test results. Data analysis techniques carried out are data reduction, data presentation, and conclusion. This research was conducted in March 2019. The research subjects were 20 seventh grade students of the Yogyakarta Indonesian Institute Junior High School. The results of this study are in the form of a description of the implementation of a problem-based learning model in triangular material and the analysis of problem-solving skills of seventh grade students of the Yogyakarta Indonesian Institute Junior High School after the learning outcomes test. Based on the results of the learning process description, the steps of the problem-based learning model in the triangular material at Indonesia Institute of Yogyakarta Junior High School at the first and second meetings were carried out according to the design made by the researcher. For analysis of problem-solving skills, in the number one problem, students have reached 4 indicators of problem-solving skills according to NCTM. Whereas in question number two, students have reached 3 indicators of problem-solving skills according to NCTM.

Keywords: Problem based learning, learning design, problem solving skills.

Introduction

Based on the results of observations that have been carried out in class VII of the Yogyakarta Indonesian Institute Junior High School on February 5 and 8, 2019, researchers found problems that occurred during mathematics learning activities. Most students are very active to play and do not focus on learning activities. Only a few students in the class listened to the teacher who gives learning material. This certainly influences the activities of solving the problem exercises given by the teacher. In the process of solving the practice questions, students did not complete the practice independently, but the problem-solving strategies were dictated by the teacher and there were several practice questions completed by the teacher himself without any contribution from the students. Several studies that can overcome the problems above are research from Samosir and Surya (2017) and Yusri (2018). Both of these studies obtained results that the implementation of a problem-based learning model can help students in generating problem solving skills in the learning process. So, the researchers designed the Hypothetical Learning Trajectory using a problem-based learning model on triangular material in class VII of the Yogyakarta Indonesian Institute of Middle School. Furthermore, at the end of the meeting, the researcher will analyze the problem-solving skills through the test of learning outcomes that are done by students.

Students' problem solving skills are analyzed based on indicators of problem solving skills according to NCTM, namely; identify the elements that are known, asked, and the adequacy of the elements needed, formulate mathematical problems or develop mathematical models, apply strategies to solve various problems (similar and new problems) in or outside the mathematics, explain or interpret the results according to the origin problem, and use mathematics meaningfully. In this study there are two formulation of the problem, namely:

1. How is the description of problem-based learning model implementation in triangular material in class VII of the Yogyakarta Indonesian Institute Junior High School?

2. How are the problem-solving skills of the seventh-grade students of Yogyakarta Institute of Indonesia Junior High School on triangular material after implementing a problem-based learning model?

Research Method

This type of research is design research. The research subjects were 20 seventh grade students of the Yogyakarta Indonesian Institute Junior High School. The method of data collection is the documentation and implementation of learning outcomes tests after the learning process takes place. The research instruments were field notes and learning outcomes test sheets. Field notes are used to describe the steps of problem-based learning while the learning outcomes test sheet is used to see students' problem-solving abilities according to NCTM. The data analysis technique used is the process of qualitative data analysis which begins with reducing data, presenting data, drawing conclusions.

Result and Discussion

3.1 Description of the Learning Process

3.1.1 The first meeting

In this study there are five phases of the problem-based learning model namely; student orientation to problems, organizing students to study, guiding individual/group experiences, developing and presenting work, analyzing and evaluating problem solving processes. The following is the result of the description of the learning process at the first meeting:

3.1.1.1 Stage of Student Orientation on Problems

In this phase, the teacher explains the purpose of learning, namely students can identify and explain the types of triangles with achievement indicators understanding triangles based on conditions to form a triangle, and through question and answer activities, the teacher also reviews the prerequisite material: students understand triangular material for levels elementary school and students master line and angle material.

In this phase, the teacher also explains the problem that will be solved by students.

Table 1. Student and teacher conversation

Teacher:	To better understand the material to be learned today. I will provide LKS consisting of 3 questions that you must complete. (The teacher reads out the indicators of achievement of competence, instructions for work, and the questions / problems listed below)
Students:	(listen to the teacher's explanation)

Problem in student worksheet:
Indicators of competence achievement
Get to know a triangle based on the terms of a triangle
Clue: do the questions below correctly
Question:

1. draw three random triangle shapes
2. measure the length of the sides of the triangle
3. which of the lengths of the sides below can form a triangle:

Table 2. Student Worksheet

	Side 1 (cm)	Side 2 (cm)	Side 3 (cm)
a)	1	4	6
b)	6	8	10
c)	5	15	6

3.1.1.2 Organizing students to learn

In this phase, the teacher divides students into several groups, each group consisting of 4-5 students. Next, the teacher distributes logistics such as: rulers and answer sheets in the form of millimetric paper to each group.

Table 3. Student and teacher conversation

Teacher:	You will solve these questions in groups so that you can discuss and share what you know to friends then you can solve the LKS questions. One group consists of 4 people and there is 1 group of 5 people. The group is based on the seat. Please those who sit on rows 1 and 3 turn around and form groups.
Students:	(begins to turn around and sit in groups)

3.1.1.3 Guiding individual / group experiences

In this phase, the teacher actively goes around from one group to another to help students if they experience difficulties. What happened during the discussion process, most groups raised their hands to ask questions when experiencing difficulties. There is one group asking as follows:

Table 4. Student and teacher conversation

Student:	Sis, this question number 1 means drawing a random triangle of 3, right?	Student:	Isosceles triangle, equilateral triangle.
Teacher:	not a random triangle, but a scalene triangle. Scalene triangle is any triangle you know, it doesn't have to be as random.	Teacher:	Yes, good. That means you can draw those three triangles right.
Student:	So can I draw right triangle?	Student:	(bobbing while starting to draw)
Teacher:	Yes, you can. Then what else?		

3.1.1.4 Develop and present the work

In this phase, the teacher asks all groups to take turns presenting the results of their work in front of the class. When another group presents the results of their work, the teacher asks the other group to listen. After presenting the results of the group work, the teacher asks the students if there is a response from other groups. But when the four groups presented the results, none of the groups gave a response, so at the end of the presentation from each group, the teacher thanked them and together with the other groups appreciated each group that work with applause.

Presentation from one group:

Table 5. Student and teacher conversation

Student:	Assalammualaikumwarrohmatulohiwabarakatu	Teacher:	Any responses?
Teacher+ students:	Walaikumsalam	Students:	No.
Student:	After we discussed, now we will present the results of our work. Number one, first triangle all sides 3 cm. The second triangle, the sides: 4 cm, 3 cm and 5 cm. The third triangle, its sides: 4 cm, 4 cm and 2 cm. Number three a is not a triangle, b is a triangle, and c is not a triangle.	Teacher:	Ok if there is no response, thank you and please give applause.

3.1.1.5 Analyze and evaluate the problem solving process

In this phase, the teacher confirms and concludes what has been learned in today's learning.

Table 6. Student and teacher conversation

Teacher:	For numbers 1 and 2, the average response of the group is quite correct and for number 3 a, if the sides are 1cm, 6cm, and 4cm it is not a triangle. So, if you draw, there is a line that exceeds that triangle. Now for the b side with sides of 6 cm, 8 cm, and 10 cm is a triangle because when it is drawn exactly it forms a triangle. And for the third one is c with sides 5 cm, 6 cm, and 15 cm, where the side that is 15 cm long the line will be longer than the existing triangle. Like that, brothers and sisters. Then, from questions number 1 and 2, what conclusions can you take? What is the triangle like?	Teacher:	7> 5. That means right. Then the others. Now 3 and 5. 3 + 5, is it greater than 4? What is 3 + 5?
Students:	There are 3 sides.	Students:	8.
Teacher:	How about the size?	Teacher:	8. Means 8> 5. Then the last one, 4 and 5. Is 4+5 greater than 3? 4 + 5?
Siswa:	(speaking unclearly)	Siswa:	9.

Guru:	Some can be the same, some cannot. The figure is measured based on the size of the ruler. Then for number 3?	Guru:	9. 9> 3. So, the condition for making a triangle is the sum of the two sides of the side greater than the length of the other side. Like this one (while pointing at the blackboard). So all three must be true. Suppose one of them is wrong, for example, 2, then this 1 (while pointing at the board) is less than 4, meaning that it is not a triangle. Ok, do you understand the conditions, right? The number of the two sides of the triangle must be greater than the length of the other side. Ok?
Students:	(didi not answer)	Students:	Ok.
Teacher:	From number 3 it can be concluded that the number of lengths of two sides must be greater than the length of the other side. Suppose the first side length is 3 cm, second is 4 cm, and the third is 5 cm (while drawing on the board). So, we must know whether the two triangle sides lengths are larger than the other sides of the triangle. Brothers and sisters, please pay attention to this explanation, because this material or this requirement will be used for the next meeting on Friday. Is 3 + 4> 5? Is it bigger or not? What is 3 + 4?	Teacher:	Understand, right? So, this condition will be used for further material, Friday. Later you will meet with Sis Mensi, with us too.
Students:	7.		

3.1.2 Second Meeting

3.1.2.1 The student orientation stage on the problem

At this stage the teacher explains the learning objectives, which will discuss the material about the types of triangles based on the length of the sides and based on the angle. Next the teacher reviews the material at the previous meeting, namely the requirement to make a triangle. After that the teacher explains the problem that will be solved by students.

Problems in student worksheet:

1. The number of the three sides of a triangle is 9 cm. Determine the length of the sides (in positive integers) and the type of triangle.
2. Given an ABC triangle with a large angle of 50°, then determine the three most likely two other angles, and what type of triangle is that? Explain the reason.

3.1.2.2 Organizing students to learn

At this stage the teacher divides students into groups of 4 to 5 students in one group. Then the teacher distributes the LKS while expressing that the students must discuss with their group friends to do the problems given in the LKS.

3.1.2.3 Guiding individual / group experiences

At this stage the teacher monitors the course of group discussions by going around to help students who are experiencing difficulties. The teacher also said that students may ask if someone does not understand.

The teacher goes around, and a group asks:

Student: Sis, what if we have more than one triangle?
Teacher: what number do you mean?
Student: Number one, Sis.
Teacher: It's okay, what matters is that it must be in accordance with the conditions.
The teacher continues to hear other groups asking:

Student: Sis for number one, it means the overall length of the side is nine centimeters, right?	Teacher: The statement "summarizing the three sides of a triangle is nine centimeters" means that if you add all the sides to the triangle the number is nine meters
Teacher: Try to look again at the statement on question number one. Student: I'm confused Sis.	Student: Oh, that's so, hahaha ok, thanks sis.

Teacher goes around and a group asks for question number 2:

Student: Sis, how do you determine the other angles?	Teacher: The summing of the three angles in a triangle is one hundred eighty degrees. Now, in question number two, you already know one angle, how do you determine the other two angles?
Teacher: do you still remember the total sum of angles in a triangle?	Student: Oh, Sis, using reduction, right?
Student: Forgotten, how much is it, Sis?	Teacher: Yes, like that, try to do it based on the ideas that you find
Teacher: You have learned it in elementary school Student: Forget Sis. How much is it sis?	

3.1.1.4 Develop and present the work

In this phase the teacher asks 2 groups who are willing to write the results of their work on the board. The first group writes and explains the problem no.1 and the second group writes and explains the problem no. 2.

Teacher: Explain to your friends the steps you are completing.

Student: For number one, we get a triangle with a length of sides three centimeters, three centimeters, three centimeters.
Teacher: Ok so what kind of triangle is that?
Student: Equilateral triangle and isosceles triangle, sis.
Student: We get the angles of fifty degrees, fifty degrees and eighty-five degrees. We subtract 180 degrees with 50 degrees and minus 50 degrees again.
Teacher: Why do you reduce it again by 50 degrees? What is the reason?
Student: Because it's an isosceles triangle, the two angles must be the same size.
Teacher: Good, for this problem there are still unclear or anyone want to ask?
Student: No, sis.

3.1.2.5 Analyze and evaluate the problem solving process

At this stage the teacher gives test questions and asks students to work individually for 40 minutes. After completing the test, the teacher invites students to evaluate what they have learned.

Table 7. Student and teacher conversation

Teacher: What have we learned today?	Teacher: ok I confirm again, there are two types of triangles, namely triangles based on the length of the sides and triangles based on the size of the angle. Well, triangles based on the length of the side are like isosceles triangles, equilateral triangles and scalene triangles. I'm sure you can tell the difference. Triangles which are based on the size of the angles are also three, namely the right triangle, one of the angles is 90 degrees. Then there is a blunt triangle with one angle more than 90 degrees, then there is an acute triangle, all angles smaller than 90 degrees.
Student: Triangle and angle size, sis.	

Based on the description of the learning process, it is seen that the steps of problem-based learning that are designed have emerged in practice in the field.

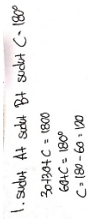
3.2 Problem Solving Skills Analysis

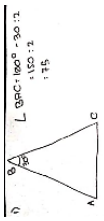
Problem 1:

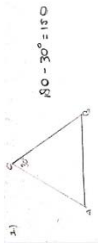
The value of one angle in an isosceles triangle ABC is 30°. Determine the other angles!
There are 3 possibilities that appear in the execution of the question.

Table 8. Student's Answer

Student Answer Group		
First group	**Second Group**	**Third Group**







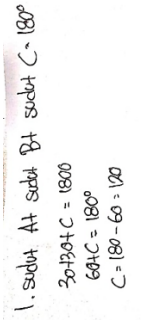
Description:

First group: it can be seen that students know that one of the angles beside the angle of ABC is 120 ° (This answer is correct according to the first strategy that the researcher has written on the THB clues). In this case, students already understand how to find the other side. But students only focus on finding angular values that are not angles forming an isosceles triangle. But from the students' answers, students actually know that the other angles (forming an isosceles triangle) are the same as in the question, which is 30 °. But students seem to forget that the other two angles are also asked, not just one, even though they understood that the other angle was the same as in the question.

Second group: it appears that students get the value of one angle beside the angle ABC is 75°. The results obtained are in accordance with the results stated in the second strategy the researchers wrote on the THB clues. Unfortunately, the way to get these results is still wrong. This is because students make a counting operation as follows, 180° – 30°: 2. Obviously, in the counting operation students are still mistaken. The division counting operation must be completed first, then the addition operation. If the counting operation is done incorrectly, the results obtained are also wrong. So, the researchers can conclude that students are able to understand, know, and solve problems that are being faced but the way it solved is still wrong and have not answered the whole question (students only answer 1 angle, they should answer the value of 2 angles, too).

Third group: it can be seen that students do not understand yet that the triangle should have three values of angle. The following is a justification based on indicators of problem-solving skills according to NCTM on student work:

Table 9. The Analyze of Problem Solving Skills According to the NCTM Indicators

Student's answer	Problem Solving Skills Indicator that reached	Explanation
	Identifying the elements that are known, asked, and the adequacy of the elements needed.	Students are able to identify the elements that are known, asked, and the adequacy of the elements needed in the problem even though implicitly. This is because the teacher gives less detailed instructions on the questions given.
	Formulating mathematical problems or compiling mathematical models.	Students are able to develop mathematical models to solve the problem. This can be seen from the student's answer: "angle A + angle B + angle C = 180°"
	Implement strategies to solve various problems (similar and new problems) within or outside mathematics.	Students use the addition and subtraction operations to obtain the angle they want to find.

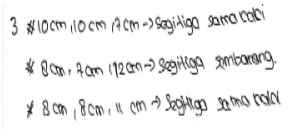
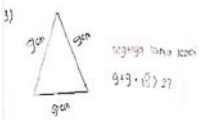
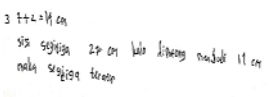
Explain or interpret the results according to the origin problem.	Students are able to interpret the results according to the original problem. Where the results are obtained from the problem given by the teacher and students' reasoning that if it is an isosceles triangle, it means that the other angles are also 30 °, so they can just look for another angle with a mathematical model and get another angle of 120°.
Use mathematics significantly.	Students have not been able to use mathematics significantly. This is because the teacher is less detailed in giving instructions to the questions given.

Conclusion

Students in the first possible answer have reached the four indicators of problem-solving skills, but the fifth problem solving skills, namely: using mathematics significantly has not been achieved. This is because the teacher is less detailed in giving referrals to the questions given. In the first indicator of problem-solving skills the teacher can only see the students' answers implicitly. Just like the fifth indicator of problem-solving skills, this is because the teacher is less detailed in giving instructions on the questions given. This is a mistake from the teacher. So that it is expected, the researcher / teacher can be more detailed and thorough in making the instructions and questions that will be given to students.

Problem 2:

Table 10. Student's Answer

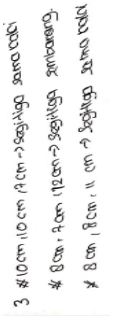
First Group	Second Group	Third Group
		

Description

First group: it can be seen that students have been able to determine three possible sides of the triangle with the length of the sides of the triangle is 27 cm. The students implicitly understand the terms in forming a triangle, it can be seen from the determination of the length of the three sides of a triangle that meets the requirements to form a triangle, namely the sum of the lengths of the two sides of the triangle must be greater than the third side. Then students can determine the type of triangle according to the length of the side.

Second group: show that students have determined one possibility about a triangle with a length of sides 27cm. Implicitly students have understood the terms in forming a triangle. This can be seen from the determination of the length of the three sides of the triangle that meets the requirements to form a triangle, namely the number of lengths of the two sides of the triangle must be longer than the third side. But students are still mistaken in writing the meaning of the terms for the triangle "9 + 9 = 18 > 27" should be written like this: 9 + 9 > 9. Students have been able to represent triangles in the form of images, but the size of the sides does not match the 9cm scale. In the third student's answer, it can be seen that students do not understand the question well, students do not understand the terms of forming a triangle and determining the type of triangle based on the length of the sides. The following is a justification based on indicators of problem-solving skills according to NCTM on student work:

Table 11. The Analyze of Problem Solving Skills According to the NCTM Indicators

Student's answer	Problem Solving Skills Indicator that reached	Explanation
	Identifying the elements that are known, asked, and the adequacy of the elements needed.	Students have not been able to identify the elements that are known, asked, and the adequacy of the elements needed in the problem even though implicitly. This is because the teacher is less detailed in giving instructions to the questions given.
	Formulate mathematical problems or compile mathematical models.	Implicitly students have been able to compile a mathematical model, this can be seen from the determination of the type of triangle whose total sides are 27 cm. Students have determined the sides correctly. In this case, before students determine the intended sides, students must perform a calculation operation that involves the process of making mathematical models.
	Implement strategies to solve various problems (similar and new problems) within or outside mathematics.	Implicitly students have been able to apply strategies in determining the lengths of the sides of a triangle based on the requirements to form a triangle. The sum of the two sides must be longer than the third side.
	Explain or interpret the results according to the origin problem.	Students are able to interpret the results according to the original problem. Where students have been able to determine the three sides of the triangle which if added together the result is 27cm, and students have been able to determine the type of triangle based on the length of the sides.
	Using mathematics significantly.	Students have not been able to use mathematics significantly. This is because the teacher is less detailed in giving instructions to the questions given.

Conclusion:

Students in the first possible answer have achieved three indicators of problem-solving skills but have not achieved the first and fifth problem solving abilities. This is because the teacher is less careful in giving referrals to the questions given. This is a mistake from the teacher. So that it is expected, researchers / teachers can be more thorough in making instructions and questions that will be given to students.

Conclusion

Based on the results of the learning process description, the steps of the problem-based learning model in the triangular material at Indonesia Institute of Yogyakarta Junior High School at the first and second

meetings were carried out according to the design made by the researcher. From the results of the analysis of problem solving abilities, in question number one, students have reached 4 indicators of problem solving skills according to NCTM, namely identifying elements that are known, asked and adequacy of necessary elements, formulating mathematical problems or developing mathematical models, applying strategies to solve various problems (similar and new problems) in or outside mathematics, explain or interpret the results according to the original problem. Whereas in question number two, students have reached 3 indicators of problem solving skills according to NCTM, namely formulating mathematical problems or developing mathematical models, applying strategies to solve various problems (similar and new problems) in or outside mathematics, explaining or interpreting results according to original problem.

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