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RESEARCH ARTICLE

Junior High School Students Ability to Use The Polya's Step to Solve Mathematical Problems Through Problem Based Learning

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ABSTRACT

This study purpose to determine the ability of students to use Polya's step in solving mathematical problems through Problem Based Learning. This study used a quantitative approach with a total sample, as many as 26 students of 7th grade of Junior High School 2 Kusan Hulu student. Problem Based Learning activities held in four meetings and two tests. The test results were analyzed based on the Polya's problem solving steps, calculated with the percentage in each step. The results showed that the ability of junior high school students to use Polya's steps in solving mathematical problem through Problem Based Learning was: 1) ability to understand problems at 83.80%, 2) ability to plan problem solving at 71.42%, and 3) ability to do counting at 75.61%.

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1. INTRODUCTION.

The ability solve problems is a competency in form of concepts application and skill in understanding, choosing a solution strategy, and solving problem (Polya, 1985; Napitupulu et al., 2016). The ability to solve problems needs to be developed so that students are able to apply their knowledge to solve problems in their daily lives. Today, the ability to solve mathematical problems is an international study seen in Trends in International Mathematics and Science Study (TIMMS). The purpose of TIMMS is to see how the curriculum launched by each country is implemented and the achievements of students, especially in the fields of mathematics and science. The 2015 TIMMS results showed the ranking of Indonesia's mathematics scores 45th ranked out of 50 participating countries. In all aspects, especially in applying, the mathematics achievement of Indonesian students is still low. Indonesian students are only able to solve routine questions, simple computation, and measure knowledge of facts that are in context daily (Rahmawati, 2018).

Based on information from Junior High School 2 Kusan Hulu teacher, the results of previous semester test which contained non-routine questions showed that students' problem solving skills were still low at 36% of students who could achieve the minimum completeness criteria. The low ability to solve this problem is suspected because class learning is less effective in developing students' problem solving skills.

The National Education Standards Corporation gives an overview of Indonesia's human ideal that could be created by 2013 Curriculum (Yani, 2013). Among them are having critical thinking skills, namely to think critically, laterally, and systemically, especially in the context of problem solving. One learning model that can support the achievement of the expected human ideal is Problem Based Learning (PBL). This learning model trains and develops ability to solve problems that are oriented to authentic problems from the actual life of students. It is an instructional learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem (Savery, 2006). The effect of Problem Based Learning is better than direct learning and has a positive effect on student learning outcomes or performance (Kaharuddin, 2018; Fatade, 2013; Ajai & Imoko, 2015; Tarmizi & Bayat, 2012, Ajai et al, 2013, Mulyanto et al., 2018).

There are three main characteristics of Problem Based Learning: (1) is a learning activity which means that in its implementation there are several activities that students must do, (2) learning activities are directed at solving problems, and (3) problem solving is done using a scientific thinking approach. The process of scientific thinking is carried out systematically and empirically. Systematic means through certain stages, while empirical means that the problem solving process is based on clear data and facts. The effectiveness of PBL depends on student characteristics and classroom culture as well as the problem tasks. Proponents of PBL believe that when students develop methods for constructing their own procedures, they are integrating their conceptual knowledge with their procedural skill (Al-Tabany, 2014; Mokhtar et al., 2010; Roh, 2003; Ali et al, 2010). PBL can increase the likelihood of conceptual change dan students' thinking skills (Loyens et al, 2015; Ari & Katranci, 2013).

The steps of Problem Based Learning (Shoimin, 2014; Wood, 2004; Peranginangin et al., 2019; Hendiana et al., 2018) which is as follow.

1. The teacher explains the learning objectives. Motivate students to be involved in selected problem solving activities.
2. The teachers' help students define and organize learning tasks related to the problem.
3. The teacher encourages students to collect appropriate information, experiment to get an explanation and problem solving, data collection, hypotheses, and problem solving.
4. The teacher assists students in planning and preparing reports and helps them share tasks with their friends.
5. The teacher helps students to reflect or evaluate their investigations and the processes they use.

Problems that are designed in Problem Based Learning challenge students to develop more critical thinking skills and be able to solve problems effectively. In Problem Based Learning, students can develop understanding of concepts, ability of procedures, ways of thinking by launching a related problem so that they can understand the problem settings and can know the next steps that must be done through discussion. As a result of the discussion, students will become more skilled at using ideas and techniques that result in experiences of problems encountered (Royani and Saufi, 2016).

One of the problem solving steps was put forward by George Polya. There are four steps to solve the problem that are understand the problem, devising a plan carrying out the plan, looking back (Polya, 1973; Chang et al, 2012). The completion step can be seen in each step of the student's answer and followed by an interview. The Polya's steps have a positive impact on learning outcomes. Students use prior knowledge to solve problems (Bilgin & Ibrahim 2006; Voskoglou, 2011). Furthermore, PBL used the Polya's problem solving procedures more effective and displayed better mathematical communication skills and showed stronger teamwork (Abdullah et al, 2010).

2. METHOD

This research is using a quantitative approach. The populations in this study were all VII grade students of Junior High School 2 Kusan Hulu in the school year 2017-2018, while the sampling technique used a total sampling technique that was 26 students of class VII.

The purpose of the study was to describe the ability of junior high school students to use Polya's steps in solving mathematical problems through Problem Based Learning. Problem Based Learning activities were held in four meetings and two tests. Written tests were given after the learning activities were held in two meetings. Learning material is Social Arithmetic in the section understanding the profit and lose out, determining single interest, discount, tax, gross, net, and tara.

The aspects observed based on Polya's steps are the ability to understand the problem, the ability to devise a plan and the ability to solve problems (carrying out the plan) through document analysis. While the aspect of checking back all steps that have been done (looking back) cannot be observed without conducting an interview. Furthermore, the results of the problem solving ability test are calculated using a percentage.

3. RESULT AND DISCUSSION

3.1 Result

Learning activities through Problem Based Learning were carried out for four meetings. After the second meeting, the first test was carried out to determine the ability of students to use Polya's steps to solve mathematical problems. The results of the first test can be seen in the following table.

Table 1. Ability to Use Polya's Steps on Test 1

No.	Aspect Assessed	f	Percentage
1	Ability to understand problem	74	52.85
2	Ability to plan problem solving	65	65
3	Ability to counting	555	60.32

Based on Table 1, the data on students' ability to use Polya's steps is obtained, namely the ability of students to understand the problem is 52.85%, the ability of students to plan problem solving is 65%, and the ability of students to counting is 60.32%.
Furthermore, learning is carried out again through Problem Based Learning for two meetings so that students get used to problem-based questions and continue with the second test. The purpose of this test is to determine the consistency of students' abilities to use Polya's steps in solving mathematical problems.

Table 2. Ability to Use Polya's Steps on Test 2

No.	Aspect Assessed	f	Percentage
1	Ability to understand problem	88	83.8
2	Ability to plan problem solving	75	71.42
3	Ability to counting	524	75.61

Based on Table 2, the data on students 'ability to use Polya's steps is obtained, namely the students' ability to understand problems is 83.80%, students 'ability to plan problem solving is 71.42%, and students' ability to counting is 75.61%.

3.2 Discussion

Before the first test, learning activities implemented through Problem Based Learning with material profit, lose out, and determine a single interest. On the first test, the following problems were given: "Mrs. Reni wants to open a nasi uduk restaurant, to meet her capital needs, Mrs. Reni plans to borrow Rp 50.000.000,00 in the bank, with a loan period of 1 year. There are two banks that offer capital assistance to Mrs. Reni. Bank A provides interest at 20% per year. Bank B gives interest of 2% per month. Both banks provide conditions for installments every month with a fixed nominal. If you are Mrs. Reni, which bank do you choose? "For example, the following is an example of the answer of an initial student of MD who solved the problem based on Polya's steps.

Table 3. First Problem Solving with Polya's Steps

No.	Problem Solving Steps	Student Answer
1	Ability to understand problem	
2	Ability to plan problem solving	Interest on A bank: $= \frac{20}{12} \times \text{Rp}50.000.000$ Interest on B bank: $= \frac{2}{100} \times \text{Rp}50.000.000$

3	Ability to counting	Interest on A bank : $= \frac{20}{12} \times \text{Rp}50.000.000$ $= 120.000.000$ (per year) Interest on B bank : $= \frac{2}{100} \times \text{Rp}50.000.000$ $= \text{Rp}2.500.000.000$ (per month) The percentage given by B bank in months because Mrs. Reni planned to borrow for 12 months, the amount of interest became $\text{Rp}2.500.000 \times 12 = \text{Rp}30.000.000$ So, the bank that provides the lightest interest loan is A bank, which is equal to Rp120.000.000,00

In this first problem, students do not understand the problem well. This can be seen in the answers the students do not write down what is known or what is unknown from the problem given. Students immediately plan problem solving by formulating interest rates in bank A and B. In addition, the formula that is planned as problem solving is not appropriate because students misinterpret 20% interest in bank A. 20% which should mean 20/100 written by students as 20/12, students are not able to associate with the concept of percentage. Students do not check every step of the planned completion so the work on calculating interest in bank B is also not correct, the results should be Rp1.000.000,00. The inability of students to understand problems results in mistakes in planning problem solving and working on the right count.

Next is the example of students' answers to the second problem: "Mr. Ari is an electronic seller, he bought a television for Rp2.000.000,00. If the television is resold at a price of Rp2.400.000,00, then determine if profit, how much profit? If he gets a loss, then what is the loss? And determine the percentage of profit or loss. "

Table 4. Second Problem Solving with Polya's Steps

No.	Problem Solving Steps	Student Answer
1	Ability to understand problem	Known: $\text{HB} = \text{Rp}2.000.000$ $\text{HJ} = \text{Rp}2.400.000$ Asked: Is it profit or lose out? What is the percentage?
2	Ability to plan problem solving	$\text{HJ} - \text{HB}$ $\text{HJ} - \text{HB} = \text{Rp}2.400.000 - \text{Rp}2.000.000$ (get profit) $\text{PU} = \frac{\text{HJ}-\text{HB}}{\text{HB}} \times 100\%$
3	Ability to counting	$\text{PU} = \frac{\text{Rp}2.400.000-\text{Rp}2.000.000}{\text{Rp}2.000.000} \times 100\%$ $= \frac{\text{Rp}400.000}{\text{Rp}2.000.000} \times 100\%$ $= 20\%$ So, the percentage of profits obtained by Mr. Ari is 20%.

In this second problem, students are able to solve problems based on Polya's steps; starting with understanding the problem correctly (rewriting what is known). Then students plan problem solving by trying to find the difference between the selling price and the purchase price of the television. After knowing that the selling price is greater than the purchase price, the student determines that Mr. Ari makes a profit by calculating the difference and begins to draw up a plan to calculate the percentage of profit. Students calculate the percentage of profits appropriately and are able to write conclusions according to the results of the calculation.

After the first test, Social Arithmetic was followed by two meetings through Problem Based Learning. Then the second test is carried out related to material about discounts, taxes, gross, net, and tara. The following is one of the problems given: "Mr. Dodi went to the Jaya Makmur electronics store to buy a television because the television in the house was damaged. After making a choice, Mr. Dodi bought a television with the brand AZ at a price of Rp2.000.000,00. Incidentally on that day the store was holding a promo with a 20% discount for every purchase. How much money does Mr. Dodi have to pay if the tax is charged 10%? ".

Table 5. Third Problem Solving with Polya's Steps

No.	Problem Solving Steps	Student Answer
1	Ability to understand problem	Known: Starting price $\text{Rp}2.000.000$ Discount $20\% = \frac{20}{100}$ Tax $10\% = \frac{10}{100}$ Asked: What is the price after discounts and taxes?
2	Ability to plan problem solving	Discount=20/100 × starting price Tax= 10/100 × the price after discounts
3	Ability to counting	Discount=20/100 × starting price =20/100 × Rp2.000.000,00 =Rp400.000,00 The price after discounts =Rp2.000.000,00 – Rp4.000.000,00 =Rp1.600.000,00 Tax=10/100 × The price after discounts =10/100 × Rp1.600.000,00 =Rp160.000,00 The price after taxes =Rp1.600.000,00 + Rp160.000,00 =Rp1.760.000,00 So, the price of the television that must be paid by Mr. Dodi is Rp1.760.000,00.

In the third problem, students were more skilled at solving some problems. In the step of understanding the problem, students were able to write down a number of things, namely the initial price, discount, and tax. Students were able to interpret a 20% discount as 20/100 and a 10% tax as 10/100. Furthermore students plan problem solving by formulating a discount multiplied by the initial price and tax multiplied by the price after the discount. Furthermore, students smoothly carried out work or calculate prices after discounts and after-tax prices. Then students made conclusions correctly. In the second test, MD students were more fluent and fluent in solving the problems given.

Another problem in the second test was: "When I want to take a shower, it turns out Bahar runs out of bath soap and then goes to the nearest shop to buy bath soap. Bahar saw that there were three

types of bath soap packaging for the brand he was going to buy. Soap A with a net 200 ml for Rp8.000. Soap B with a net 300 ml for Rp11.000,00. Soap C with a net 400 ml for Rp14.000,00. Bahar's money is only enough to buy one of the three types of soap. Give advice to Bahar, which soap should he buy? Please explain."

Table 6. Fourth Problem Solving with Polya's Steps

No.	Problem Solving Steps	Student Answer
1	Ability to understand problem	Package | Net | Price A | 200 | 8000 B | 300 | 11000 C | 400 | 14000
2	Ability to plan problem solving	Price per ml = Price/net
3	Ability to counting	The price of A soap = 8000/200 = 40 The price of B soap = 11000/300 = 36,66 The price of C soap = 14000/400 = 35 So, Bahar should buy C soap because the price per ml is the cheapest.

Students' answers on the fourth problem describe the three aspects or steps of completing the Polya. The ability of students to understand the problem can be seen in the initiative of students writing things that are known in the form of tables so that it is easier to understand the link between net and price. While the ability of students to have plan problem solving can be seen in the formula for calculating the price of soap per ml. Furthermore, students easily calculate the price per ml of each soap according to the formula written. Of the three calculations, students concluded that the price of C soap should be purchased because of the lowest price per ml.

If we compare the ability of students to solve problems in the first and second tests, the aspect of the ability to solve problems has increased significantly, which is equal to 30.95%. While the aspects of the ability to plan problem solving and the ability to counting each increased by 6.42% and 15.29%.

These results indicate that there is an increase in the ability to solve problems after students are familiar with the problems through Problem Based Learning. Problem Based Learning enables students to increase independence in thinking to analyze problems. Although initially students experience difficulties, but slowly students begin get used to analyzing a problem. The results of this study are in line with the results of the research of Supiandi and Hendrikus (2016), namely Problem-Based Learning significantly increases students' ability to solve problems.

The ability of students to analyze problems will have an impact on the ability of students to plan problem solving and do the work or calculation correctly. In Problem-Based Learning students were asked to understand the problem, plan problem solving, and did counting independently, the teacher just directs. Students were optimized for group activities, where together develop their thinking skills independently (Rusman, 2014). This is in accordance with the objectives expected by the government with the implementation of the 2013 Curriculum. It is expected that students can have critical thinking skills and problem solving, namely to think critically, laterally, and systemically, especially in the context of problem solving.

4. CONCLUSION

Based on the results of the study, it was concluded that the ability of junior high school students to use Polya's steps in solving mathematical problems through Problem Based Learning was: 1) the ability to understand problems was 83.80%, 2) the ability to plan problem solving was 71.42%, and 3) the ability to counting was 75.61%.

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