Analysis of Problem Solving Abilities of Junior High School Students on the HOTS Problems

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Abstract. Problem-solving is one of the abilities that are essential in mathematics learning. Students who have the skill can understand, plan, and solve an uncommon problem by using mathematical models and look back of the results obtained. This research aims to analyze the problem-solving steps of HOTS problems according to Polya which can be achieved by junior high school students. This research was designed in descriptive qualitative that involved 30 students consisting of three levels: high, medium and low-level students. Data were collected by using a HOTS problem test and an interview. HOTS problems are measuring instruments used to measure high-level thinking skills. The results showed that the high-level students are able to solve the problem but have not been able to look back of the results, the medium level students are able to reach the steps of making mathematical models, while the low-level students are not able to make mathematical models. It shows that student's problem-solving skills in junior high schools are different with respect to the abilities of each.

Keywords: problem-solving, HOTS problem, Polya steps

INTRODUCTION ~ According to Bell (1978),the research results show that problem-solving strategies that are generally studied in mathematics, in certain cases, can be transferred and applied in other problem-solving situations. Mathematical problem solving can help students to improve their analytical skills and can help them to apply the skills in a variety of situations.

Sumarmo (2006) defines problem-solving as activities to solve story problems, solving non-routine problems, applying mathematics in daily life or other circumstances, and proving or creating or testing the conjectures. While Polya (Hardian et al, 2018) defines problem-solving as an attempt to find a way out of a difficulty to achieve a goal that is not so immediately attainable.

The four steps to solving mathematical problems according to G. Polya (2004) are: (1) Understanding the problem (2) Devising a plan (3) Carrying out the plan, (4) Looking back. According to Saiful (2013), The four steps will be explained as follows.

a. Understanding the problem

In this step, students are encouraged to understand the problem with their own words. Understanding the problem is an important step in solving the problem. Without a good understanding, a student will not be able to solve the problems. Mistakes in understanding the problem can also cause the incomplete and incorrect solving of the problem correctly. The activities carried out at this stage are: 1) Determine what is known. 2) Determine what is being asked. 3) Determine whether the information needed is enough. 4) Determine the conditions that must be met. If students do the whole activities mentioned above, it shows that the students have understood the questions given.

b. Devising a plan

In this step, the ability to see the relationship between data and what conditions exist with the data sought is needed. To perform good planning requires deep thought. This is generated by the work of analysis and synthesis of existing data and possessing the necessary knowledge. The results of this analysis and synthesis can be in the form of alternatives or allegations of solving problems or steps that need to be passed to get an answer. To answer the given problem, students must make plans to solve the problem, gather information or data that have been studied before. The teacher motivates students by asking them to pay attention to the question being asked, and try to think of solving the problem. Wheeler (in Hodojo, 2001: 178) suggests a problem-solving planning strategy, namely: 1) making a table, 2) taking pictures, 3) guessing, testing and correcting, 4) looking for patterns, 5) restating the problem, 6) using reasoning, 7) using variables, 8) using equations, 9) trying to simplify the problem, 10) eliminating something that is not possible, 11) working backwards, 12) constructing a framework, 13) using an algorithm, 14) using indirect reasoning, 15) using properties of numbers, 16) using cases or dividing into parts, 17) validating all possibilities, 18) using formulas, 19) solving the equivalent problems, 20) using symmetry, and 21) using known information to develop new information.

c. Carrying out the plan

The plan that has been developed through the mastery of the concepts and various strategies above is then implemented step by step to achieve what is expected. The experience of solving problems and the patterns that exist from the problem-solving process are very helpful to students in running the problem-solving plan.

d. Looking Back

The solution that has been obtained is reviewed to make sure that it is the expected answer. Students often assume that the results of the implementationof a predetermined plan is the exact answer to their problem. They do not realize that there is possibility that the answer does not make sense, is not just in one form, may still need a process of obtaining other answers, and so on.

These four steps will be used to test students' problem-solving skills on HOTS problems. HOTS has been one of the forms in the higher and more complex thinking activities (King et al., 2010). The HOTS associates the students in applying and linking the knowledge that they will learn and the knowledge that they have learned. Concerning the cognitive dimension, the HOTS is characterized by the three higher levels in Bloom's taxonomy namely analysis, evaluation and creation (Anderson & Krathwohl, 2001; Moore &

Stanley, 2010; Ramos, Dolipas & Villamor, 2013).

The problem-solving capacity has been one of the indicators in the higher-order thinking skills or also known as the HOTS (King, Goodson & Rohani, 2010; Conklin, 2012; Tan & Halili, 2015). Problem-solving is an activity that involves various of actions in the mind of thought like accessing and using knowledge and experience (Lester& Kehle, 2003).

A study conducted by Susanti et al. (2014) found out that the students feel difficult to solve HOTS problems and among the difficulties faced by them are a) reading and interpreting data, b) determining and delegating data, and c) making conclusions and arguments. In this research the student will be analyzed the step of solving HOTS problems by Polya.

Based on the Ministry of Education and Culture (2017, p.3), HOTS problems are a measurement instrument used to measure higher-order thinking skills,which arethe ability to think not merely in the form ofa recall, restate, or refer without doing processing (recite).HOTS problems in the assessment context measure the ability of 1) transferring one concept to another, 2) processing and applying information, 3) looking for links from different information, 4) using information to solve problems, and 5) analyzing ideas and information critically. However, HOTS-based questions do not necessarilymean more difficult than therecallones.

The Ministry of Education and Culture (2017, p.9-13) describes the characteristics of HOTS questions, namely measuring high-level thinking skills, contextual-based problems, non-routine, and diverse in forms.

Based on the importance of problem-solving skills and HOTS questions, this study will discuss the results of the analysis of problem-solving skills on HOTS problems.

METHOD

This research is a qualitative descriptive study. According to Syaodih (2005: 54), descriptive research is a method aimed at illustrating existing phenomena, which take place on the present or past. The steps of qualitative descriptive research include data collection, compilation, analysis, and interpretation. The research subjects include 30 students of grade VIII junior high school consisting of 10 high-level students, 10 medium-level students, and 10 low-level students. Data collection techniques were aided with the instrument of essay-formed HOTS question and an interview then the analysis was conducted on the results of student scores and student working process with Polya'sproblem-solving steps. The research results were analyzed through three stages, namely the orientation or description stage, the reduction or focus stage, and the selection stage. According to Sugiyono (in Sugiarto,2015), the orientation or description stage includes that the researcher describes what is seen, heard, felt, and asked. At the reduction or focus stage, the researcher reduces all information obtained to focus on a particular problem. At the selection stage, the researcher elaborates the established focus into more details.

RESULTS

The HOTS questions were assigned to 30 students of gradeVIII junior high school which consisted of 3 questions on the Flat Side Geometry subject matter. The results of the set of tests of HOTS questions are presented in Table 3.1 for the high level, Table 3.2 for the medium level, and Table 3.3 for the low level.

High-Level Score Results

Table 1 shows the results of the HOTS questions for the high-level group. The ideal score to be obtained is 36. Based on the test results, the average score of the high-level students is 30.5. The high-level average score is in the good category.

Medium-Level Score Results

Table 2 shows the results of the HOTS questions for the medium-level group. The ideal score to be obtained is 36. Based on the test results, the average score of the medium-level students is 27. The medium-level average score is in the moderate category.

Low-Level Score Results

Table 3 shows the results of the HOTS questions for the low-level group. The ideal score to be obtained is 36. Based on the test results, the average score of the low-level studentsis 19.3. The low-level average score is in the poor category.

Table 1. High-Level Score Results

No	Subject	No 1	No 2	No 3	Total Score
1	Khalilah	12	10	11	33
2	Amirah	12	10	10	32
3	Zidane	10	10	10	30
4	Ainura	10	10	10	30
5	Shilfina	10	10	10	30
6	Fahira	10	10	10	30
7	Audhia	10	10	10	30
8	Amalia	10	12	8	30
9	Asma	10	10	10	30
10	Haliza	10	10	10	30
	Sum	104	102	99	305
	Average	10,4	10,2	9,9	30,5

Table 2.Medium Level Score Results

No	Subject	No 1	No 2	No 3	Total Score
1	Maura	10	8	10	28
2	Aretha	8	10	10	28
3	Syahadah	10	10	8	28
4	Asfa	12	6	10	28
5	Hafsah	10	8	10	28
6	Muthi	10	8	10	28
7	Fawzia	10	12	6	28
8	Ariqah	10	8	8	26
9	Syafiana	8	8	8	24
10	Fayruzia Binar	8	8	8	24
	Sum	96	86	88	270
	Average	9,6	8,6	8,8	27

Table 3. Low Level Score Results

No	Subject	No 1	No 2	No 3	Total Score
1	Nazmi	10	8	6	24
2	Azra	8	4	10	22
3	Bilqis	10	2	10	22
4	Nada	10	6	6	22
5	Maharoh	10	6	4	20
6	Salwa	8	4	8	20
7	Nadia	8	6	6	20
8	Nadhira	10	4	4	18
9	Keisha	4	4	4	12
10	Almaisya	4	4	4	12
	Sum	82	48	62	192
	Average	8,2	4,8	6,2	19,2

DISCUSSION

Based on the scores obtained, the scores of the high-level, medium-level, and low-level group are different with respect to the abilities of each. The average score of the high level is good, the average score of the medium level is fair, the average score of the low level is poor.

Polya's problem-solving approach

In the high-level group, for question number 1, number 2 and number 3 all students have been able to formulate the existing problems by writing down what are known and asked within the problem. Thus, all of the high-level students are able to formulate the main points of the problem and reveal the facts needed for the problem. Furthermore, in the Polya's second step, all students of the high level are also able to determine a plan for the completion of question number 1, number 2 and number 3. This can be seen from the formula selected to be used by the students, all students of the high level are able to write the formula to beused in solving the problems and to describe the situation requested. In the step of solving problems for questions number 1 and number 2, all students of the high level provide the correct solution. Whereas for question number 3, 1 out of 10 students of the high level was mistaken during the calculation. Therefore, it can be concluded that high-level students can carry out the step of solving problems. Furthermore, at the final stage, that is checking the answers correctness by using another way, only 2 students are able to check the answers by employing the other way on the answer sheet, each for question number 1 and question no. 2. Next, the students of the high level were interviewed regarding step four, the results of the interview show that the high-level students are confident in their answers by checking them from the beginning. They check the results by reviewing each step of their answer. However, they find it was difficult to write it down in another way. This shows that the high-level students have actually conducted the looking back process, only they cannot write it down.

In the medium-level group, all students either for question number 1, number 2, or number 3 have been able to formulate the existing problems by writing down what are known and asked within the problem. Besides, they are able to determine the data adequacy as required on the problem. Thus all students in the group are able toformulate the main points of the problem and reveal the facts needed for the problem. This means that the Polya's second step can also be fulfilled by the students oft his group for each question given, which is by determining the formula for problem-solving. Mean while, at the third stage for question number 1, 3 students are not able to provide the correct solution because of miscalculation. For number 2, 4 students miscalculate, 4 student provide the incorrect solution, and 1 student cannot solve the problem. For the fourth stage, there is only 1 student for the first question and 1 student for the second question who can check the answers by theory her way, while the rest of the students still cannot determine other ways to check answers. After being confirmed through interviews on the fourth step, the results showed that they did not re-check their work anymore because time was running out.

The students should develop the strategies that they had selected to solve the problems by associating the ideas to the other knowledge or discipline. Within the problem-solving process, the students made use of all capacities and skills that they possessed concerning the problem contexts, including the ones in the students' problem-solving capacities (Loyens, Magda & Rikers, 2008; Hung,2009). One of the examples from this situation would be the analysis and the problem-solving process (Jailani et.al.,2017)

Meanwhile, for the low-level group, 1 student are not able to interpret the complete information about the problem, which is in question number 2 that therefore cannot proceed to the next stage. While the rest of the students of this group are able to understand question number 1, 2, and 3 by determining the known facts and what is asked in the questions. In the second step, there are 2 students for question number 1, 4 students in question number 2, and 4 students in number 3 who still miss the correct way to solve the problem that, therefore, cannot proceed to the next stage. Likewise, in the third step, only 4 students for question number 1 and 2 students for question number 3 can solve the problems correctly.
This shows that most of the low-level students are not able to solve HOTS problems very well. Furthermore, for the fourth stage, none of the lower-level students can check the correctness of their answers by using another way. Confirmed through the interviews, 8 out of 10 students of this low level did not know what strategies to take in solving the problem. The results are consistent with the study conducted by Singh et al. (2010) that the students fail to convert mathematical problems into mathematical forms. According to the results, some students of the low level are able to solve problems of number 1 and 3 but only complete the first step for the other questions. This shows that the Polya's steps taken by students can be different, depending on the questions given.

More specifically, the findings of this study are as follows:
1. The high-level students are able to obtain good scores in solving the HOTS questions.
2. The medium-level students are able to obtain fair scores in solving the HOTS questions.
3. The low-level students only obtain poor scores in solving the HOTS questions.
4. In the steps of Polya’s problem solving, the high-level students can mostly solve the problems appropriately but have not been able to check the correctness by using other ways in writing.
5. In the steps of Polya’s solving problem by the medium-level students, some cannot solve the problem correctly. The error found in this level is in the calculation but they are correct in determining the strategy to be taken.
6. In the low level, the Polya’s problem solving to be completed by the students only meet the first step. The students of this group can write down the known facts but have difficulty in determining the strategy

that must be taken after obtaining the information within the questions. 7. Some students can solve problems completely for certain questions but cannot determine the correct strategy for the other problems. This can be influenced by several factors including the level of difficulty of the questions and the time required to work on the problems.

These findings agree with the study conducted by Abdul Halim (2015) that the students have problems to convert mathematical problems into mathematical forms. The problem solving process is one of the cognitive strategies and skills that are carefully planned by individuals to achieve goals. Therefore, for students with low achievement levels, they do not have a clear plan and strategy to solve the problem. They are facing difficult and challenging situations while solving problems. The situations of the low level student are more complicated when they do not understand the given problems and can not identify the mathematical operations involved, so they do not carry out the plan.

CONCLUSION

The results of the study showed that the high-level students obtain good average score, the medium-level students obtain fair average score, and the low-level students obtain poor average score in solving HOTS problems.

Moreover, for the Polya's problem-solving steps, all students of the high level can solve the problem correctly but have not been able to re-check the answers by using other ways. All students of the medium level can determine a plan or strategy to solve the problem correctly but still performing some errors in solving the problem. In the low level, all students can only fulfill the initial step which is understanding the problem by writing down what is known and asked but they have difficulty determining the correct strategy to be applied to solve the problem.

The study shows that the students feel that the given HOTS problems are rarely encountered. The results showed that the high-level students are able to solve the problem but have not been able to look back of the results, the medium level students are able to reach the steps of making mathematical models, while the low-level students are not able to make mathematical models. It shows that student's problem-solving skills in junior high schools are different with respect to the abilities of each.

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