Analysis of student’s problem solving ability at junior high school

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Abstract. Problem solving is an intellectual activity to resolve faced-problem uses their own insight. In addition, it is one aspect of higher thought such as processing of receive and resolving the problem as well. In Mathematics, Problem solving is one of the important abilities since it helps the student to think analytically to make decision in their life, or promotes critical thinking ability to deal with any new situations. The research was a qualitative research that aims to describe the mathematic problem solving capabilities for junior high school student using written test as measurer. The result of data analysis describes resolving emerge problems of mathematic, implementing and adjusting the appropriate strategies to resolve the problems as well as monitoring and reflecting problem solving process of mathematic. Based on the data analysis, the problem solving ability of the students is in the poor category.

1. Introduction
Mathematics is one of education fields that can improve and develop human resources. Mathematics gives opportunities in developing logical, systematical, critical, and accurate reasoning skill, creativity, self-confidence, sense of beauty toward the regularity nature of mathematics, and also objective and open-minded attitude which are highly needed in facing the fluctuate future [1]. Mathematics has several skill areas consisting of problem solving, reasoning and proving, communication, and representation [2]. Mathematics has to be taught to students because (1) it is always used in life aspects, (2) all life sectors need appropriate mathematical skill, (3) it is a strong, brief, and clear mean of communication, and (4) it can be used to present information in various ways, and it gives the satisfaction in trying to solve challenging problems [3]. Mathematics is a curriculum content that functions as a tool for deepening and solving problems to help people solving problems in real life [4].

The aim of mathematics learning is to develop the problem solving skill of complex mathematics problems [5]. Having problem solving skill helps students to think analytically in making decisions in daily life and to improve their critical thinking skill in facing new situations [1]. In reality, students’ mathematics problem solving skill is not fully or far from the expectation [6]. Based on the data of TIMSS in 2015, the Indonesian students’ mathematics mastery is in the 45th rank out of 57 countries. Indonesia can only accumulate the score of 397. Moreover, the data of PISA in 2015 states that Indonesia ranks 62nd out of 70 countries participating in that survey.

Problem solving is a skill obtained from a series of important activities in mathematics learning that can be used in solving other more complex problems or problems in real world [7]. Problem solving helps students to understand how mathematics can be used in daily life situations [8]. Mathematics problem solving is one of the most central aspects of mathematics [9]. Based on several
opinions, it can be concluded that problem solving is an important skill to possess by students in order to be able to solve complex problems.

The aim of problem solving in mathematics is to increase students’ readiness in improving their skill when solving problem, to improve students’ self-concept relevant to their skill in solving problems, to make students aware of problem solving strategy, and to make students aware that there are a lot of problems that can be solved through more than one way [10]. Besides that, the aims of mathematics problem solving are to improve students’ skill to choose a solution with an appropriate strategy, and also to improve students’ skill to obtain the most correct answer of the problems faced [11].

Non-routine problems are required to develop problem solving skill. Non-routine problems are usually related to the questions in the form of story, while most students avoid reading texts about stories [12]. Solving math word problems are often difficult because it needs reading comprehension skill, mathematical skill, and skill to translate words and numbers into appropriate operations [13]. Polya steps are required in the process of problem solving, namely 1) understanding the problem, 2) planning the problem solving, 3) implementing the problem solving plan, and 4) rechecking the result [14].

This research aims to analyze, describe, and provide information related to the problem solving skill of junior high school students. The focus in this research is to give information about problem solving skill possessed by junior high school students.

2. Method
This research used descriptive qualitative method. In this research, the mathematics problem solving skill of 8th grade students in Public Junior High Schools in Surakarta was analyzed. The population in this research was the 8th grade students in 29 Public Junior High Schools in Surakarta. Among the 29 schools in Surakarta, they were divided into 3 school categories based on the students’ ability in doing the National Examination of Junior High School 2016/2017, namely high category, medium category, and low category. There were 12 schools with high category, 5 schools with medium category, and 12 schools with low category. In this research there were 3 schools chosen with one school for each category. They were one school with high category, one school with medium category, and one school with low category. The data collection technique in this research was three essay questions. The instruments were used to answer the research questions. The evaluation technique was done using the following Table 1 guidelines and researcher classified into five criteria as shown in Table 2:

Then, to determine the problem solving ability based on the indicators, the researcher used the following formula:

\[ K = \frac{\text{student indicator score}}{\text{maximum indicator score}} \times 100\% \]

K was the mathematical problem solving ability.

| Table 1. The criteria of problem solving ability |
|-----------------------------------------------|
| Interval | Category |
| 80 < k ≤ 100 | Very Good |
| 60 < k ≤ 80 | Good |
| 40 < k ≤ 60 | Sufficient |
| 20 < k ≤ 40 | Bad |
| 0 ≤ k ≤ 20 | Very Bad |

Source : Trianto [15]
### Table 2. Scoring Guideline of Problem Solving Skill

| Indicators of Problem Solving Skill | Scoring Indicator                                                                 | Score | Question Number |
|------------------------------------|-----------------------------------------------------------------------------------|-------|-----------------|
| Understanding the problem          | Writing what is known and explaining it correctly and completely.                  | 5     | 1, 2, 3         |
|                                    | Writing what is known and explaining it correctly and incompletely.                | 3     |                 |
|                                    | Writing what is known and explaining it incorrectly.                              | 1     |                 |
|                                    | Not writing what is known nor explaining at all.                                  | 0     |                 |
| Planning the problem solving       | Writing the problem solving strategy correctly and completely.                    | 5     | 1, 2, 3         |
|                                    | Writing the problem solving strategy correctly and incompletely.                   | 3     |                 |
|                                    | Writing the problem solving strategy incorrectly.                                 | 1     |                 |
|                                    | Not writing the problem solving strategy at all.                                  | 0     |                 |
| Implementing the problem solving   | Writing the problem solving process correctly and completely.                     | 5     | 1, 2, 3         |
|                                    | Writing the problem solving process correctly and incompletely.                    | 3     |                 |
|                                    | Writing the problem solving process incorrectly and incompletely.                  | 2     |                 |
|                                    | Not writing the problem solving process at all.                                   | 0     |                 |
| Rechecking the problem solving     | Writing the review of the problem solving correctly and completely.               | 5     | 1, 2, 3         |
| result                             | Writing the review problem solving result correctly and incompletely.              | 3     |                 |
|                                    | Writing the review of the problem solving result incorrectly and incompletely.    | 1     |                 |
|                                    | Not writing the review of the problem solving result at all.                      | 0     |                 |

### 3. Result and Discussion

In this study, researcher collected information based on the results of research obtained from the essay test of students’ mathematical problem-solving ability. The description was focused on problem solving skill based on Polya stage. The essay test of problem-solving ability which was given to the students consisted of 3 items in which the score of each item was 0-15. Each question which was accomplished by 84 students consisted of Polya stages, namely understanding the problem, planning the problem-solving plan, and rechecking the results.

The data from the measurement of student’s problem-solving ability in each school category were entirely presented in Table 3 below.

### Table 3. The descriptions of Students’ Mathematical Problem Solving Ability

| School                | Problem-Solving Ability Test | The Steps of Problem-Solving Ability |
|-----------------------|------------------------------|-------------------------------------|
|                       | Understanding the Problem    | Planning the Problem-Solving         | Implementing the Problem-Solving | Rechecking the Result |
| High Category School  | Student’s score: 335         | 60                                  | 60                                | 0                        |
|                       | Total Score: 383             | 173                                 | 174                               | 9                        |
|                       | Percentage: 87.47%           | 34.68%                              | 34.48%                            | 0%                       |
|                       | Criteria: Very Good          | Bad                                 | Bad                               | Very Bad                 |
| Medium Category School| Student’s score: 270         | 85                                  | 100                               | 0                        |
|                       | Total Score: 345             | 164                                 | 168                               | 42                       |
|                       | Percentage: 78.26%           | 51.83%                              | 59.52%                            | 0%                       |
|                       | Criteria: Good               | Sufficient                          | Sufficient                        | Very Bad                 |
| Low Category School   | Student’s score: 185         | 0                                   | 0                                 | 0                        |
|                       | Total Score: 300             | 72                                  | 72                                | 4                        |
|                       | Percentage: 61.67%           | 0%                                  | 0%                                | 0%                       |
|                       | Criteria: Good               | Very Bad                            | Very Bad                          | Very Bad                 |
Based on the results obtained from the problem-solving ability test, it was obtained that the indicator of understanding the problem in high category schools was in a good category with the percentage of 87.47%. The indicator of planning the problem-solving and the indicator of implementing the problem-solving got bad category with the percentage of 34.48% and 34.48% each respectively. The indicator of rechecking the results got very bad category with the percentage of 0%. It showed that none of the students who rechecked the results correctly.

The results in medium category schools showed that the indicator of understanding the problem got good category with the percentage of 78.26%. The indicator of planning the problem-solving got good category with the percentage of 51.83%. The indicator of implementing the problem-solving got good category with the percentage of 59.52%. Moreover, the indicator of rechecking the results in medium category schools got similar result with the high category school namely very bad category with the percentage of 0% in which none of the students in the medium category schools rechecked the results correctly.

Furthermore, the indicator of understanding the problem for low category schools got the good category with the percentage of 61.67%. The indicator of planning the problem-solving, implementing the problem-solving, and rechecking got very bad category with the percentage of 0% meaning that none of students could answer correctly for the three indicators.

In the first indicator of problem-solving namely understanding the problem, the three categories of school got a good category. It showed that some students could achieve the indicator well. For example: A cat can run at speeds or run at other speeds. If the cat walk for 20 seconds and ran for 10 seconds, the cat can reach 80 m. If the cat walk 10 seconds and ran for 20 seconds, it can reach 50 m. Determine the speed of the cat when walking and running!

By that problem, the following was two figures which showed the results of the students' answers on the indicators of understanding the problem. In the figure 1, it indicated that the subjects wrote down what was known and described it correctly and completely so that they got score of 5. Then, in figure 2, the subjects showed that they wrote what was known and described incorrectly since they incorrectly wrote 'cat walks for 20 seconds and ran for 10 seconds so that the cat moves 50 m' in which the sentence should be 'the cat walks for 10 seconds and ran for 20 seconds ...' in point two.

The second indicator was planning the problem solving. The school with a high category got bad category, the school with medium category got a good category, and the school with low category got very bad category since none of the students planned problem solving. On the second problem, it was
shown how students planned to solve the problem. The second problem was as follows. Rectangular circumference is 31 cm. the difference between the two sides are $3 \frac{1}{2}$ cm. Determine the area of the rectangle $3 \frac{1}{2}$!

Figure 3 was the subject of the medium school category. The subject planned the problem-solving well. The subject wrote the strategy of problem solving correctly and completely. The third indicator was planning the problem solving. The school with the medium category got the best criteria namely sufficient criteria, the school with the high category got bad criteria, and the school with the low category got very bad criteria as none of subject made a plan to solve the problem correctly. It would be showed how the subject planned the problem solving on the third problem as follows.

An ABC triangle with the side length of AC, AB, and BC is x, y, and 2x respectively. The circumference of the ABC triangle is 14 cm, and the side length of AB side is 2 cm longer than that of AC side. Determine the length of each side of the ABC triangle!

Figure 4 showed that the subject wrote the process of problem solving correctly but incompletely as what was asked on the third questions was the length of each side of the ABC triangle. Meanwhile, the subject still looked for the score of ‘x’, and it had not been substituted yet to each of the triangle equation, namely AB, AC, and BC. The fourth indicator was rechecking the problem solving result. The three school categories had the same criteria namely very bad because none of the subjects had recheck the results correctly.

4. Conclusion
Based on the data analysis, the subjects of high, medium, and low category schools show that the students merely master the indicator of understanding problems. On the second and third indicators, namely planning the problem solving and implementing the problem solving, the subjects begin to get difficulties. No school has good criteria. Furthermore, on the last indicator namely rechecking the problem solving result, no subject writes rechecking the problem solving result correctly and completely. In conclusion, it is only one of the four indicators of problem solving that has been fulfilled. It shows that the students’ ability in solving the problems is still in the bad category.
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