Students’ mathematics problem solving ability through Model Eliciting Activities (MEAs)

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Abstract. Mathematical problem solving is an ability that is needed in the real world, especially in the field of work. Therefore, it is necessary to hone these skills from an early age. This study aims to describe the mathematical problem-solving abilities of students who learn to use MEAs. This research was conducted in class VIII at a junior high school in Bandung, Indonesia. The research method used is a qualitative approach. The instrument used was a test of mathematical problems solving and interviews. The results showed that the description of the mathematical problem-solving abilities of students who learned using MEAs, namely low category students succeeded in getting to the simple problem-solving planning stage so that the solving steps were not correct. Students in the category of being successful in problem planning but mistakenly seeing the facts in the problem, so that mistakenly made the first stage mathematical model so that students were wrong in determining the final goal of the solution. High category students succeed at the completion plan implementation stage of making the first stage mathematical model but mistakenly consider the real-world situation after the mathematical model at a later stage.

1. Introduction

Mathematical problem solving is an important aspect of mathematics which is also one of the main objectives of the school mathematics learning curriculum [1]. Mathematical problem solving emphasizes the development of students' thinking skills. Mathematical problem-solving abilities allow students to apply a variety of knowledge and skills they already have to solve problems [2] both related to school mathematics and real life. Mathematical problem solving involves cognitive processes to solve problems. Students who have been able to solve problems can make this experience as new knowledge that can be used on relevant problems or develop as a basis for more solving complex problems. This means that mathematical problem-solving skills are important to develop. Students are skilled in applying their knowledge to solve various mathematical problems in situations that are not routine.

Realizing the importance of mathematical problem-solving abilities, efforts are needed to develop and be well integrated into the learning process at school. The effort in question is teacher intervention in learning, which is expected to optimize students' mathematical problem-solving abilities in the learning process, through the connection between pedagogical knowledge and teacher expertise to decide the right way to support students' mathematical problem-solving abilities [3]. One way is to provide students with problem-solving experiences through activities to develop ideas, find problemsolving solutions, and have confidence in the solutions that have been made. The application of
learning makes it possible to provide student learning conditions to actively develop mathematical problem-solving abilities through the Eliciting Activities Model (MEAs).

In principle, MEAs use mathematics in real-world contexts to encourage students to actively build and develop mathematical models. The mathematical model that is made aims to develop students' skills in investigating the reality of problems, planning resolution strategies, developing ideas and validating solutions, whether the solutions meet the requirements of the assumptions given [4]. These activities can help students understand the problem using a conceptual system to get used to evaluate the results and the problem-solving process. Learning through the Eliciting Activities Model (MEAs) can help students explore creativity in understanding situations or develop problem-solving models and consider whether the solution strategy is good or bad and can encourage students to play an active role learning process [5,6]. Thus, MEAs can make an extraordinary contribution to the skills to use school mathematics to be applied in everyday life [7].

Developing mathematical problem-solving skills is an ever-growing and ongoing challenge. Modernization activities in the teaching and learning process can support efforts to develop mathematical problem-solving abilities. The modernization process in question can be in the form of utilizing technological developments, both online and offline. The technology challenge in the learning process has been accelerated by the Corona Virus Disease (COVID-19) pandemic hitting the world, including in Indonesia since the beginning of 2020. This pandemic has forced all sectors, including education, to change the conventional face-to-face system in schools to switch to online learning. This was done as an effort to prevent COVID-19 from spreading widely through school clusters. The use of digital technology can allow students and teachers to carry out the learning process even though they are in different places [8]. In other words, E-learning is the only option that allows the teaching and learning process to continue in any circumstances.

The collaborative use of MEAs and the use of e-learning in the teaching and learning process is expected to provide a pleasant learning experience for students, and still fulfil the goal of developing students' mathematical problem-solving abilities. With all the challenges faced in the learning process during the pandemic period, the purpose of this study was to see how the description of students' mathematical problem-solving abilities after learning to use MEAs was applied through online learning.

2. Method
This research is a qualitative case study type. The case studied was to see a description of students' mathematical problem-solving abilities after being treated using MEAs, which were applied through online learning. The qualitative data were obtained by describing the results of the students' mathematical problem-solving posttests. To get deeper information on the posttest results, a semi-structured interview was conducted. Interview data were collected by online media (Zoom, WhatsApp, or Google Meet).

2.1. Participants
This research was conducted at a junior high school in Bandung, Indonesia. The research sample was class VIII students of the 2019/2020 school year with heterogeneous characteristics and abilities. The research sample was taken using the purposive sampling technique. Two students in each group high (G10 and G6), medium (G22 and G9), and low (G8 and G2) were selected to be analyzed and interviewed. Students have been given a pretest, the majority of students have problem-solving abilities in the low category (50%), the medium category (37.5%), and the high category (12.5%). Interviewed students have good communication skills with sufficient online learning support facilities.

2.2. Procedure
Students are given a pretest and posttest of mathematical problem-solving abilities on the material of flat-sided shapes with each number containing each indicator. One of the problems in the posttest that will be discussed is how students determine the price of wall paint that suits their needs at the lowest
price. Students have been given various information needed, such as room size and various types of paint and their prices. The test instrument grid description is adjusted to the problem-solving ability indicators, namely 1) identifying known data, questioning data, sufficient data for problem-solving; 2) identify strategies that can be taken; 3) selecting and completing a mathematical model made with reasons; 4) check the correctness of the solution obtained. Guidelines for assessing students' mathematical problem-solving abilities in this study were adapted from the analytical scoring scale by Charles, Lester & O'Daffer [9].

Qualitative data were taken from the results of students' posttests that had been scored and totalled. The results of the total score are categorized into the high, medium and low categories. Subjects were taken by two students in each category, then analyzed by indicators and conducted interviews. The categories used were adopted from [10] as follows.

| Score                  | Category |
|------------------------|----------|
| X ≥ 75%                | High     |
| 55% < Score < 75%     | Medium   |
| Score ≤ 55%           | Low      |

### 3. Result and Discussion

The description of the answers to the problem-solving students of the high, medium, and low categories will generally be described on each indicator as follows.

#### 3.1. Indicator 1

Indicator 1 in questions 1a, 2a, 3a, and 4a, namely identifying known data, asking for data, the sufficiency of data for problem-solving (description). In this question, students are required to be able to describe the adequacy of the data provided in order to solve problems through the identification of known and questioned elements. The following are examples of student answers.

Figure 1. G28's answer for indicator 1.

Completeness of data:
- Room size
- Door
- Window

Figure 1 is an example of the low category student answers. In Figure 1, it can be seen that the low category students tend to write down the existing data incompletely. After being confirmed through interviews, low category students generally knew what data was contained in the problem but tended
not to write it down completely. This is because students are still confused about which data is needed to solve existing problems.

Meanwhile, students in the medium category tend to write down the existing data correctly but not completely. Students write down the size of the room and the maximum price for purchasing paint while the size of doors and windows is not written. After being confirmed through interviews, the moderate category students already knew what data was contained in the problem, but they did not write it down completely because they did not double-check what data was on the problem. Meanwhile, high category students write down the existing data correctly and completely. Students write down the size of the room, the size of the doors and windows, and the maximum price for the purchase of paint. After being confirmed through interviews, high category students generally read the problem carefully and write down what data they know and what they want to look for to make it easier for students to find solutions to problems.

3.2. Indicator 2
Indicator 2 in questions 1b, 2b, 3b, and 4b is concerning identifying strategies that can be taken (manipulation), by writing down ideas or steps that will be taken to solve the given problem. Low category students are not yet in detail and even tend to be unclear what steps will be taken to write down how to solve the problem. After being confirmed through interviews, low category students generally know the purpose of the problem but are still confused about choosing and writing about the strategy to be used.

1. Calculating the surface area of the wall
2. Add up the surface area of the wall with paint, then calculate the total cost
3. Determine the required paint according to price

Figure 2. G22's answer for indicator 2.

Steps
1. Find the surface area of the room
2. Subtract window and door sizes
3. Then divide the surface area of the room by the scattering power of the paint
4. Choose paint

Figure 3. G8's answer for indicator 2.
Meanwhile, students in the medium category (figure 2) have not completely written the problem-solving strategy. However, the students already know what steps need to be taken to solve the problem from these results. Meanwhile, the high category students (figure 3) wrote down the problem-solving strategy not much different from the medium category students. Namely, they had not written the ideas in detail yet, meaning that they already knew what steps needed to be taken to solve the problem.

3.3. Indicator 3
Indicator 3 for questions 1c, 2c, 3c, 4c is concerning solving mathematical problems using a plan or strategy made with reasons (translation).

| Size r: 6 x 6 x 3 = 90 m |
| Size P: 1x2 = 2 m |
| Size J: 2x2 = 4 m |
| Total size: 84 m |
| Mr Amin has to buy products A and B. |

**Figure 4.** G2's answer for indicator 3.

G28 low category students solve the problem using the formula for the surface area of the beam in general without considering the parts that are not used, namely the floor, ceiling, windows and doors. Students also do not write down the process from the final result looking for the paint price that matches the needs written on the answer sheet. Answer G2 (Figure 4) does not clearly state how he got this answer. After being confirmed through interviews, students G28 and G2 did not carry out a thorough review of the known data and questions of the problem so that the resolution steps were not suitable. G2 also stated that he did not fully understand the problem given, so he was just trying to write a solution like the problem of the surface area of a block in general.

When viewed from the completion step, G22 students (moderate category students) ignore important information to solve problems. This can be seen in the students' initial steps to determine the surface area of the wall to be painted. G22 students solve the problem using the formula for the surface area of a block reduced by the size of doors and windows only. Meanwhile, the problem of finding the cost of painting walls without ceilings, floors, windows and doors, but students did not reduce them with the windows and doors. If the area of the room to be painted is not suitable, then the calculations to determine the paint needed are not in accordance with the needs. After being confirmed
through interviews, G22 students did not carry out a thorough review of the information provided on the problem. The initial steps for solving it were not suitable. One of the factors that the G22 did not carry out the review was that it took too long to seek out problem-solving ideas.

\[
\text{Wall area} = \text{wall area} - (\text{door area + window area}) \\
= 2(18 + 15) - (2 + 4) \\
= 66 - 6 = 60 \text{ m}^2
\]

\[
\text{Amount of paint} = 60:12 \times 2 = 10 \text{L}
\]

The price of paint for each product:

A) Rp. 420,000
B) Rp. 294,000
C) Rp. 556,000
D) Rp. 272,000

So, the product Mr Amin should buy is D because the price is the cheapest and according to the cost.

**Figure 5.** G10's answer for indicator 3.

An example of the answer to G10 (high category student) in Figure 5 shows that the students wrote down the correct completion up to the calculation of paint product C, then in the section calculating...
product paint D students wrote \( \frac{\text{ten liters}}{3 \text{ liters/Container}} = 3.4 \) containers. Meanwhile, the paint shop sells container paints. If the results of 3.4 paint containers to be purchased are multiplied by the price of the product, the final price will be the cheapest. However, if you want to buy product D, the painting price should be multiplied by four paint containers instead of 3.3 paint containers (paint is not sold in retail). This means that students must be observant to see the information that has been given and try to consider the possibility of paint not being sold in retail. These problems allow students to pay attention to mathematical results and relate problems to real life. This was also confirmed by students who did not consider that paint products were usually sold as containers.

3.4. Indicator 4

Indicator 4 in questions 1d, 2d, 3, 4d is concerning checking the correctness of the solution obtained (verification) by explaining or concluding from the solution made based on the problem correctly and completely. Low category students did not write down the answers to indicator four correctly. Students in the medium and high categories have been able to understand the solution according to the initial problem but are not precise in the calculation; this causes the conclusions made to be less appropriate to the initial problem and incomplete. After being confirmed through interviews, low category students experienced confusion in reinterpreting the results obtained; this was because the solutions they made were also not completely appropriate. Meanwhile, students in the medium and high categories feel hesitant to interpret the results of the initial problems. Even so, students of medium and high have understood what to look for in this problem. Most students have not carried out a thorough review of known data and are less aware of the final purpose of the problem so that the written settlement steps are not appropriate.

This study was conducted to see an overview of junior high school students' problem-solving abilities after learning to use MEAs that are fully implemented online. In this study, the students involved were divided into three categories, namely high, medium and low. The findings show that students in the low category have been able to write down general ideas for solutions, but still have difficulty finding initial steps to solve the problem. This results in the problem-solving strategies carried out by students being less precise and unclear. Students' errors in understanding problems can be caused because students fail to make relevant assumptions in the situation to be modelled, and students anticipate implementing the steps required for problem-solving [11]. The results of this study also show that although there are still low category students who are not yet fully able to show ideas and problem-solving steps clearly and precisely, these errors have generally decreased compared to before the treatment. This means that low category students still need more effort in order to develop their abilities.

Meanwhile, students in the moderate category generally made mistakes in understanding the purpose of the given problem. Students have not fully analyzed the framework for the solution strategy that has been selected in the initial model of problem research. Students need to involve metacognitive behaviour in managing their own problem-solving process [12] to ensure that the initial model of solving that is made is valid or needs revision. This means that students have not fully paid attention to the facts on the problem to be represented to facilitate the completion strategy. Furthermore, high category students have been able to more clearly write down the settlement strategy that will be taken and make initial models of problem-solving correctly. However, high-category students experienced errors when making several possible models for advanced settlement. This is shown from the results of the students' completion who have not been able to fully interpret the final results with the possibility of real-world situations. In other words, students still need adaptation to problem-solving habits through consideration of real situations.

Learning MEAs facilitates real context problems that can support students' mathematical problem-solving abilities. The real context of the MEAs problem affects the construction process of solving models which emphasizes the importance of linking real-life experiences to situations that are not yet clear to provide an opportunity to consider the factors involved [6,13] in problem-solving. The
mathematical problem-solving ability of each student varies depending on the level of intellectual ability, processing experience in solving problems and other related factors. These differences contribute to success in solving problems [14]. Based on the results of the test of mathematical problem-solving abilities, it is also known that the students have mathematical problem-solving abilities. However, they are still not completely sure to consider the possible relationship between the problems and the real world. The results also showed that the advanced completion models used by high and medium categories of students were quite diverse. In other words, the need for continuous habituation of students to solve problems and consider various possible solutions.

4. Conclusion
Overall, the mathematical problem-solving abilities of students who learn to use MEAs are as follows. Low category students succeed at the problem-solving planning stage. The moderate category is successful in problem planning but mistakenly see the facts in the problem so that they mistakenly make the first stage mathematical model; thus, the students are wrong in determining the ultimate goal of completion. High category students succeed at the completion plan implementation stage of making the first stage mathematical model but mistakenly consider the real-world situation after the mathematical model at a later stage.

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