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Execution of Students' Plans in Mathematical Problems Solving

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Abstract. Problem solving is one of the skills students need to implement and elaborate mathematical concepts in building other high-level thinking skills. Problem solving skills can be developed through practicing mathematical problem solving in a way or solving more than one. In solving problems, appropriate strategies or steps are needed, which are combining concepts, as well as principles that have been learned in advance by students. The purpose of this study was to determine the students' skills in executing mathematical problem-solving plans. This study uses a qualitative approach, then the data findings are analyzed descriptively. Data were collected from 4 grade 11 students of state high schools in Jatinangor, West Java. Students are given math problems and focus group interviews are conducted. The results showed that, student work in executing problem solving plans tended to lack a lot of mathematical skills. These skills include ignoring the basic concepts and principles of calculation as well as reading the available information. In other words, students' skills in solving mathematical problems fall into the poor category. This can be caused by several factors such as inaccurate, forgetfulness, haste, surrender, and anxiety. Based on these results, it is seen that the need to design classroom learning activities that can optimize the components of students' mathematical problem-solving skills so that they can grow and develop properly.

Keywords: Mathematics education, High school, Process, Problem solving, Open problems

INTRODUCTION ~ One of the goals of learning mathematics is to encourage students to obtain ways of thinking and the ability to use facts and information that have been previously owned to solve problems Krulik at al., 2003); Musser at al., 2008). Solving problems were important in developing students' potential (Meerah, 2007), to utilized in solving problems in daily life. Through learning solving problems, students can develop positive attitudes, such as perseverance, curiosity, self-confidence, and never give up in dealing with unusual situations with all the challenges (NCTM, 2000); (Pimta & Nuangchalerm, 2009). However, there are still students who are reported to have difficulty and need a struggle in solving mathematical problems, and teachers find it difficult to teach problem solving (Tarzimah, 2010); Suherman, 2001); (Garcia at al., 2016).

Mathematical problems are interpreted as unusual problems and solutions cannot be immediately found, but can still be solved by more than one possible way or solution Polya, 1973); Posamentier & Krulik, 2009); Zeitz, 2009). Mathematical problems can be classified as open problems and closed problems. A closed mathematical problem is a procedure or result of solution which is exactly one (Bush & Geer, 1999). Whereas an open mathematical problem is a problem where the procedure or the results of completion have various possibilities (Bush & Geer, 1999). Open mathematical problems can be classified into two types, namely problems with

varying ways and results of solutions, and problems that are exactly one final result, but have a variety of alternative ways of solving. Problems that have a variety of ways of solving can encourage students to have the ability to think creatively in finding the final outcome of completion.

The problem-solving process can be carried out through different stages. Polya stated, problem solving is a process that starts from the beginning when facing problems until finding a solution to the solution (Polya, 1981). There are several stages of problem solving that can be done: 1) Constructing information and getting an understanding and idea of resolution: 2) Creating a solution and implementing it. 3) Revise and validate the process and the final results of the settlement. In carrying out the strategies that have been made at the time of problem solving, these stages are not always carried out by students, especially the validation of the solution (Prabawanto, 2019). The implementation of the settlement strategy sometimes does not match on what was planned. In implementation, there could be a change in the idea of completion which caused students to switch from the initial strategy to another strategy. Therefore, this study wants to see how students' skills in implementing the strategies that they have made and planned, whether in the way there are obstacles or changes in different ideas or remain in accordance with the initial strategy that has been set, and see whether students have built and developed alternative solutions to other solutions which allows.

METHOD

The aim of this study is to find out how the students' skills are, when students execute plans to solve open mathematical problems, so as to obtain the final results that are appropriate and satisfying. The research subjects were 4 students of 11th grade of one of high school in Jatinangor, West Java. The next four research subjects will be written with K, SPM, ES and MD.

In this study students are given an open mathematical problem with the type of having the truth of the end result only one but more than one alternative solutions. This study uses a qualitative approach, then the data findings are analyzed descriptively and interviews are also conducted in order to obtain clarity from the results obtained.

RESULTS

This research uses two mathematical open problems with the topic of circle, and students are required to be able to solve in more than one alternative way. Following are the problems given to students (table 1). In the problem of one information that is known is the equation of the circle, then asked to determine the center and radius of the circle and find other alternative solutions.

The results of the solution of problem 1a show that K, SPM, ES and MD write the

solution and how to solve it right and correctly by using the formula. Whereas in problem 1b, SPM try to find a center point using other alternatives, namely "-2a = A", and "2a = 2" so that a = -1 is obtained, then write "-2b = B" and "-2b = 4" , yields "B = 2", but SPM does not write down another way to resolve the radius. In the implementation of the predetermined plan, SPM was not sure of the alternative solutions, SPM tried to revise the alternative methods that were made until the stage SPM decided to write down the alternatives. Furthermore, MD tried to write other alternative solutions with the idea of completing squares, but the solutions written were incomprehensible and imprecise. Subject MD did not factor so that the center and radius were not obtained. In this section MD writes several times the completion of the quadratic equation, but MD does not continue because MD confused to determine the next step. In problem 1b, subjects K and ES did not write down other alternative solutions. They express ware only tried to use one strategy that they believed to be the truth and did not try to find or did alternative strategies, because they did not know how to solve other forms. They also said that they had not revised nor reviewed the solutions that had been made.

Solving problem 2a, subject K tries to solve using the equation of the circle but the method used cannot be understood. K stated that confused deciding what to do with the existing problem, trying to remember and using the method "a = -A / 2" then "A = 2.a" then obtained "A = -4", subject wrote and dabbled operating the numbers contained in the problem. SPM also did the same thing trying to use the equation of the circle but it had not yet reached the stage of correct and precise results. First, SPM determines "A = -2a" and "B = -4" then writes that "-2a = A" is a formula. Then substitute "a = $\frac{2a}{2}$" into the formula, then "-2 ($\frac{2a}{2}$) = - 2a" until get "a = 1". This final result is based on validation and consideration by SPM. SPM explained that was experimenting with possible methods to be used in the settlement. Although SPM final result is not right and correct.

Subject ES, tries to find a solution using the general equation of the circle, namely "$x - a)^2 + (y - b)^2$= 0", then substitutes the value of a with 2 which according to ES is obtained from the known equation. ES tries to find a new equation "$x^2 + y^2 + 4y +$ 29=0", but ES ignores information that the circle equation corresponds to the x-axis which means y = 0. The completion of ES has not yet found the point of truth and accuracy. Subject ES also did not revise the settlement made, subject ES focused on its calculation procedures and assumed no other strategy might be carried out again. MD subject used "A =$\frac{-2a}{2}$ " and "B =$\frac{-4}{2}$" to obtain "A = a" and "B = 2", then use the formula "r =$\sqrt{a^2 + B^2 - C}$", and states that the value of r is 2 because of the use of information that the equation pertains to the x-axis, then the value of r= y. Then MD substitutes all values into the

formula, on its way MD carries out the calculation procedure, which is obtain correct the final result but the way is incorrect. The final result of MD shows the truth and correct. MD also tries to write another alternative solution, MD has written "through the point (2.0)", the assumption is of a known equation. The solution made is not yet resolved, MD has tried to revise and validate but fails to find the right and correct results.

Table 1. Table of problems used

Problems	
1	a. A circle with the equation $x^2 + y^2 + 2x - 4y - 20 = 0$. Determine the center and radius of the circle! b. Is there any other alternative solutions to determine the center and radius of the circle? If there is, solve it that way.
2	a. Circle with the equation $x^2 + y^2 - 2ax - 4y + 9 = 0$ allude to the x axis. What is the value of a that satisfies the circle equation? b. Is there any other alternative solutions to determine the value of A in the circle? If there is, solve it that way.

DISCUSSION

The success of problem-solving activities carried out cannot be separated from the initial stages of understanding the problem and utilizing existing information, then formulate a strategy and represent the strategies made. The determining factor for successful problem solving is revising and validating the solution (Garcia at al., 2016); Montague at al., 2011); (Prabawanto, 2019). Students tend to ignore a lot of basic calculation facts and let the solution match what is desired and expected to be true and correct. Subjects tend to shut themselves down and give up looking for or try other strategies in solving the problem given. Lack of practicing problems with various types and strategies is an obstacle faced. In a hurry to solve the problem without considering whether the solution obtained has gone through the correct calculation procedure or there was a mistake in its implementation. Generally, students make changes to the completion plan, because they don't get a reasonable solution. But there are also those who try to make a strategy change but return to the original strategy again. The change in strategy has not yet met the right solution. This change was made because there was confusion about the steps that had been made and then resigned in looking for other ways that the truth was never found.

CONCLUSION

Students tend not to optimally use a lot of skills in carrying out mathematical problem solving plans. These skills include ignoring the basic concepts and principles of

calculation as well as reading the available information. In other words, students' skills in solving mathematical problems belong to the category not yet skilled enough to find alternative solutions. This can be caused by several factors such as inaccurate, forgetfulness, haste, quitter, anxiety, and lack of motivation in solving problems. Based on these results, it appears that need to design classroom learning activities that can optimize the components of students' mathematical problem-solving skills, so that they can grow and develop properly.

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