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High School Students' Mathematical Skills in Addressing Minimum Competency Assessment Problems using Working Backward Strategy

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ABSTRACT

Strategy problem-solving is a technique or method for finding answers to problems. Students' different maths skills can affect how they use and figure out ways to solve problems. This type of research is descriptive and uses a qualitative approach. Its goal is to find out and analyse how the backward working strategy is used to solve the Minimum Competency Assessment (AKM) questions on the spatial structure in terms of students' maths skills. After giving people a test of their maths skills and giving them problems to solve, they were interviewed. Students with high, medium, and low maths skills are taking part in this study. Data analysis used is data reduction, data presentation, and data retrieval. The results were based on the six students who participated in the research. Students could use Polya problem-solving steps with high and moderate maths skills, but they didn't work well for students with low maths skills. Working backwards is not a method used by everyone. The first student with good maths skills can use the strategy of working backwards from the correct answer. The second student with good maths skills can't do that. The backward plan makes few mistakes. The answer is wrong for the first student with average maths skills because they do not have a backwards strategy. The second student with average maths skills can use the backward working strategy, but they make a lot of mistakes. The first and second students with low maths have not used the backward working strategy, even though the mathematically able student has. The first low can show that the statement is true.

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1. INTRODUCTION

Problem-solving ability is an ability that must be possessed by students (Fauziah & Setiawan, 2018). Problem-solving ability can be said to be a prerequisite ability that must be possessed by students to be able to improve high-level abilities, which include creative and critical thinking skills (Rowdlotul Jannah & Wijayanti, 2021). This is in line with Safitri (2018), who says that the mathematics learning process will be of higher quality if it includes communication, problem-solving, representation, understanding, reasoning, and connections. Therefore, students will experience meaningful mathematics learning through problem-solving.

The importance of mathematical problem-solving skills is also stated by NCTM (2000), that "Problem-solving is an integral" part of all mathematics learning" which means problem-solving has the most important role in learning mathematics. This is in line with the content standards of the BSNP (2006), which says that mathematics learning focuses on a problem-solving approach where there are closed problems with a single solution, open problems with a non-single solution, and problems with various solutions. However, students' mathematical problem-solving abilities are still relatively low. This is in line with the TIMSS in 2011 Puspendik Team (2012). The results of student achievement in Indonesia at a high level only had an average percentage with a score of 2. With the results obtained, Indonesian students ranked at the bottom compared to several countries that participated in TIMSS. The highest level in the TIMSS assessment consists of reasoning, which consists of the ability to analyze, synthesize, evaluate, generalize, and solve non-routine problems. The process of solving problems from non-routine questions is a kind of problem-solving problem. This is the basis and illustrates how the problem-solving ability of students in Indonesia is still low.

One of the non-routine questions applied at the high school level is the AKM question. Minimum Competency Assessment (AKM) is a tool used with the aim of developing students' self-potential who contribute positively to society (Aisyah, 2019). There are two assessments in the AKM, namely literacy and numeracy. Numeration is a literacy that exists in mathematics. The numeracy AKM system aims to discover mathematics's role in everyday life (Dwi Cahyanovianty & Wahidin, 2021; Sari et al., 2021). Students with high mathematical abilities will be able to use various numbers and symbols to solve mathematical problems, analyze the information contained in graphs, tables, charts, etc., and take advantage of existing information to solve mathematical problems (Kurniawan & Rahadyan, 2020).

However, during implementation in the field, teachers still have difficulty guiding the solving of non-routine problems, one of which is the AKM, so it has an impact on students who are also difficult to understand and solve. The difficulty arises because solving the problem has not used the right problem-solving strategy. They solve it by using a formula. It was also said by Andinasari et al. (2019) that students rarely respond to solving problems because they are used to thinking procedurally by using formulas. In line with Aydogdu & Kesan (2014) that there are several determining factors in solving problems, one of them shows how to select and implement problem-solving strategies.

Every student needs a solution strategy to solve a problem, and a problem-solving strategy is a method used in solving a problem on a particular material (Ayuningrum, 2017). It uses prior knowledge. There are ten problem-solving strategies to be an option in solving the problems presented (Sholihah & Afriansyah, 2018). According to (Utomo, 2019), there are various problems with different characteristics, some can be solved with only one strategy, and there are also problems that can be solved with various strategies. However, what is still being debated is in determining the best and most efficient problem-solving strategies to solve problems that must be based on the experience and knowledge of students.

One of the problem-solving strategies that can be an option in learning is the strategy of working backwards (work backwards). According to Andinasari et al. (2019), working backwards begins with analyzing how to complete the goals to be achieved. By applying this strategy, the problem-solving process starts with what is known, and asked, then adjusts both to solve the problem. To solve problems involving a sequence of actions in which the final result is known but the initial conditions are not known, students automatically can effectively consider actions in reverse order. In this heuristic, students work from problems and work backwards to the initial state by reversing the conditions given in the problem until the solution is found (Amri, 2021; Riffyanti & Setiawan, 2017).

Many factors affect students' ability to solve problems, one of which is individual differences. In line with Rowdlotul Jannah & Wijayanti (2021), each student can solve problems with different strategies depending on their experience and knowledge of students. It can be concluded that there are differences in students' mathematical abilities depending on the understanding of each student's concepts and problem-solving abilities. This is in line with research conducted by Dwi Chyanovianty & Wahidin (2021) that there are significant differences in time and strategy in solving problems. Learners with a more reflective style take longer to solve problems and apply drawing strategies. Meanwhile, impulsive subjects need a faster time to solve problems and apply strategies to list all possible answers. This illustrates that the differences in the character and ability of each individual influence the selection of strategies that students will choose in solving problems.

Problem-solving is a part of the mathematics curriculum which is very important because, in the learning process as well as solutions allow students gain experience using knowledge and skills that have been has to be applied to problems that non-routine (Atsnan & Gazali, 2018; Susiana, 2018) Problem-solving in learning mathematics can interpreted as understanding the process in an attempt to solve/resolve problem, or direct goal (goal-directed) of cognitive process learning. What is meant here is a student's cognitive ability (Yuwono, 2016).

The study is about the analysis of the working backward method in answering AKM problems based on the mathematical abilities of High School Students because of this justification for its existence. This article investigates and examines the impact of teaching students to adopt backwards working strategies on their mathematical proficiency. The value of this study Solving maths problems, especially AKM issues, can be facilitated by training the mind to reason backwards. Teachers might use the working backward strategy as a supplementary method for solving mathematical problems. This research's backwards-planning approach can be employed as a training tool for students' mathematical abilities in the classroom.

2. METHODS

This research is a descriptive study using a qualitative approach, namely an overview and overall analysis of the strategies used by students in solving mathematical problems. This research was conducted in class XI of the Superior White Lion, Prigen, Pasuruan, in the even semester of the 2021-2022 Academic Year. In the preparation stage, the researchers carried out several activities, including (1) Observing schools; (2) Determining the research class; (3) Developing research instruments consisting of mathematical ability test questions, SMA AKM test questions for building space, as well as interview guide instruments; (4) Validating/testing research instruments; and (6) Analysis/improvement of research instruments if needed.

At the implementation stage, the subject is determined by giving a mathematical ability test to class XI students offline through paper. The mathematical ability test consists of 2 description questions with class XI material with a processing time of 45 minutes. Based on the student's mathematical ability test results, the researcher took 6 subjects consisting of 2 students each with high, medium and low mathematical abilities. The following are the categories of students' mathematical abilities, (Jannah & Wijayanti, 2021).

Table 1. Category of Mathematical Ability

Score	Category
85 x 100	High
85 < x 75	Medium
x < 75	Low

After 6 subjects were selected, they were given a mathematical problem-solving task for data collection. This task was carried out to find out the backward working strategy used by students in solving the AKM questions on Building Space in terms of the category of mathematical ability. Then after the research data was obtained, the researcher conducted interviews to clarify and complete the unclear information orally. This interview has been adapted to the results of the completion of the AKM questions on the Building Space material.

The results of solving the AKM questions on the Building Space material will be analyzed in order to get a picture of students' ability to solve problems based on polya-solving steps using a backward working strategy. The analysis is adjusted to the indicators of polya's problem-solving steps, including: (1) understanding the problem, (2) planning problem-solving, (3) solving problems, (4) re-examining (POLYA, 1973).

As well as indicators of the strategy of working backwards, among others: (1) Solving problems starting with the final result; (2) Move backwards to determine the initial state, (Posamentier & Krulik, 2009). In the final stage, namely data analysis, the data analysis technique used is descriptive qualitative analysis using analysis stages consisting of data reduction, data presentation, and data collection or verification (Sugiyono, 2013).

3. FINDINGS AND DISCUSSION

3.1 Finding

Based on the results of the mathematical ability test, the students who were selected to be research subjects were 2 students who had the high mathematical ability (ST), 2 students who had moderate mathematical ability (SS), and 2 students who had low mathematical ability (SR). . The following are the results of students' mathematical problem-solving that have been analyzed based on the application of the backward working strategy.

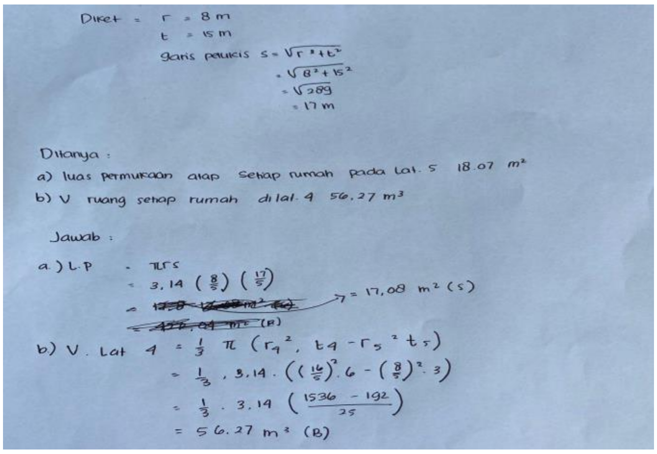

Figure 1. The results of SR1 students' work

Students are able to identify information from the questions, write down what is known, be asked, and determine the radius (r), height (t), as well as the painter's line(s). Students cannot interpret the information in the form of sketches, but each element is still inaccurate, including determining the radius (r) on each floor and determining the location of the floor on the sketch image that has been made. This causes the answer to be inaccurate. At the end of the completion, students re-check their answers. So Polya's troubleshooting steps are implemented perfectly. According to the results of the work and interviews, it was found that in determining the truth of the statement, students tried to prove the value of the radius (r) when determining the volume and the value of the diameter (d) when determining the surface area, by being proven true if the volume was 56.27^{m3} and surface area 17.08 m^2. students do not apply the strategy of working backwards but the answer is correct.

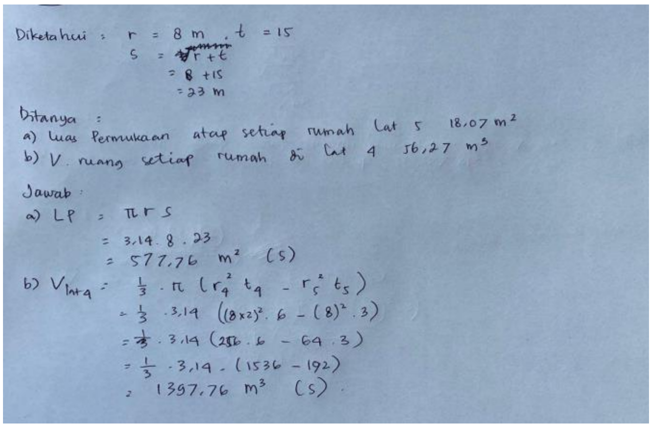

Figure 2. The results of SR2 students' work

Students were able to identify information from the questions, write what they knew, were asked, and determine the radius (r), height (t), and lines painter(s). Students interpret the information in the form of sketches, but each element is still inaccurate, including determining the radius (r) on each floor and determining the location of the floor on the sketch image that has been made. Students forgot the formula when calculating the roof surface area on the 4th floor, so students used an inaccurate formula, where the roof surface area = $\pi x r x s$ to be the roof surface area = $\pi x d x s$. The two things above make the results of the answers less precise. At the end of the completion, students re-check their answers. So Polya's troubleshooting steps are implemented perfectly. According to the results of the work and interviews, it was found that in determining the truth of the statement, students tried to prove the value of the radius (r) when determining the volume and the value of the diameter (d) when determining the surface area, by being proven true if the volume was 56.27m^3 and surface area 18.07 m^2. Although the answer to the calculation is not quite right, students are able to make the initial information, namely the final answer of the volume and surface area, as the basis for determining the truth of the values of r and d, so it can be concluded that students apply the strategy of working backwards.

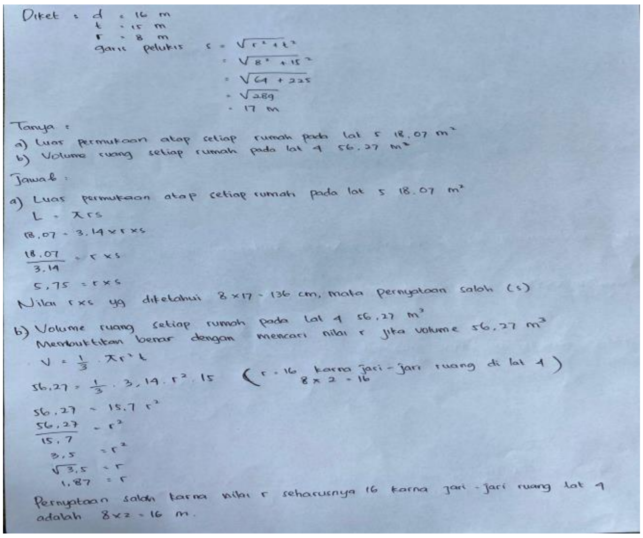

Figure 3. The results of SS1 students' work

Students who are able to classify information from the problem, then write down what is known and asked, are able to determine the radius (r), height (t), and painter's line (s) correctly, determine the formula used by correctly, and produces calculation results and concludes the truth of the statement correctly. However, from the results of the interview, it was explained that students did not re-check their answers. This shows that students applied Polya's solving steps perfectly. On the other hand, the results of interviews related to the work steps, students explained that from the values of r, s, t that were determined, they were then substituted into the formula for the surface area of the roof on the 5th floor and the volume of space for each house on the 4th floor, then calculated them. These results are used in drawing conclusions on the truth of the statement. From this explanation, it can be seen that students do not use initial information, namely the final results of the volume and surface area in the statement as a basis for solving problems, namely determining the truth of the statement, so it is concluded that students do not apply the strategy of working backwards.

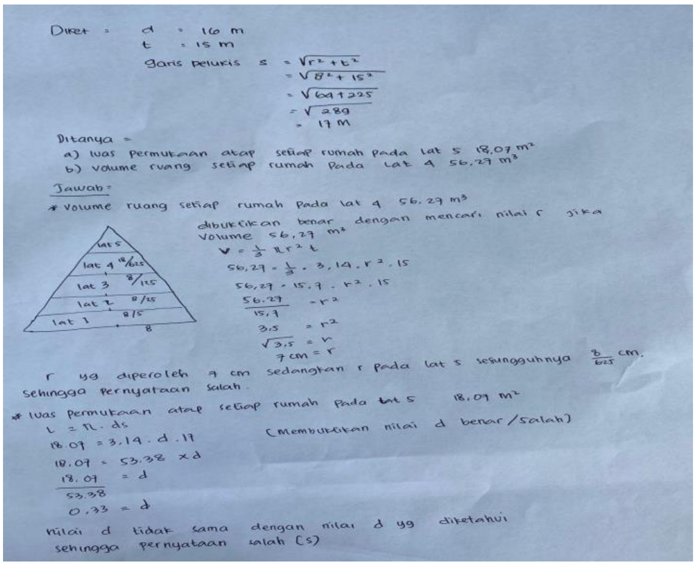

Figure 4. The results of SS2 students' work

Students are able to identify information from the problem, then write down what is known and asked, with the finger (r) and height (t) students know to look for the value of the painter's line (s), but it is not precise in determining the formula $painter's\ line\ (s) = radius\ (r) + height\ (t)$, whereas it should be $s = \sqrt{r^2 + t^2}$. From these results, the value of the surface area will also be less precise. In addition, in determining the volume, students have been unable to find or determine the value of the radius (r) of the 4th and 5th floors. Thus, it results in an inaccurate volume. The results of the interviews are related to the work steps. Students explained that the determined values of r, s, and t were then substituted into the formula, and then calculated. From this explanation, it can be seen that students do not use initial information, namely the final results of the volume and surface area, in the statement, as a basis for solving problems, so it is concluded that students do not apply the strategy of working backwards.

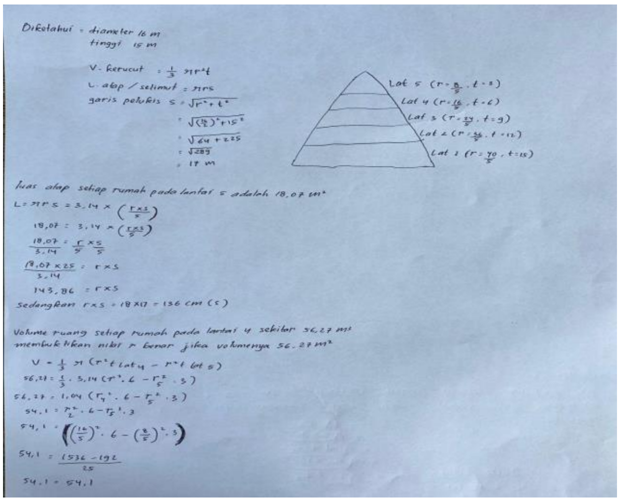

Figure 5. The results of ST1 students' work

Students are able to identify information from the problem, write down what is known, be asked, and determine the radius (r), height (t), and painter's line (s). Students can interpret the information in the form of a sketch, and it is correct. At the end of completion, students re-check their answers. So Polya's troubleshooting steps are implemented perfectly. According to the results of the work and interviews, it was found that in determining the truth of the statement, students tried to prove the value of the radius (r) when determining the volume and the value of the diameter (d) when determining the surface area, by being proven true if the volume was 56.27^{m3} and surface area 17.08 m^2. Students are correct in determining the radius and line of the painter. Students are able to make the initial information, namely the final answer of the volume and surface area, as the basis for determining the truth of the values of r and d, so it can be concluded that students apply the strategy of working backwards, and the answer is correct.

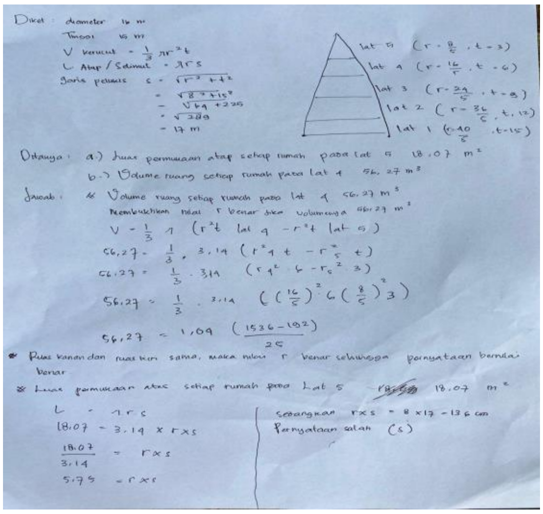

Figure 6. The results of ST2 students' work

Students are able to identify information from the problem, write what is known, be asked, and determine the radius (r), height (t), and the painter's line (s). Students can interpret the information in the form of a sketch, and it is correct. At the end of completion, students re-check their answers. So Polya's troubleshooting steps are implemented perfectly. According to the results of the work and interviews, it was found that in determining the truth of the statement, students tried to prove the value of the radius (r) when determining the volume and the value of the diameter (d) when determining the surface area, by being proven true if the volume was 56.27^{m3} and surface area

17.08 m^2. Students are less precise in determining the radius and line of the painter so the final answer is less precise backwards but they are a little less precise in the second question

3.2 Discussion

Based on the results of research that has been done, each student is able to use the strategy of working backwards in solving problems, and some are not. Of the six students who were used as research subjects, all students were able to apply the steps to solving the POLYA problem. Students can organize the information that is known from the problem well, making it easier to solve problems. So that in this case, students can be said to be able to understand the problem well. This is in accordance with the opinion of Shidiq & Choiri (2019) that with students being able to organize the information that is known in the questions, students will more easily understand what is happening in the questions. From the results of problem-solving and interviews, only students with high and medium mathematical abilities were able to apply the POLYA solution steps perfectly.

The first high-ability student can interpret the known information as a sketch image. And students can prove the truth of the statement through initial information in the form of known volume and surface area. Students try to prove the radius and the painter's line are correct. If students can prove the truth of the value of the radius and the painter's line, then students will also be able to prove the truth of the volume and surface area of the figure. Based on the activities carried out by students with high mathematical abilities, they have implemented the strategy of working backwards. This fulfils the indicators of the backward working strategy according to Posamentier & Krulik (2009), namely: (1) Solving problems starting with the final result; (2) Moving backwards to determine the initial state.

The second high-ability student can interpret the known information in the form of a sketch image. And students can prove the truth of the statement through initial information in the form of known volume and surface area. Students try to prove the radius and the painter's line are correct. If students can prove the truth of the value of the radius and the painter's line, then students will also be able to prove the truth of the volume and surface area of the figure. However, from the completion steps taken by the second student, some are not quite right, affecting the acquisition of the final answer. Based on the activities carried out by students with high mathematical abilities, the second has implemented the strategy of working backwards even though the final results are still not quite right. This fulfils the indicators of the backward working strategy according to Posamentier & Krulik (2009), namely: (1) Solving problems starting with the final result; (2) Moving backwards to determine the initial state.

Students with moderate abilities first did not interpret the information known through sketch images. And students can prove the statement's truth through initial information in the form of known volume and surface area. Students try to prove the painter's radius and line are correct through known volume and surface area. If students can prove the truth of the value of the radius and the painter's line, then students will also be able to prove the truth of the volume and surface area of the figure. However, when proving that volume is true, students use an inaccurate value of radius. Based on the activities carried out by students with moderate mathematical abilities, they have applied the strategy of working backwards even though there are steps that are not quite right. This fulfils the indicators of the backward working strategy according to Posamentier & Krulik (2009), namely: (1) Solving problems starting with the final result; (2) Moving backwards to determine the initial state.

Students with moderate abilities can interpret the information that is known in the form of sketches. Students have not been able to prove the truth of the statement through initial information in the form of known volume and surface area because students are less precise in using the surface area formula and less precise in proving the value of the radius (r). however, the activities carried out by students with moderate mathematical abilities have already implemented the backward working strategy even though there are steps that are not appropriate. This fulfils the indicators of the backward working strategy according to Posamentier & Krulik (2009), namely: (1) Solving problems starting with the final result; (2) Moving backwards to determine the initial state.

Then, the students with the first low mathematics ability have not been seen to use the backward working strategy even though the answers obtained by the students are correct. However, it does not solve the problem of the final result known in the statement (volume and surface area). Meanwhile, students with second-low mathematical ability have not used the backward working strategy and the results of problem-solving obtained are not correct. This is because the second low mathematical ability student did not do the 4th polya step, which is to double-check the work steps and answers that have been done. This is in line with the opinion (Nugraha & Zanthy, 2020) that students with low abilities do not understand the problem well, so when implementing problem-solving strategies, students are not maximal in implementing them.

4. CONCLUSION

Based on the study's results, the researchers found two students who were good at maths, two who were average at maths, and two who were bad at maths. From the results of working on AKM questions and interviews, researchers can conclude that from the six students who were used as research subjects, students with high and medium mathematical abilities were able to apply polya problem-solving steps, while students with low mathematical abilities had not been able to apply them well. The results of the analysis and interviews had to do with how the six students who were used as research subjects used the working backward strategy. Not all of them used the strategy of "working backwards." The first student with high maths skills can work backwards to get the right answer, and the second student with high maths skills can work backwards with few mistakes. The answer is wrong for the first student with average maths skills because they do not have a backwards strategy. The second student with average maths skills can use the backward working strategy, but they make a lot of mistakes. The first and second students with low maths have not used the backward working strategy, even though the mathematically able student has. The first low can show that the statement is true.

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