

STUDENTS' PROBLEM-SOLVING ABILITY IN SOLVING MATHEMATICAL PROBLEMS BASED ON POLYA'S METHOD AS A CRITERION FOR MEASURING LEARNING RESULTS

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Abstract:

This study aims to describe students' mathematical problem-solving ability in solving story problems. The type of research used in this study is qualitative descriptive research. This research was carried out at STKIP Paris Barantai Kotabaru. The research subjects were two students in semester V with low academic ability. The researcher chose the subject because the student received lecture material about problem-solving. What was found from the scores of the student's middle and final test results, there were still students who obtained a score below 50. Data collection was carried out using written tests, interviews, and documentation. The research results related to the subject's mathematical problem-solving ability are still very lacking. It can be seen from the four problem-solving stages: (1) Understanding the problem, the two research subjects in the first question still had difficulty understanding the problem; (2) Devising a plan, both subjects applied specific strategies that were not appropriate; (3) Carrying out the plan, there were still errors in the calculation operation process, so it was wrong to find answers; and (4) Looking back, S1 did not try to carry out this stage, while S2 tried to carry out the re-examination stage even though the answer results were incorrect.

Keywords: Problem Solving, Polya's Methods

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INTRODUCTION

Widodo & Ikhwanudin (2018) said that the problem is a gap between hope and reality. It was based on the definition of error, namely deviations from those that should be appropriate and deviations previously determined (Fajriani & Permana, 2021). The problem was said to be over if one could overcome the gap. In this case, expectations already correspond to reality. In mathematics education, mathematics problems are usually in the form of math questions or issues that must be answered or done by students.

Fadilah & Bernard (2021) argued that problem-solving was a process of overcoming difficulties encountered to achieve the desired goal. Siwono (Yanti et al., 2018), argued that problem-solving was a process or effort by an individual to respond to



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or overcome obstacles when an answer or method of the answer is not yet apparent. Problem-solving in mathematics was an activity used to find solutions to mathematical problems faced by students by using all the mathematical knowledge possessed (Căprioară, 2015). Mentioned that problem-solving is an individual process of using previously existing knowledge, expertise, and understanding to fulfill requests for existing problems (Tohir et al., 2022).

Akhsani & Jaelani (2018) argued that in solving problems, it was important that complex rules or high-level rules could be achieved after mastering defined rules and concepts. Tohir et al. (2020) reported that a mathematical problem contained mathematical concepts requiring an indirect process to solve. Problem-solving was the essence of mathematics education. Accordingly, every student acquired problem-solving skills (Barham, 2019).

Phonapichat et al. (2014) said that Many scholars had studied mathematical problem comprehension. Brueckner & Grossnickle (1947), Suydam & Weaver (1977), and West (1977) have learned about difficulties affecting mathematical problem-solving. The biggest obstacle was the lack of reading, computational and mathematics skills. When students cannot understand the text, they cannot start the thinking process to solve the problem. Students know only limited keywords or technical terms. They lack interest in mathematical problems due to the length and complexity of the problem. Some scholars also studied the relationship between reading comprehension and mathematics achievement problems, such as Inoa et al. (2014), and Greisen et al. (2021). A study of indicators affecting mathematics study showed that a critical factor was reading (Kaleli-Yilmaz, 2015; Yüksel, 2014). Spooner et al. (2017) To solve a mathematical problem, students need reading skills, especially reading comprehension and text analysis.

In general, the problem-solving strategy that is often used is the strategy proposed by Polya (Tohir et al., 2020). According to Poyla, to make a problem easier to understand and solve, it is first compiled into simple problems, then analyzed (looking for all possible steps to be taken), and finally synthesized (checking the correctness of each step taken). At a certain level of the problem, the Polya steps above can be simplified into four stages: understanding the problem, devising a resolution plan, executing the plan, and looking back.

The mathematics problem-solving course is one of the courses taught in the Bachelor (S1) program majoring in Mathematics education STKIP Paris Barantai Kotabaru. The aim of this course is that students can explain the meaning of problems, learn methods and techniques for solving mathematical problems in studying mathematical problems, and solve various topics. From the students' middle and final test scores, there were still students who got below 50, which meant that the student's academic ability was relatively low. It showed that there were still students who had not obtained maximum learning results.

Observations made during classroom learning supported it. Some students still lacked an understanding of mathematical concepts and had difficulty interpreting problems given to them. The essential thing in learning mathematics was the evaluation results of the learning and the student's understanding of each material. In doing math problems, of course, not all get perfect results. Only some students got high scores, while others got medium or low scores and some couldn't solve the problem in the question.

Several studies on students' problem-solving abilities were conducted (Adibah, 2022; Albab et al., 2017; Apriani, 2018). Apriani (2018) researched the Mistakes of Elementary School Teacher Candidates in Solving Mathematical problem-solving. The results showed that 13 students experienced errors in understanding problems, 17 students experienced errors in devising the plan, four students experienced errors in implementing plans, and eight students experienced errors in looking back at the process and results. Akhsani & Jaelani, (2018) researched Improving Students' Mathematical Problem Solving Ability through the Snow Ball Throwing Method in the Graph Theory Course. The results showed that students' problem-solving ability through the Snowball Throwing Method in the graph theory course had increased from the first cycle to the second cycle. While Adibah (2022) researched the Analysis of Student Errors in Solving Transformation Geometry Problems, the results showed that students still made factual and procedural errors in solving transformation geometry problems.

This research focuses on the problem-solving ability of students with subjects with low academic ability. This study aims to determine students' problem-solving skills based on the 4 Polya steps. And it is expected that later what is the findings in this research can be evaluation material for future learning, especially problem-solving courses. It is on this basis that encourages researchers to try to conduct research with the title "Mathematical Problem-solving Ability in Semester V Students of STKIP Paris Barantai Kotabaru".

RESEARCH METHODS

This research is included in qualitative descriptive research. It is called qualitative research because the dominant activity in this research is to observe, understand the meaning and analyze. The thing described in this study is students' ability to solve mathematical problems. This description is based on direct observation and the analysis of student test results. In this study, the subject of the study was 5th-semester mathematics education students, and the research subject was selected for as many as two students. The two subjects of this study were students categorized as low (R) based on academic ability in terms of the middle and the final scores test results.

The research instruments that will be used are as follows: (1) Tests are carried out to determine students' mathematical problem-solving abilities. The test in this study is in the form of a written test in the form of non-routine story questions; (2) Interviews and interviews are conducted to test the validity of students' written answers to the problems given so that a description of mathematical problem-solving abilities is obtained based on the student's cognitive style. The stages of solving the problem are not all apparent from the solution made by the student, and not everything in the student's mind is written on the answer sheet, such as devising the plan and looking back at the results obtained. This step, however, can be considered. Structured interviews were conducted using clinical interviews and audio recordings to process unwritten data; and (3) Documentation, documentation in a study is essential because documentation has a role as evidence that the research happened. When a researcher conducts field research, documentation is taken in images, videos,

notes, transcripts, and so on. Triangulation was used to test the validity of data collected through observations, test results, and interviews.

The technique of checking the validity of the data used is triangulation methods. Triangulation of the method is carried out by comparing test result data and interview result data. The data analysis refers to data analysis according to Miles and Huberman (Sugiyono, 2017), namely data reduction, data display (data presentation), and conclusion drawing/verification.

The data analysis technique was carried out by analyzing the results of students' answers using the Polya steps (Tohir et al., 2020). The four steps include;

1) Understanding the problem

The troubleshooter should determine what is known and asked in this first step. Important notes can be made to help problem solvers understand the problem and get an overview of its solution. The records can be in pictures, diagrams, tables, graphs, or others. The problem-solving process will have a clear direction by knowing what is known and asked.

2) Devising a plan

To be able to resolve the issue, the troubleshooter must be able to find the relationship between the data to the one in question. The theorems or concepts learned are combined in such a way that they can be used to solve the problems encountered. As a result, rules are required to ensure that no alternative is overlooked during the problem-solving process. If necessary, the troubleshooter should follow the steps below.

a) collect data/information by attributing the specified requirements for analysis.

b) if necessary, analysis of information obtained using analogies of problems that have been solved

c) if it turns out to be "stuck", it needs to be helped to look at the problem from a different angle.

3) Carrying out the plan

Based on the plan, the planned problem-solving is implemented. In solving the problem, each step is checked, whether the step is correct or not. The results must be tested to determine whether they are the results sought.

4) Looking back

The stage of looking back at the acquired troubleshooting results is probably the most crucial part of the troubleshooting process. Once the completion results are obtained, they must be reviewed and double-checked to ensure that no alternatives are overlooked., e.g., through

a) Looking back at the results

b) look back at the reasons used

c) find other results

d) using the results or methods used for other problems

e) reinterpreting the problem

f) interpreting the results

g) solving new problems

RESULTS AND DISCUSSIONS

Before conducting research, preparations are made, one of which is validating learning devices and instruments by validators to determine whether learning devices and instruments are suitable for a study. The results of expert validation must be considered. Expert validation results are used to revise learning tools and research instruments.

The aspects considered in validating the learning outcomes test are the content, answer scoring guidelines, and language.

Table 1. Summary of Learning Outcomes Test Validation Results

No.	Assessment Aspects	\bar{x}	Information
1.	Content	3.9	Valid
2.	Scoring guidelines	3.9	Valid
3.	Language	4.0	Very Valid
Total average rating (\bar{x})		3.9	Valid

The average score of the total validity of the study result test obtained is = 3.9. Based on the established validity criteria, this value falls into the "valid" category ($3.00 \leq SP < 4.00$). As a result, the learning outcomes test is declared to meet the validity criteria in all aspects.

The interview guidelines made by the researcher before obtaining the final score from the validator are the result of revisions based on the suggestions of the validator. Based on the assessment of interview guidelines obtained from validators 1, 2, and 3 that have been set, the interview guidelines are stated to be usable.

The following are presented the results of student answers. Researchers gave tests to students with as many as three questions, namely:

1. Mrs Nety went to the market to buy meat and spent $\frac{1}{4}$ of the money. Then she bought fruit and paid $\frac{1}{3}$ of the remaining money, and then she paid $\frac{1}{2}$ of the remaining money to buy her husband's shirt. After that, the remaining money was Rp. 30.000.-, how much money did Mrs Nety bring before going to the market?

Subject 1

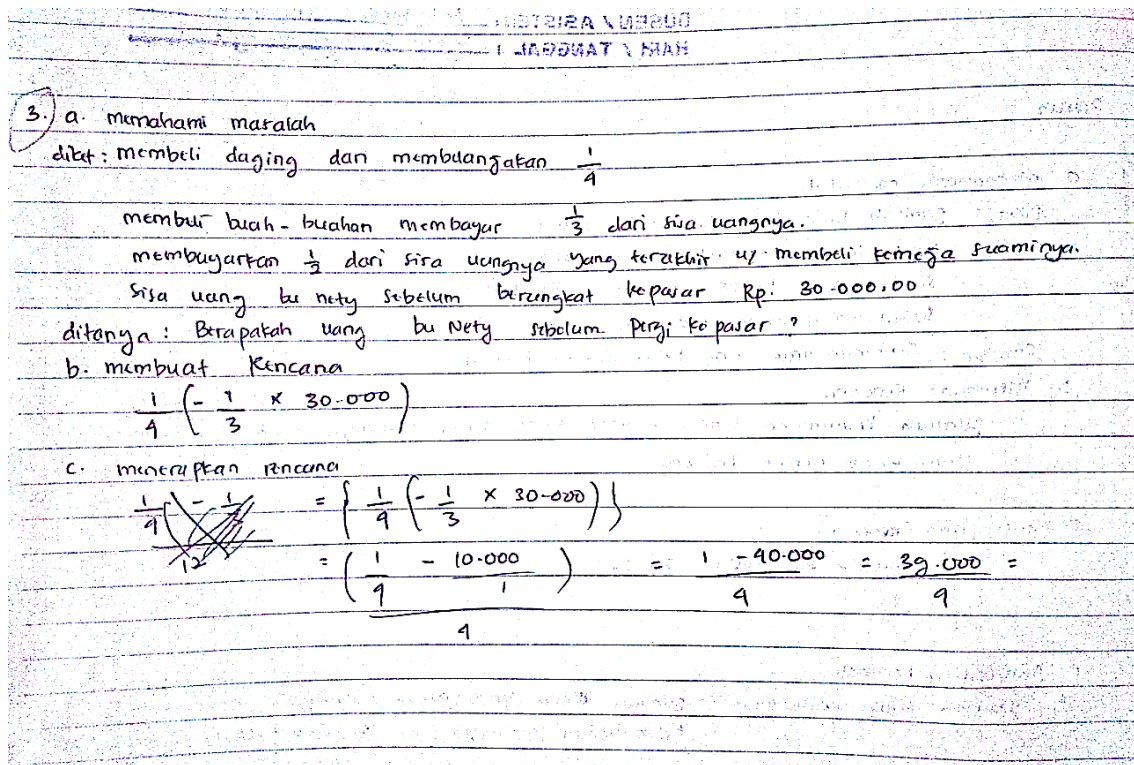


Figure 1. Student Answer of S1

(1) Understanding The Problems

a. Written test analysis

Based on the written test analysis, S1 is incorrect in determining what is known and correct in deciding what is asked correctly and according to the question.

b. Analysis of interview excerpts

Q : Did you understand question number 3?

S : Yes, I did, Miss

Q : What is known from this question?

S : Mrs Nety buys meat and spends 1/4 of her money, buys fruit, and pays 1/3 of the remaining money, she pays 1/2 of the last remaining money to buy her husband's shirt, and the remaining money is Rp. 30.000 before going to the market

Q : Thus, does it mean that the money Mrs Nety brought to the market was Rp. 30.000?

S : Yes Miss

Q : What is being asked?

S : Mrs Nety's money when going to market

(2) Devising a plan

a. Written test analysis

Not writing the formula correctly or not presenting the correct sequence of steps for solving it.

b. *Analysis of interview excerpts*

Q : Is there a relationship between what is known and what is asked in the questions?

S : Yes, Miss

Q : What is it?

S : Determine how much money Mrs Nety has when she goes to the market with what is known in the problem

Q : Have you come across questions like this before?

S : I Forgot, Miss. hehe

Q : What steps or plans were made to solve the problem?

S : I operate on what is known in the problem

(3) Carrying out the Plan

a. *Written test analysis*

Because S1 is wrong in step 2, namely devising a plan, automatically, in step 3 S1, the settlement procedure is incorrect, so it is wrong to find the answer.

b. *Analysis of interview excerpts*

Q : How does the procedure work? Try to explain!

S : $\frac{1}{4}$ times $\frac{1}{3}$ times 30.000

Q : Your answer is multiplied by $-\frac{1}{3}$. Try to explain why?

S : Because it's reduced by another $\frac{1}{3}$ of the remaining money Miss

(4) Looking back

Written test analysis

Based on the written test results above, S1 did not carry out the looking back stage.

Subject 2

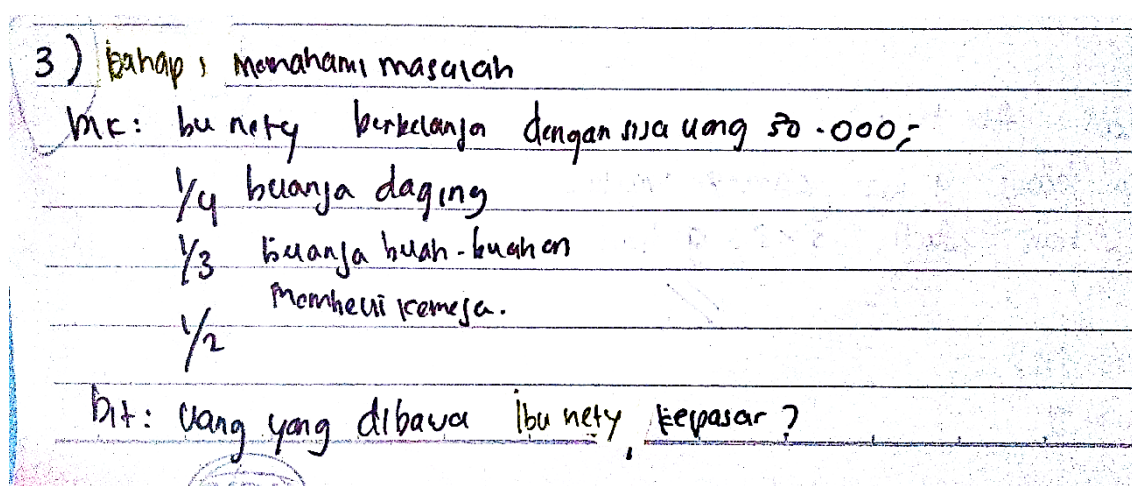


Figure 2. Student Answer of S2

tahap 2 Membuat Rencana Penyelesaian.
 tambahkan seluruhnya x soal dengan sisa uang keranjang.

tahap 3 Merencanakan rencana

$$\frac{1}{4} + \frac{1}{2} + \frac{1}{2} = \frac{9}{12} + \frac{6}{12} + \frac{6}{12} = \frac{21}{12}$$

$$\frac{21}{12} \times 30.000 = 525.000$$

tahap 4 penyesuaian kembali

$$\frac{1}{4} \times 525.000 = 131.250$$

$$\frac{1}{2} \times 525.000 = 262.500$$

$$\frac{1}{2} \times 525.000 = 262.500$$

	130.000
	195.000
	325.000
	65.000
	390.000

Figure 3. Student Answer of S2

(1) Understanding The Problems

a. Written test analysis

Based on the analysis of the written test above, S2 was wrong in determining what was known and was correct in deciding what was asked correctly by the questions.

b. Analysis of interview excerpts

Q : Did you understand question number 3?

S : Yes, I did, Miss

Q : What is known from this question?

S : Mrs Nety goes shopping with 30.000, 1/4 of her money to buy meat, 1/3 of the remaining money to buy fruit, then 1/2 of the remaining money to buy her husband's shirt

Q : Thus, does it mean that the money Mrs Nety brought to the market was Rp. 30.000?

S : Yes Miss

Q : What is being asked?

S : How much money does Mrs Nety have when going to the market?

(2) Devising a plan

a. Written test analysis

Did not write down the planned completion steps to solve the problem properly

b. Analysis of interview excerpts

Q : Is there a relationship between what is known and what is asked in the questions?

S : Yes, there is, Miss

Q : Try to explain what it is!

S : Looking for the results that are asked must be from what is known

Q : Have you come across questions like this before?

S : Yes, Miss

Q : What steps or plans were made to solve the problem?

S : add $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$ then multiply by 30.000

(3) Carrying out the Plan

a. Written test analysis

Because S2 is wrong in step 2, namely devising a plan, automatically, in step 3, S2 is wrong in finding the answer

b. Analysis of interview excerpts

Q : Try to explain the process of working on question number 3!

S : I add $\frac{1}{4}$ $\frac{1}{3}$, $\frac{1}{2}$, I multiply the result by 30.000

Q : I see you are still wrong in adding up $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$

S : Yes, Miss, I'm not concentrating

(4) Looking back

a. Written test analysis

Based on the results of the written test above, S2 tries to carry out the stage of looking back

b. Analysis of interview excerpts

Q : What is the conclusion from question number 3?

S : Mrs Nety's money when going to the market was 390,000, Miss

Q : Are you sure about the steps and answers?

S : In my opinion, Miss, the answer is like that

Q : What was done to check the correctness of the answer?

S : I multiply $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$ by 390.000, then I add up the results again

2. In the housing complex, three security guards were carried out on patrol. Patrol A is on duty once every two days, Patrol B every three days, and Patrol C every four days. They keep patrol together on Mondays. On what day can they carry out patrol together again?

Subject 1

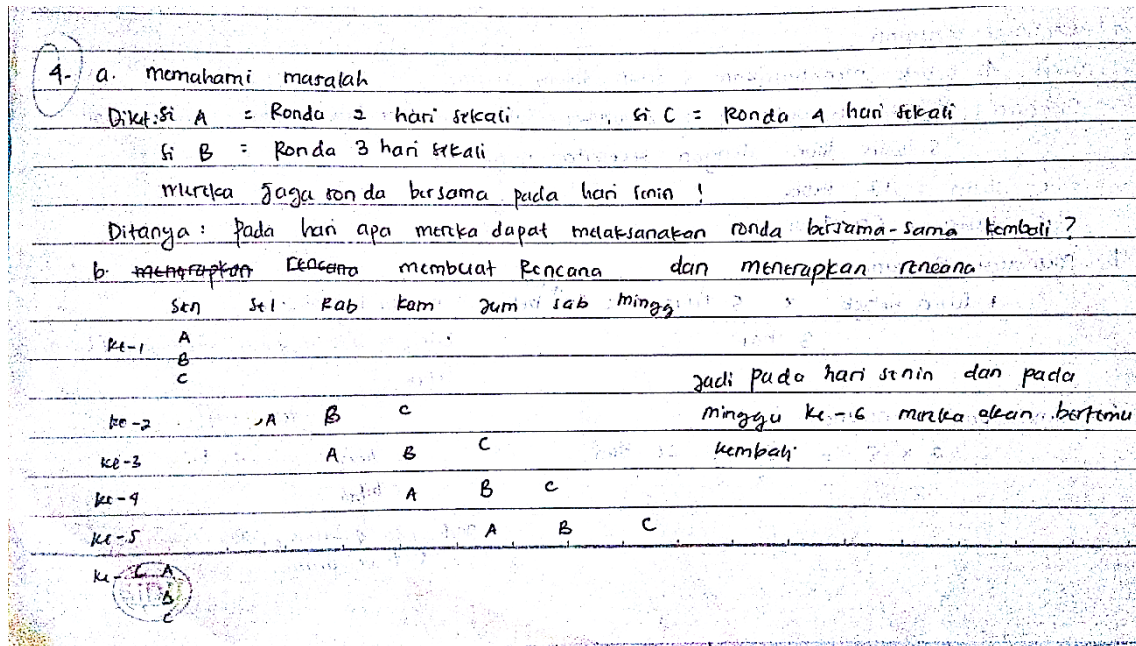


Figure 4. Student Answer S1

(1) Understanding the Problem

a. Written test analysis

Based on the written test analysis, S1 can determine what is known and asked correctly by the questions.

b. Analysis of interview excerpts

Q : What is known about this problem?

S : A keeps every two days, Miss. B once every three days and C once every four days, and they carry out together on Monday

Q : Then what is asked in this question?

S : On what day do they carry out together

(2) Devising a Plan

a. Written test analysis

S1 experienced an error at the stage of planning a solution. In this second stage, S1 should determine the least common multiple from 2, 3, and 4.

b. Analysis of interview excerpts

Q : How do you solve it? What steps do you use?

S : I made a list of them patrolling together, starting on Monday

(3) Carry out the Plan

a. Written test analysis

Because S1 was wrong in step 2, namely devising a plan, automatically, in step 3, S1 was wrong in finding the answer.

b. Analysis of interview excerpts

Q : How does the procedure work? Try to explain!
 S : From what is known about joint patrols on Mondays, A keeps every two days Miss, B every three days, and C every four days, so I start counting on Mondays, Miss.

(4) Looking back

a. Written test analysis

Based on the results of the written test above, S1 wrote the conclusion of the problem but did not do it in the stage of looking back at the results obtained.

b. Analysis of interview excerpts

Q : Are you sure about the answers you got?
 S: Yes, Miss, they will meet again on Monday
 Q : Why are the calculations not rechecked:
 S : I'm Sure, Miss

Subject 2

1) tahap 1 memahami masalah.

Dik: si A = 2 kali sehari. ronda. } hari senin ronda bersama
 " B = 3 " " " " " " " }
 " C = 4 " " " " " " " }

Dit: kapan mereka bertemu ronda bersama lagi.

tahap 2 membuat penyelesaian.

si A + B + C + ronda bersama = jumlah keseluruhan.

tahap 3 penyelesaian.

2 + 3 + 4 = 9 hari ronda masing.
 ditambah 1 hari ronda bersama.
 9 + 1 = 10 hari

tahap 4 pemeriksaan kembali
 10 hari dari hari senin adalah hari Rabu
 jadi mereka akan ronda bersama pada hari Rabu

Figure 5. Student Answer of S2

(1) Understanding the Problem

a. Written test analysis

Based on the written test analysis, S2 can determine what is known and what is asked correctly and correctly by the questions.

b. Analysis of interview excerpts

Q: What is known about this problem?

S: A keeps patrol every two days, B every three days, and C every four days, and together on Mondays

Q: Then what is asked in this question?

S: When will they keep patrolling together again?

(2) Devising a Plan

a. *Written test analysis*

S2 encountered an error at the planning stage of the solution. In this second stage, S2 should determine the least common multiple of 2, 3 and 4

b. *Analysis of interview excerpts*

Q: How do you solve the problem? What steps do you use?

S: I have the number of days they patrol, Miss

(3) Carrying out the Plan

a. *Written test analysis*

Because S2 is wrong in step 2, namely devising a plan, automatically, in step 3, S2 is wrong in finding the answer

b. *Analysis of interview excerpts*

Q: What is the completion process? Try to explain!

S: Thus, from the number of times they patrol, I will add up Miss, the result is 10, then I count the days starting from Monday, ten days from Monday to Wednesday, Miss

(4) Looking back

a. *Written test analysis*

Based on the results of the written test, S2 carried out the stage of looking back, but the results of the answers were wrong

b. *Analysis of interview excerpts*

Q: Are you sure about the answers you got?

S: Yes, Miss

Q: On your answer sheet, you wrote down the stages of looking back, but why are only the conclusions written down? Check back the stage that was not done!

S: I'm confused about the stage of checking the return, Miss

Based on the results of the written test analysis and interview results, the problem-solving abilities of the two subjects can be described as follows; For the first question of S1 and S2, there are still errors, namely, wrong in determining what is known at the stage of understanding the problem. S1 and S2 are not careful in interpreting or understanding the sentence in question. The result is consistent with the research findings of Arumiseh et al. (2019). Students do not understand the meaning of the questions well, do not understand what is asked in the questions, and are not used to mentioning what is known and asked in the answer sheet, according to their research findings. For the devising planning stage, S1 did not write down the formula correctly, the complete sequence of steps was also wrong, and S2 did not write down the solution steps. At this stage, S1 and S2 still have difficulty determining how to solve the problem correctly. For the stages of carrying out the plan, the S1 and S2 plan, the complete procedure is incorrect, so

the answer is wrong. For the stage of looking back, S1 does not carry out the review stage, while S2 tries to do this stage.

For the second question, both S1 and S2 have determined what known is and what asked is. An error occurred in writing down the formula for the planning stage of completing S1 and S2. S1 and S2 still have difficulty integrating concepts or previous knowledge. It is suitable for research with the topic; the ability of students to understand problems is greatly influenced by knowledge from material concepts previously owned by Zayyadi et al. (2019). It is also suitable to Saparwadi (2022) that problem-solving carried out by students at least involves an assimilation scheme; this is one of the main prerequisites for students to learn and interpret the given story. For the implementation stage of the plan, because S1 and S2 were wrong in the previous step, the process is automatically wrong in finding answers.

Students' lack of familiarity with problem-solving problems makes it difficult to solve these problems (Gulacar & Fyneweever, 2010; Nugraha & Zanthi, 2019). Judging from the results of the answers and interviews, the two subjects that are the focus of the research are still seriously lacking in mathematical problem-solving skills. It can be a collective reflection because students' low ability to solve mathematical problems is prone to the ineffectiveness of the learning process in the classroom (Collins et al., 2018; Hung, 2011; Mushlihuiddin, 2018; Zimmerman, 2013).

CONCLUSIONS AND SUGGESTIONS

Based on the research results obtained on the two students, the mathematical problem-solving abilities of the two research subjects were still lacking. It is shown from the analysis of the answers and subject interviews. For the understanding problem stage, the two research subjects in the first question still had difficulty understanding the problem, and the interpretation of the problem was incorrect for the given problem. For the planning stage of completion, the two subjects implemented specific strategies that were not appropriate or could be said to be missteps. There are still errors in the calculation operation process for the stage of carrying out the plan, so it is wrong to find answers. In the rechecking stage, S1 did not try to carry out this stage, while S2 tried to carry out the rechecking stage even though the answers obtained were wrong.

Students should be given a lot of varied questions and do a lot of practice questions. It is necessary to emphasize the basic concepts in mathematics to improve students' ability to solve mathematical problems.

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