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Students' Mathematical Problem Solving Ability in Arithmetic Rows and Sequences in Grade VIII Junior High School

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Abstract: *This study aims to evaluate the mathematical problem-solving ability of eighth grade students of SMP Negeri 1 Bitung. This study is qualitative. The research methodology includes the planning stage, the implementation stage, and the data analysis stage. The selection of research volunteers was carried out by grouping them into three ability categories: high, medium, and low. Information on students' mathematical problem-solving abilities was obtained through exam results and interviews. The verification of the validity of the data used was technical triangulation. The findings of this study indicate that high-ability students are comprehensively involved in the problem-solving stages described by Polya, namely by effectively executing the process of understanding the problem, formulating the plan, implementing the plan, and verifying it. Medium-ability students did not complete the problem-solving stages described by Polya, because they were only able to understand the problem and verify the solution. Low-ability students did not complete the problem-solving stages described by Polya, especially not being able to understand the problem, not being able to formulate a plan, being able to execute the plan, and not being able to verify the solution.*

INTRODUCTION

Education is the most important thing in life, inseparable from human existence, and very important in the context of individual, family, and national identity. The importance of education requires its implementation in the most effective way to achieve the desired results. In addition, education is an important aspect of nation-building. The progress or retreat of a nation depends on its education system (Anwar, 2013; Azizah, 2016). According to Article 3 of the Constitution of the Republic of Indonesia No. 20 of 2003, curriculum developers must understand and implement educational objectives to empower all Indonesian citizens to develop into quality individuals to respond to the challenges of the ever-changing times proactively. Mathematics is an important component of the school curriculum, significantly affecting daily life and advancing science and technology (Chotimah, 2014; Lahinda, 2015).

Yuwono et al. (2018) stated that mathematics plays an important role in life, facilitating students' ability to analyze problems logically and systematically and in daily activities. Mathematics education must be emphasized in schools to foster students' critical thinking, systematic reasoning, and problem-solving skills (Rofiqoh, 2015; Mairing, 2018). In mathematics, problem-solving skills are important for individuals pursuing advanced mathematics education and those applying mathematics to other disciplines and real-life situations (Siahaan, 2017; Satriani, 2020). In mathematics, problem-solving abilities are important not only for individuals pursuing advanced mathematics education but also for those who apply mathematics to various disciplines and everyday situations. Sumarmo defines problem-solving ability as an activity or process that is carried out to overcome existing challenges in order to achieve the desired results (Sulasamono, 2012; Harahap & Edy, 2017). Sumartini (2016) emphasized that problem-solving skills are one of the requirements for the achievement of the mathematics curriculum, which aims to foster students' critical thinking and reasoning skills in concluding, improving problem-solving skills, and improving the ability to communicate information through oral, written, visual, and diagrammatic means. Hidayat and Sariningsih (Aisyah et al., 2018) emphasized that problem-solving is the essence of mathematics education.

The ability to solve problems is important in mathematics because it is the main goal of learning mathematics and reflects the nature of the challenges that exist in human life. Problem-solving skills are crucial for students and their future (Tarigan, 2012; Utami, 2017). Problem-solving is a method or approach to achieving expectations that are aligned with the right and accurate method. Mathematics includes an understanding of problem-solving. Mathematical observers often quote Polya's views.

Polya (Anisa, 2015) describes the stages of problem-solving as follows: (1) Understanding the problem: What is the nature of the problem? What is set, and what is asked? What information is provided? Can the information be requested in an alternative equation format? Is the information provided adequate for the settlement? Is the information adequate or redundant and inconsistent? Provide a description and annotate accordingly! Formulate a strategy: have similar problems ever occurred before? Do comparable problems occur in different manifestations? Do you know of an issue similar to this one? What techniques can be used to solve this problem? Have similar problems been solved, and if so, can the insights gained from overcoming those difficulties be applied to current problems? Can the previous strategy be applied in this context? Should we look for more information or elements to solve the problem? Can it be repeated? If the problem remains unresolved, try to reflect and find a solution! (3) Executing the plan: What is the method to implement the previously formulated plan? Verifying the accuracy of each stage? How can one validate the accuracy of the specified stage? (4) Reflect: How can the results of the solution be verified? Are there any alternative methods to get answers? Can the answer be seen at a glance? Does this strategy apply to other questions?

To improve students' proficiency in mathematical problem-solving, strategies based on Polya's problem-solving theory can be applied. Polya's theory describes four crucial stages of problem-solving development. The problem comprehension stage involves reading to understand the situation and critically evaluating the material presented.

During the planning phase, it is important to identify the relationship between the information provided (known elements) and the information that does not exist (the elements in question). During the plan implementation stage, verifying the steps of implementing the solution or the predefined solution plan is important. The verification stage is related to the accuracy of the strategy used in relation to the results achieved (Netriwati, 2016).

Students are considered to understand the problem if they can identify the known and sought-after elements of the problem presented. Formulating a plan requires students to identify solutions or methods that apply to overcome the challenges presented. During the implementation phase of a strategy designed to address the identified problem, the process is carried out methodically to resolve the problem. Students must verify the results of the solutions that have been implemented.

An interview with a grade VIII mathematics teacher of SMP Negeri 1 Bitung revealed that many students had difficulty understanding the concept of solving mathematical problems and had difficulty working on story problems or problems related to real life. This happens because students often memorize formulas and procedures demonstrated by teachers. The learning carried out still uses traditional models, especially the lecture, question and answer, and practice methods. The learning process has not run optimally.

The lack of students' ability to solve math problems significantly hampers the improvement of math learning outcomes. Learning outcomes involve an individual's interaction with the environment, resulting in a change in behaviour. Therefore, educators must develop learning strategies that improve students' problem-solving skills related to the subject matter.

Sumartini (2016) emphasizes that students must have problem-solving skills to facilitate their learning, thus allowing them to overcome challenges when faced with them effectively. In math education, students often assume that the main goal of solving a problem is to get the final answer. The main goal of studying mathematical problem-solving is the problem-solving process itself. Vilianti et al. (2018) stated that many experts identified various methods to solve mathematical problems, one of which is attributed to Polya. Polya identifies practical and systematic methodologies for problem-solving, which facilitate students' ability to overcome mathematical challenges. Manah (2016) asserts that upper-group students can effectively run the Polya phases to solve math problems, but middle-group students cannot fully implement these stages. Students in the lower group could not fully carry out the phases of Polya, which was one of the basis of this study. Given the abovementioned context, the author seeks to investigate students' mathematical problem-solving competencies. The author intends to conduct research titled Mathematical Problem Solving Ability in Row and Series Content for Eighth Grade Junior High School.

METHOD

This study provides a qualitative analysis of student's ability to solve mathematical problems related to arithmetic rows and series. This research was conducted at SMP Negeri 1 Bitung. The participants in this study are grade VIII students of SMP Negeri 1 Bitung. The reason for choosing this class is because, in addition to the limitations of problem-solving skills, grade VIII students have an adequate learning experience. It is hoped that students in this subject can solve mathematical problems using the Polya technique.

This study uses data from the written exam results, which consist of multiple-choice and narrative questions, and data from direct interviews. A multiple-choice assessment will be used to evaluate students' ability to solve mathematical problems, in addition to narrative inquiry and interviews, to assess their problem-solving abilities according to Polya's methodology.

In this study, researchers collected data directly from the field. The main instrument is the researcher, supported by additional instruments consisting of written tests that include multiple-choice questions, narrative questions, and interviews. Multiple-choice questions are an initial assessment of students' mathematical problem-solving abilities, complemented by narrative questions and interviews to evaluate their proficiency in this area. In qualitative research, it is very important to ensure the validity of the data to strengthen and support the data collected. The validity

of the data in qualitative research can be achieved by triangulation. In this study, the validity of the data was determined using triangulation techniques. The triangulation method is the collection of data through various approaches by researchers to obtain information from one source. Triangulation methods involve using various data collection techniques to obtain information from a single source, which in this study is achieved through written assessments and interviews.

RESULT AND DISCUSSION

This research was carried out at SMP Negeri 1 Bitung, especially in grade VIII, from July 29, 2024, to July 31, 2024. This research was carried out through three stages: planning, implementation, and data analysis. This qualitative research assesses students' competence in solving mathematical problems according to the Polya methodology. Data was obtained using two methods: assessment of problem-solving skills and interviews with three participants. Participants in this study were selected after an initial aptitude assessment of 32 students. The following table presents the results of the initial talent assessment of students in grades VIII-1 of SMP Negeri 1 Bitung.

Table 1. Initial Ability test scores for Grade VIII – 1 State Junior High School 1 Bitung

No	Student Code	Question Number															Total Score	Value
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
1	ACS	0	0	0	0	2	0	0	0	0	0	0	2	0	0	2	6	20
2	**AWT**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**4**	**13**
3	**AMB**	**2**	**2**	**2**	**2**	**2**	**2**	**0**	**0**	**2**	**2**	**0**	**2**	**2**	**0**	**2**	**22**	**73**
4	AGL	2	2	0	0	2	2	0	2	2	2	0	2	2	0	0	18	60
5	AMS	0	2	2	0	2	2	0	2	2	2	0	2	2	0	0	18	60
6	BMG	2	2	2	2	0	0	0	0	2	0	0	2	0	0	0	12	40
7	CJS	2	2	2	0	0	0	0	0	2	0	0	2	2	0	2	14	47
8	CH	2	2	2	0	2	2	0	2	0	2	0	2	2	0	2	20	67
9	CB	2	2	0	2	2	2	0	2	2	0	0	2	2	2	2	22	73
10	CST	0	2	2	2		2	2	2	2	0	0	2	2	0	2	20	67
11	**CAT**	**2**	**2**	**2**	**2**	**2**	**2**	**0**	**2**	**2**	**2**	**0**	**2**	**2**	**0**	**2**	**24**	**80**
12	ECT	0	2	2	0	2	2	0	2	2	2	0	2	2	0	2	20	67
13	ETT	2	2	2	0	2	2	0	2	0	0	2	2	2	0	2	20	67
14	FNP	2	2	0	0	2	2	0	2	2	0	0	2	2	0	2	18	60
15	FMK	2	2	2	0	2	2	0	0	2	2	2	0	2	0	2	10	33
16	FAS	0	0	0	0	2	0	0	0	0	0	0	2	0	0	2	6	20
17	IAM	2	2	2	0	2	0	0	0	0	0	0	2	0	0	0	10	33
18	JNB	0	0	2	0	2	0	0	0	0	0	0	2	0	2	0	8	27
19	JS	0	0	0	0	2	0	0	0	0	0	0	2	0	0	2	6	20
20	JYA	2	2	2	2	0	0	0	0	0	0	0	2	0	0	2	12	40
21	JNM	2	2	2	2	0	0	0	0	2	0	0	2	0	0	0	12	40
22	JKD	2	2	2	2	0	0	0	0	0	0	0	2	0	0	2	12	40
23	JPA	0	2	0	0	2	0	0	0	0	0	0	2	0	0	2	8	27
24	JMS	2	2	0	0	2	2	0	2	0	2	0	2	2	2	2	20	67
25	JPT	0	2	2	0	2	0	0	0	0	0	0	0	0	0	0	6	20
26	KLK	2	2	2	0	2	2	0	0	0	0	0	0	0	0	0	10	33
27	KVG	2	2	0	0	2	2	0	2	2	0	0	2	2	0	0	16	53
28	KR	2	2	2	2	2	2	0	0	0	0	0	2	2	0	2	18	60
29	LNA	2	2	2	0	2	2	0	0	0	0	0	2	0	0	0	12	40
30	LAG	2	2	2	0	2	0	0	2	2	2	0	2	2	0	2	20	67
31	MJP	2	2	2	0	2	2	0	0	0	0	0	2	0	0	0	12	40
32	MRW	2	2	2	0	0	0	0	0	0	0	0	2	0	0	0	8	27

Based on data collected at school, students' mathematical problem-solving skills can be categorized into three levels, namely high, medium, and low, based on assessment indicators put forward by Chotimah (2014). The following table presents the data collected regarding the mathematical problem-solving ability of SMP Negeri 1 Bitung grade VIII students.

Table 2. Accumulated Data on Mathematics Problem-Solving Skills of Grade VIII Students

Criterion	Score Range	Sum
High	≥ 80	1
Moderat	≤ 79	19
Low	≤ 54	12

The data in Table 2 shows that there are 1 high-ability student, 19 medium-ability students, and 12 low-ability students related to problem-solving skills. In addition, one subject is selected for each level of students' mathematical problem-solving ability: CAT subjects for high-ability students, as the subject, includes only high-ability students; the subject of AMB for medium-ability students, because their scores are superior to other medium-ability students; and the subject of AWT for low-ability students, as it has the lowest score among its peers. The selected research subjects are shown in the following table.

Tabel 3. Subjek Penelitian terpilih

Criterion	Initials
High	CAT
Moderat	AMB
Low	AWT

After obtaining the subject, the next stage involves giving problem-solving questions to the three subjects to assess the student's proficiency in solving mathematical problems according to the Polya methodology. The following table presents the results of students' proficiency in problem-solving according to the Polya methodology.

Table 4. Table of Students' Mathematics Problem-Solving Ability Based on Polya Steps

Polya Steps	Indicator	Question Number					
		CAT		AMB		AWT	
		1	2	1	2	1	2
Understanding the problem	Students are able to find out what things are known and asked	√	√	√	√		
Plan a plan	Students can determine formulas that can be used to solve problems	√	√	√	√		
Executing the plan	Students can carry out the plan they have created to solve the problem	√	√	√		√	√
Double-check	Students can double-check the results of their completions	√	√				

Furthermore, interviews were conducted with three participants to assess students' proficiency in solving problems using the Polya technique. The subject's response will be given a six-digit code. The rules for subject response codes are described in the following table.

Table 5. Subject Answer Quote Code Rules

Digit Order	Information
First and second digits	Initial of the interviewee ("CAT", "AMB", "AWT")

Third digit	Stating the number of the problem solving question
Fourth digit	Stated the subject's level of problem-solving ability ("T", "S", "R")
Fifth and sixth digits	Stating the order of the question passages

The initial digits indicate the subject classification: CAT for high-ability subjects, AMB for medium-ability subjects, and AWT for low-ability subjects. The third digit indicates the number of questions completed, the fourth digit indicates the student's proficiency level, and the fifth and sixth numbers indicate the order in which the questions are cited. The next section contains the code for the researcher's questions aimed at the topic, using a five-character question code. Guidelines for researcher question codes are described in the following table.

Table 6. Researcher Question Quote Code Rules

Urutan Digit	Information
First digit	"F" denotes the researcher's question
Second digit	Stating the number of the problem solving question
Third digit	Stated the subject's level of problem-solving ability ("T", "S", "R")
Fourth and fifth digits	Stating the order of the question passages

The initial digit is "F," which indicates the researcher's question is directed at the subject; the second digit indicates the question number; the third digit reflects the problem-solving ability of the interviewed students; and the fourth and fifth digits represent the order of the question quotes.

A. Data Analysis of Problem-Solving Ability of High-Ability Subjects (CAT Subjects)

The problem-solving questions in this study are presented as narrative questions consisting of two questions related to series and arithmetic series. The results of the test and interviews show that CAT can solve problems by using Polya's steps, specifically by understanding the problems presented by the researcher, formulating strategies by identifying applicable formulas, executing plans through the application of identified formulas, and then verifying the results.

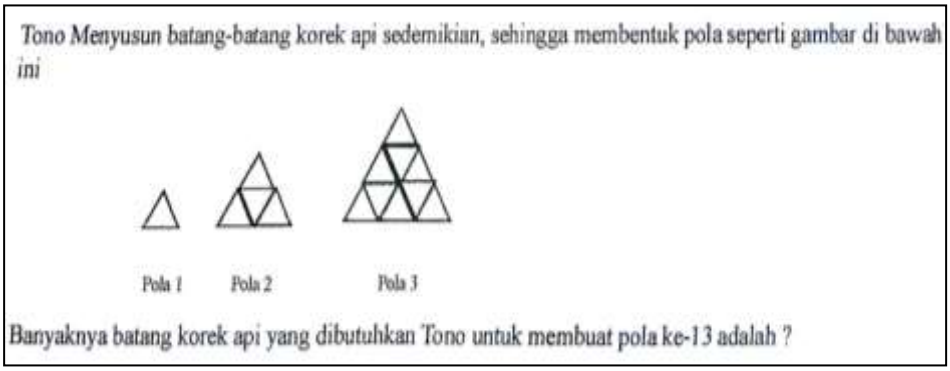


Figure 1. Question Number 1

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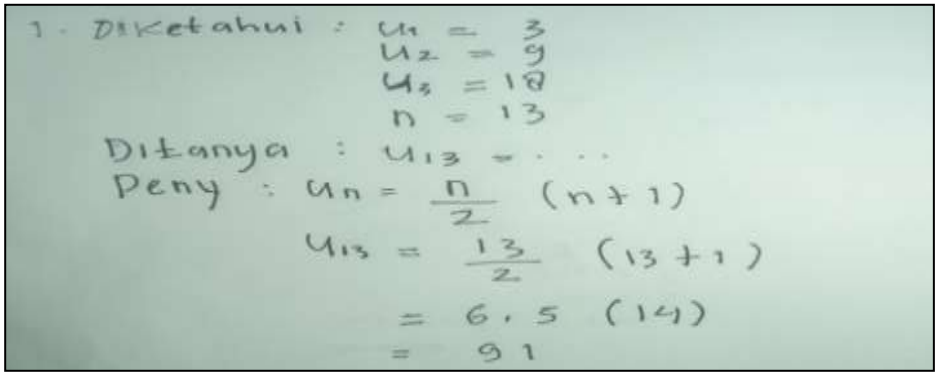


Figure 2. CAT problem-solving test results for question number one

The results of the problem-solving ability test for the first question showed that CAT subjects could solve the question accurately using the Polya technique. CAT can understand problems, strategize, execute plans, and evaluate solution outcomes. This image depicts the results of the CAT subject's problem-solving ability test for the first question.

1. Understanding the Problem

Students must understand weaknesses in their own reasoning. Students must understand the problem presented in the question to solve it. The results of the problem-solving ability test conducted by the researcher showed that CAT understood the problem presented in the first question. CAT accurately identifies the known elements U1 = 3, U2 = 9, U3 = 18, and the element sought in the question, U13 = ?, indicating CAT's understanding of the problem in the first question. This picture depicts the results of the CAT problem-solving ability assessment for question number 1 comprehension stage.

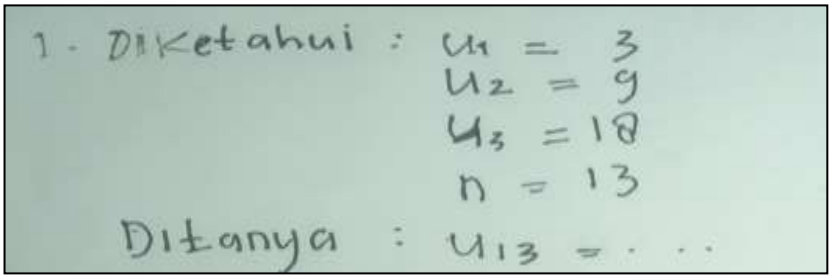


Figure 3. The results of the CAT subject's problem-solving ability test for the stage of understanding the problem in question number 1

The researcher conducted an interview to review CAT's ability to understand the problem. The following are the results of the interview with CAT for the stages of understanding the problem

F1-T01 : If given a math problem, can you understand the problem??
CAT1-T0 : I can
F1-T02 : You think it's important to determine the known and asked elements to solve a math problem ?
CAT1-T0 : It is important, so that it is easier to understand the problemia kak penting, agar lebih mudah dalam memahami soalnya
F1-T03 : Can you determine the known and asked elements in a math problem?
CAT1-T0 : I can

The results of the interviews showed that, in the first question, the CAT demonstrated the capacity to understand the problem by using the Polya procedure (CAT1-T03). Based on the exam and interview results, it can be determined that CAT can understand the problem stage.

2. Formulating a Strategy

After understanding the problem, students must consider the concepts or methodologies that apply to overcome the challenges. At this point, students must identify the applicable technique or formula to solve the problem at hand. The results of the problem-solving ability assessment carried out by the researcher on the first problem produced data that showed that CAT could confirm the formula that was applied to its solution. CAT can accurately ascertain formulas, in particular, indicating that CAT can formulate strategies for question number one. This is a picture depicting the CAT problem-solving ability exam results for the planning phase of the first question $U_n = \frac{n}{2}(n+1)$.

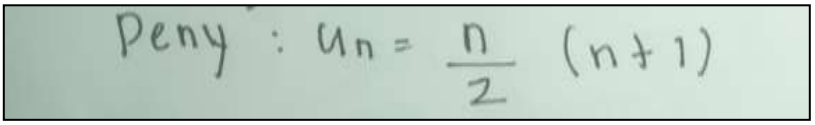


Figure 4. The results of the CAT subject's problem-solving ability test for the planning stage in question number 1

The researcher conducted an interview to review CAT's ability in the planning stage. The following are the results of the interview with CAT regarding the stages of planning the plan.

Based on the interview results regarding students' proficiency in solving problems using the Polya method during the planning stage for the first question, CAT can determine the right formula to apply to the first question (CAT1-T05). Based on the exam and interview results, it can be concluded that CAT is able to carry out the planning steps for the first question.

3. Executing the Strategy

The strategy is established by formulating applicable solutions to the challenges presented in the investigation. Furthermore, the strategy is implemented in stages to achieve the anticipated solution results. Based on the results of the problem-solving ability assessment carried out by the researcher in the first question, CAT can carry out the plan by applying a predetermined formula, , to solve the problem presented in the question. "CAT" then applies the formula gradually to obtain accurate results, specifically U_13 = 91. Thus, it can be said that CAT is able to carry out the stages of implementing the plan in the first question. This is an image depicting the results of the CAT problem-solving ability assessment for the first question implementation phase $U_n = \frac{n}{2}(n+1) U_{13} = \frac{13}{2}(13+1)$.

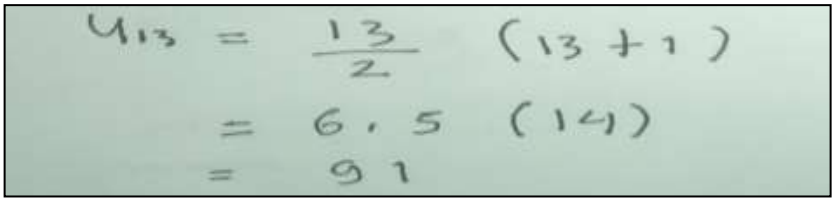


Figure 5. Results of the CAT Subject Problem Solving Ability Test for the stage of implementing the plan in question number 1

The researcher conducted interviews to assess the abilities of CAT subjects during the planned implementation stage. Further data relate to these interviews.

F1-T06	:	*If you have determined the formula, will you be able to solve the problem using the formula you have determined beforehand?*
CAT1-T06	:	*hmmm,… yes*

The interviews showed that students could utilize the Polya stages throughout the planning implementation stages, which allowed CAT to apply a pre-defined formula to address the identified problems (CAT1-T06). Based on the test and interview results, it can be concluded that CAT can carry out the planned implementation stage, as referred to in question number one.

4. Double-check

Students must verify their solutions to ensure accuracy. The re-evaluation stage can be observed during the interview. Based on the results of the students' math problem-solving ability interviews, the CAT can verify their responses' accuracy, ensuring that the truth is paramount. The results of the subsequent interview with CAT for the re-evaluation stage are presented.

F1-T07	:	*Do you think it's important to recheck the results of the settlement?*
CAT1-T07	:	*It's important to check if there are any errors in the solution*
F1-T08	:	*Can you check the results of the completion that you have completed?*
CAT1-T08	:	*Yes, you can*

The interview results showed that the student was able to use the Polya process during the re-examination phase, which allowed the CAT to verify the solution and confirm the absence of errors, thus obtaining the correct response (CAT1-T08). The test and interview results show that the CAT is able to perform the re-examination stage for question number one.

B. Data Analysis of Problem-Solving Ability of Moderate Ability Subjects (AMB)

The problem-solving problem in this study is presented as a narrative question consisting of two questions related to series and arithmetic series. The results of the assessment and interviews showed that AMB understood the problems presented by the researchers, formulated strategies by identifying the applicable formulas, showed reduced ability to implement the plan using the established formulas, and could not verify the accuracy of the solution results. Evaluation of the results of the problem-solving aptitude test for question number 1 in the medium ability domain (AMB)



Figure 6. Question Number 1

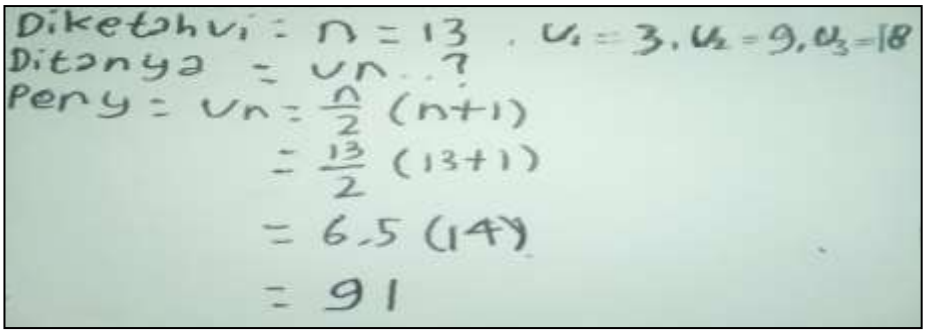


Figure 7. Results of the AMB subject problem-solving ability test for question number one

AMB subjects successfully solved the problem in the first question according to Polya's steps, as indicated by the results of the problem-solving ability test. AMB can understand problems, strategize, execute plans, and evaluate the results of solutions. This picture depicts the results of the problem-solving ability test for the AMB subject related to question 1.

1. Understanding the Problem

Students must understand the problem presented in the question to solve it. The results of the problem-solving ability assessment conducted by the researcher showed that the AMB accurately identified the relevant information, in particular by documenting the known elements and the questions asked, thus demonstrating the AMB's understanding of the initial problem. This image depicts the results of the AMB problem-solving test for the comprehension stage related to question number one $n = 13, U_1 = 3, U_2 = 9, U_3 = 18 U_{13} = ?$.

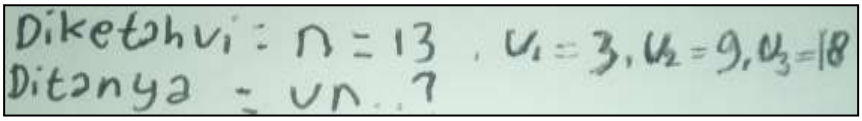


Figure 8. The results of the AMB subject's problem-solving ability test for the stage of understanding the problem in question number 1

The researcher conducted interviews to assess AMB's proficiency in the problem-understanding stage. The next results are related to the interview with AMB regarding the stage of understanding the problem.

F1-S01	:	*You think it's important to determine the known and asked elements to solve a math problem ?*
AMB1-S01	:	*It is important, so that it is easier to understand the problem*
F1-S02	:	*Can you determine the known and asked elements in a math problem?*
AMB1-S02	:	*ee..,, I can*

The interview results showed that AMB could carry out the problem-understanding stage in the first question, as evidenced by AMB1-S02. Based on the exam and interview results, it can be determined that AMB is able to understand the problem presented in the first question.

2. Formulating a Strategy

After understanding the problem, students must then develop a strategy by considering the methodology applicable to its solution. Based on the results of the problem-solving ability assessment provided by the researcher, AMB could identify the applicable methods and formulas to solve the problems presented in the first question. The AMB can accurately confirm the formula,

specifically $U_n = \frac{n}{2}(n+1)$, which indicates that the AMB is able to formulate a strategy for the first problem. This is a picture depicting the AMB problem-solving ability assessment results for the planning stage in the first question.

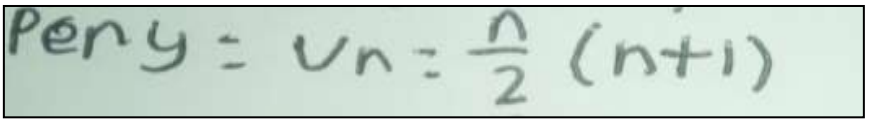


Figure 9. Results of the AMB subject problem-solving ability test for the planning stage in question number 1

The researcher conducted interviews to assess AMB's ability during the planning stage. The results of the interview with AMB are related to the planning stage.

F1-SO3	:	*In working on math problems, it is important to determine the formula that can be used to solve the problem ?*
AMB1-S03	:	*important sister*
F1-SO4	:	*If given a math problem, can you determine a formula that can be used to solve it?*
AMB1-S04	:	*Yes, because it has been studied*

Based on the interview results regarding the students' proficiency in solving problems using the Polya method during the preparation phase for the first question, AMB can choose the right formula to solve the first problem (AMB1-S04). As a result, based on the exam and interview results, it can be determined that AMB is able to carry out the planning phase on question number one.

3. Executing the Strategy

A strategy has been devised to address the problems presented in the investigation. Furthermore, the strategy is carried out methodically to achieve the anticipated solution. Based on the findings of the problem-solving ability test conducted by the researcher in the first question, AMB can carry out the plan by applying a predetermined formula, $U_n = \frac{n}{2}(n+1)$, to solve the problem presented in the question. AMB then runs the algorithm in stages, $U_{13} = \frac{13}{2}(13+1)$, Generate accurate answers, $U_{13} = 91$. It can be concluded that AMB can execute the plan outlined in the first problem. The figure depicts the AMB problem-solving ability assessment findings for the implementation phase in the first question.

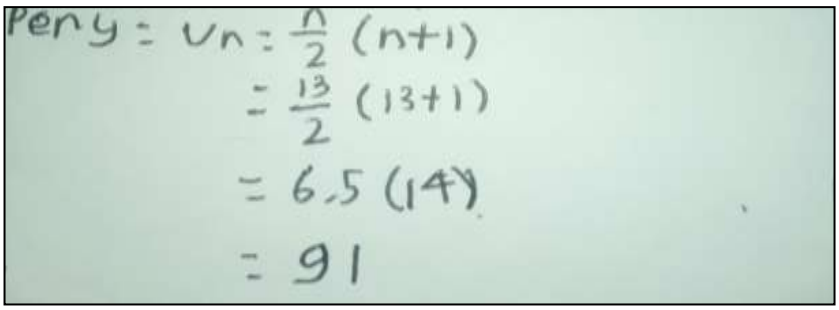


Figure 10. The results of the AMB subject's problem-solving ability test for the stage of implementing the plan in question number 1

The researcher conducted interviews to assess AMB's capacity during the plan's implementation phase. The results of the interview with AMB about the plan's implementation phase are as follows.

F1-S05	:	*If you have determined the formula, can you solve the problem using the formula that you have determined before?*
AMB1-S05	:	*Hmm... Yes, if the formula is not difficult*

The interviews showed that students could utilize the Polya stages throughout the planning implementation stages, which allowed AMB to apply a pre-defined formula to address the identified problems (AMB1-S05). Based on the test and interview results, it can be concluded that AMB can carry out the planned implementation stage, as referred to in question number one.

4. Double-check

The re-examination stage can be observed during the interview. The results of the interviews showed that students had to verify their solutions to ensure accuracy, and AMBs also had to validate the results of these solutions, emphasizing the need for truth. The results of the subsequent interview with AMB for the re-evaluation stage are presented.

F1-S06	:	*Do you think it's important to double-check the results of the settlement?*
AMB1-S06	:	*important sister*
F1-S07	:	*Can you check back the results of the settlement you have completed?*
AMB1-S07	:	*Maybe you can, but sometimes you can't*

The interview results showed that AMB was unable to verify the accuracy of its solution during the re-examination stage of Polya's problem-solving process, thus failing to identify potential shortcomings (AMB1-S07). The exam and interview results show that AMB is unable to complete the re-examination stage for question number one.

C. Data Analysis of Problem-Solving Ability of Low-Ability Subjects (AWT)

The problem-solving problem in this study is presented as a narrative question consisting of two questions related to series and arithmetic series. The test and interview results showed that AWT could not understand the problem presented in the researcher's question, formulate a plan by identifying the applicable formula, implement the plan by applying the predetermined formula, and verify the accuracy of the solution results. Evaluation of the results of the problem-solving aptitude test for question number 1 among low-ability subjects (AWT)

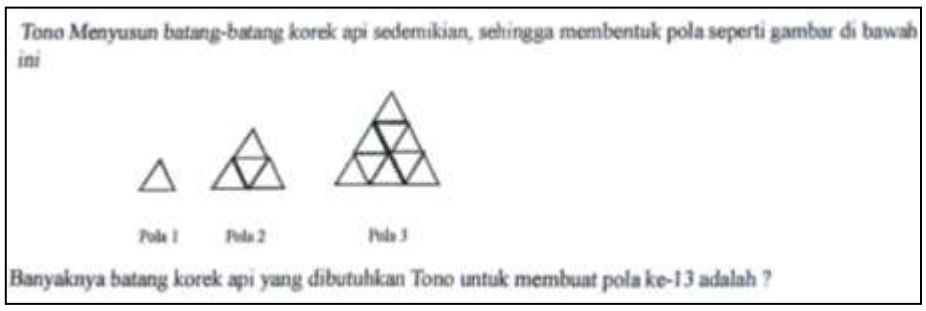


Figure 11. Question Number 1

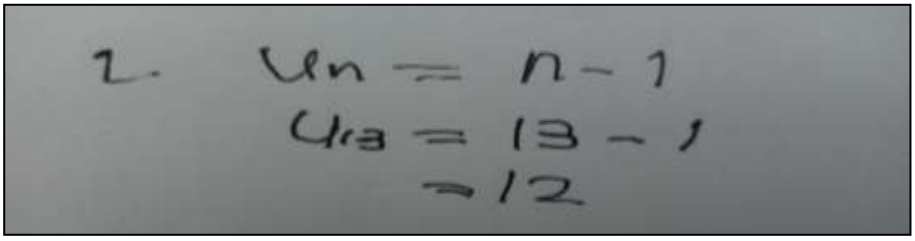


Figure 12. Results of the AWT subject problem-solving ability test for question number one

According to Polya's steps, AWT students fail to solve the problem in question in question on the first question of the problem-solving ability test. AWT fails to understand the problem, strategize, execute the plan, and evaluate the results of the solution. The following is an overview of the AWT subject problem-solving ability test findings for the first question.

1. Understanding the Problem

Students must understand the problem presented in the question to facilitate its completion. Based on the results of the problem-solving ability test given by the researcher, AWT failed to identify the known elements and the questions asked on question number one. Furthermore, to evaluate AWT's proficiency in the problem-understanding stage, the researcher conducted an interview. The results of the subsequent interview with AWT are related to the stage of understanding the problem.

F1-R01	:	*Do you think it is important to determine the known and asked elements to solve a problem in a math problem?*
AWT1-R01	:	*No, because it slows down the process of the*
F1-R02	:	*Can you determine the known and asked elements in a math problem?*
AWT1-R02	:	*ee..,, no sister*

Based on the interview results regarding the students' proficiency in solving problems using the Polya stage during the problem understanding phase in the first question, AWT was unable to identify the known and sought-after elements in the question (AWT1-R02). The test and interview results showed that AWT could not understand the situation presented in question number 1.

2. Formulating a Strategy

After the problem-understanding phase, students must identify the applicable techniques or formulas to solve the questions presented. According to the findings of the problem-solving skills test given by the researcher for question number one, AWT could not formulate a plan correctly. AWT establishes the formula $U_n = n - 1$ to solve the problem. AWT should use the formula $U_n = \frac{n}{2}(n + 1)$ to solve question number one. This is an image depicting the results of the AWT problem-solving ability assessment for the planning phase of the first question.



Figure 13. Results of the AWT problem-solving ability test for the planning stage in question number 1

Researchers conducted interviews to evaluate AWT skills during the planning stage. The following results are related to these interviews.

F1-R03	:	*In working on math problems, it is important to determine the formula that can be used to solve the problem ?*
AWT1-R03	:	*No need, because it slows down the process if you have to see or remember the formula*
F1-R04	:	*If given a math problem, can you determine a formula that can be used to solve it? ?*
AWT1-R04	:	*No, because it's hard to remember the formula*

In the results of interviews regarding the problem-solving ability of students who utilize the Polya phases, AWT was unable to identify the right formula for the planning stage in the first question (AWT1-R04). The findings of the test and interviews showed that AWT could not carry out the planning stage on the first question.

3. Executing the Strategy

After developing a strategy, students must implement a predetermined plan or formula to overcome the existing challenges. Based on the results of the researcher's problem-solving skills assessment in the first question. AWT can apply the formula they have created before, Un=13-1=12, due to inaccuracies in the early stages of its formulation, resulting in inaccurate solutions. The next figure illustrates the results of the problem-solving ability assessment for the implementation stage in the first question.

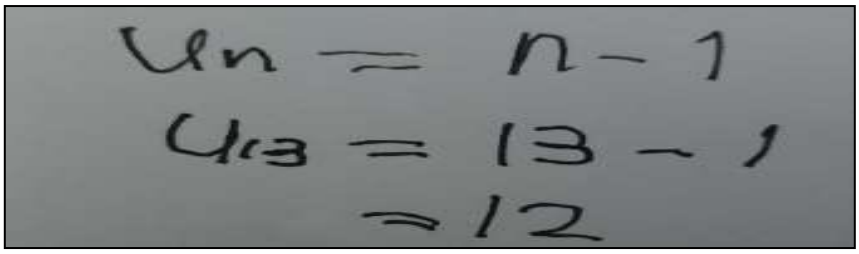


Figure 14. The results of the AWT problem-solving ability test for the stage of implementing the plan in question number 1

The researcher conducted interviews to evaluate AWT's capabilities during the planning and implementation stage. The interview results with AWT about the planning implementation stage are as follows.

F1-R05	:	*If you have determined the formula, can you solve the problem using the formula that you have determined beforehand? ?*
AWT1-R05	:	*e.. Sometimes you can*

Based on the interview results regarding students' proficiency in solving problems through the Polya implementation stage, AWT can apply a predetermined formula to overcome the problem (AWT1-R05). However, the solution was not appropriate due to an error in the early stages that led to the determination of the wrong formula. Based on the test and interview results, it can be concluded that AWT can carry out the plan's implementation stage to overcome the problems in the first question; However, the results are somewhat less precise.

4. Double-check

The re-examination stage can be observed during the interview. Based on the results of interviews regarding problem-solving skills, AWT was unable to verify the solution's results. AWT argues that the recheck stage is critical to validating the solution's results; however, AWT has not carried out the implementation stage effectively. The results of the subsequent interview with AWT for the re-evaluation stage are presented.

F1-R06	:	*Do you think it's important to double-check the results of the settlement?*
AWT1-R06	:	*Yes, so that you know, if something is wrong*
F1-R07	:	*Can you double-check the results of the settlement you have completed ?*
AWT1-R07	:	*not too much*

The interview results showed that AWT was unable to verify its solution at the stage of re-examining Polya's problem-solving process, thus failing to ensure that there were no errors in its solution (AWT1-S07). According to the exam and interview results, AWT cannot perform the re-examination step for question number one.

Solving math problems requires a methodical approach that involves sequential stages. The results of the initial ability test conducted using multiple-choice questions for 32 students in grades VIII-1 of SMP Negeri 1 Bitung showed that there was 1 student who was at the High Ability Level, 19 students were at the Medium Ability Level, and 12 students were at the Low Ability Level. Students are grouped into three levels of mathematical problem-solving ability according to their respective scores. Next, three students were selected to represent each level of mathematical problem-solving ability among the children.

a. Abilities obtained by high-ability students

The results of the previous study showed that high-ability students effectively solved problems using the Polya technique. During the problem-understanding phase, high-ability students can accurately understand the problem presented in the question, interpreting the information provided correctly. Relevant information relating to the recognized and questioned elements: These students believe that knowing is important because it facilitates understanding the problem presented in the question. So, when completing the exam questions given by the researcher, students with high abilities can accurately articulate their knowledge and answer the questions posed in each question. This shows that high-ability students can effectively navigate the problem-understanding stage. During the planning phase, high-ability students can identify the formulas necessary to solve the questions presented accurately, demonstrating their proficiency in carrying out planning steps effectively. These high-ability students believe that it is important to identify the applicable formula to solve the problem presented in the question, thus facilitating the completion of the question. This shows that high-ability students can effectively carry out the planning phase. After the formula is set, high-ability students can apply a predetermined formula to solve the given problem. High-ability students can systematically apply pre-defined algorithms to solve problem-solving ability test questions given by researchers. It can be concluded that high-ability students effectively carry out the implementation steps of the plan.

The re-evaluation of high-ability students can be judged by the interview results, as the students do not show the process of reviewing their work when answering the test questions. According to the results of the interviews, high-ability students said that they were able to verify the correctness of their solutions. Highly capable students can comprehensively address the problem by following Polya's steps: understanding the problem, drawing up a plan, executing the

plan, and verifying the solution. This is in line with the statement of Taringan (2012) that high-ability students can carry out problem-solving using the Polya procedure accurately and effectively.

b. Skills acquired by students of medium ability

The results of the previous study showed that students with medium aptitude were less capable of applying Polya's problem-solving techniques comprehensively. Students with average abilities can understand the problem presented in the question by interpreting the facts accurately. The information relates to the known and questioned elements, specifically identifying those elements in question. Thus, in answering the test questions the researcher gave, students with medium aptitude can articulate their knowledge and answer the questions asked. This shows that students with moderate skills can carry out the stages of understanding the challenge.

In the planning step, students with medium aptitude can identify the formula needed to solve the problem, which shows their ability to execute the planning process. During the interview, the student states that he can choose the formula he wants to use to answer the problem. This shows that students with moderate abilities can carry out the phases of plan formulation.

In addition, students with average abilities cannot fully apply the pre-established methods to solve a given problem. Errors persist in using pre-defined formulas when handling issues. During the interview, the student stated that he continued to make mistakes while applying the prescribed formula. It can be said that students with moderate abilities are less capable of carrying out the steps of implementing the plan.

The interview results evidently show that students with moderate abilities were reassessed, as they did not show the process of reviewing their work when completing the exam questions. According to the interview results, students with moderate abilities showed that they could review their answers, but they were unable to implement them.

According to the signs of problem-solving, students with intermediate problem-solving skills have not fully complied with the Polya process, particularly in understanding problems, formulating strategies, executing plans inadequately, and failing to verify their solutions. This aligns with Manah's (2016) statement that students with moderate abilities cannot fully complete the Polya stages.

c. Abilities acquired by low-ability students

The results of the previous study showed that students with low abilities could not apply Polya's problem-solving method comprehensively. During the problem comprehension phase, students with limited abilities have difficulty understanding questions and accurately identifying relevant information. The information relates to known and questioned elements, specifically identifying those elements in question. As a result, when answering the exam questions the researchers gave, students with limited abilities cannot articulate their knowledge and the questions asked. During the interview, the student asserts that identifying the known elements and questions in the problem is unimportant, as it hinders progress in addressing the topic. This shows that students with low ability cannot carry out the stages of understanding the problem. During the planning phase, students with limited abilities cannot identify the formula necessary to solve the problem, indicating their inability to carry out the planning stage. The student stated that during the interview, he could not choose the right formula for problem-solving, and identifying the correct formula could hinder the solution process. This shows that students with low abilities cannot carry out the planning phase. In addition, students with lower abilities can carry out the stages of the plan to overcome the specified problem. However, the resulting solution is wrong due

to their lack of understanding of the topic and inability to ascertain formulas. It can be concluded that students with poor abilities can carry out the plan; However, due to errors in the early stages, the resulting solution is wrong.

The interview data evidently show the re-evaluation stage for low-performing students, as these students do not show a review process in their test responses. According to the interview results, it is very important for students with low ability to verify their problem-solving solutions to avoid mistakes; however, they were unable to do so.

According to problem-solving indications, students with low problem-solving skills have not followed Polya's steps well. They have difficulty understanding the problem, fail to develop a plan, have limited ability to execute it, and cannot verify their solution. This aligns with Satriani's (2020) statement that low-ability students have difficulty understanding problems, fail to understand the concept of the given problem and show inaccuracies in problem-solving methods.

CONCLUSION

From the results and discussion, the following conclusions can be drawn: High-ability children comprehensively carry out the stages of problem-solving described by Polya, which include recognizing problems, developing plans, implementing plans, and verifying solutions. Medium-ability students have not fully implemented the problem-solving process outlined by Polya. They can only identify problems and strategize but have difficulty implementing plans and fail to verify their solutions. Low-ability students cannot fully carry out the problem-solving stages outlined by Polya, especially with difficulty understanding the problem and formulating strategies. At the same time, they can execute the plan but fail to do the re-checking stage.

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