Analysis of Problem Solving Abilities based on Polya Steps if Viewed from Student's Initial Mathematics Abilities

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Abstract. The importance of mathematical problem solving skills in learning is students are able to analyze and solve problems mathematically in different situations. However, students' ability to solve mathematical problem solving problems is still low. This research aims to analyze and describe problem solving abilities based on polya steps in terms of students' initial mathematical abilities (IAM). The research method uses a qualitative approach with descriptive methods. The data instruments used were mathematical problem solving ability tests and interviews. The results of the research show that students with high IAM are able to understand the problems, but the devise a plan, carry out the plan steps and look back are still not accurate, while students at medium IAM and low IAM still make many mistakes in the steps of understanding the problem, devise a plan, carry out the plan and look back.

Keywords: problem-solving abilities, polya steps, initial mathematics abilities

1 Introduction

Mathematics is a mandatory subject that students must be able to master well. One of the basic sciences that plays an important role in the world of education is mathematics, through mathematics it can shape students' scientific thinking processes [1]. In addition to providing a tool for solving practical issues that can be simplified in mathematical models, mathematics is one of the sciences that enables people to think logically, rationally, and confidently [2]. One of the goals of learning mathematics requires students to be able to solve problems. Consequently, the capacity to solve mathematical issues is the mathematical competence that students need to possess in order to achieve the learning objectives for mathematics [3, 4].

Students need to practice and develop mathematical problem solving as a fundamental cognitive skill. This is because almost all developed countries have implemented mathematical problem solving as the main goal of mathematics learning in schools [5]. The rationale behind this implementation stems from the results of developed countries' predictions, which indicate that students with strong mathematical problem-solving skills will contribute to and support their country's economic progress

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[6]. Thus, through problem-solving skills, students are able to develop not only their critical thinking, habits, perseverance, and curiosity, but also be able to improve in confidence in unexpected situations, which will help students outside of math lessons [7, 8].

Problem solving ability refers to a person's or student's capacity to answer narrative problems, nonroutine (different) problems, and challenges involving the application of mathematics in daily life. If a student is motivated to do an assignment but lacks the processes necessary to do so directly, then the assignment is viewed as a challenge for them [9]. When associated with mathematics, mathematical problems are nonroutine mathematical problems that have never been obtained by students in the classroom, so that to solve them they need to be analyzed first [10]. If a problem in the form of a math problem can be solved immediately without the need to carry out a certain procedure, then the problem is an everyday problem that is routine in nature. However, if the task cannot be directly solved and must be done through several other relevant activities, then the mathematical task is classified as a mathematical problem [6]. Due to their inability to solve problems, students are limited to working on routine problems or questions that are precisely the same as those provided by the teacher. As a result, they are not accustomed to working on non-routine problems, which causes students made a mistakes when solving mathematical problems.

There are steps or stages that must be completed in order to answer problem-solving ability questions. Polya suggests the steps for solving problems in general, namely: Understanding the problem, Devising a Plan, Carrying out the Plan, and Looking Back [11]. The four steps according to Polya can be made in detail as follows: a) Understanding the problem, In this stage students must be able to describe the problem by identifying things that are known, asked questions and other elements contained in the problem. It is required of students to be able to present problems using charts, other patterns, sketches or drawings, b) Devising a Plan, In the second stage, Students attempt to make

connections between the components they have discovered, connect the issue to relevant content, and seek out suitable approaches or solutions to the given situation, c) Carrying out the plan. At this stage, Students solve problems by implementing the plan they generated in the second stage, d) Looking Back, Students recheck their solutions at the last steps in the problem-solving process, and they also verify that the concepts, procedures, and strategies used in the calculation process are correct.

Students with initial mathematical abilities (IAM) are those who have already learned the skills, either naturally or as a result of successfully completing a mathematical task. Pupils with higher IAM levels already possess a solid foundation in mathematics and have mastered previously taught [12]. The variety of one's innate mathematical aptitude can influence one's capacity for problem solving. This is due to the fact that foundational information is crucial as it facilitates students' learning[13] . To solve mathematical issues, students must possess the necessary background knowledge, abilities, and mathematical comprehension. Students with high IAM typically have an easier time accepting new ideas since they already have the foundational frameworks needed to develop mathematical concepts [14]. Students with high IAM may already have a system in place, but for it to be useful in developing new concepts, it needs to be reinforced.

Less comprehensive or nonexistent schema that develops mathematical problem solving skills will make it difficult for kids with lower IAM to absorb new ideas.

Based on the description above, the researcher intends to conduct a study entitled Analysis of Mathematics Problem Solving Ability in Solving Story Problems Based on Polya's Procedure.

2 Research Method

This research is descriptive qualitative research. Descriptive research is a kind of research that aims to get information about a symptom that was already there at the time of the research [15]. Descriptive research does not aim to test certain hypotheses hypothesis, but only describes "what it is" about a variable, symptoms or conditions. The subjects of this study were 27 students who took calculus courses. The instruments in this study were a description test in the form of a problem-solving ability test and interviews. This research used a qualitative approach with descriptive methods. To compare test results with interviews, researchers used a triangulation technique consisting of determining student answer errors adjusted to the results of interviews, and assessing student answers based on the tests given.

The data sources used by researchers are primary and secondary data sources. Primary data sources are obtained from problem solving ability tests and interview results, while secondary data sources are obtained from the results of documentation when carrying out research. The theoretical, methodological, and interpretative power of qualitative research is to be enhanced through triangulation. Triangulation is also defined as checking data through various sources, techniques, and time [16]. This study employed the triangulation technique, which compares student work results with interview findings before conducting an analysis using Polya's procedures. Tests and interviews, were the techniques utilized to obtain the data. The exam approach was utilized to determine how well students could solve problems. The interview used in this study was a structured interview. Data about pupils' performance on the researcher's math problem-solving ability exam was gathered through interviews.

3 Results and discussion

The initial mathematics ability (IAM) of students in this study is the ability that students have before the given learning process takes place. In this study, students' initial ability data (IAM) was obtained from the results of the IAM test given, where the material tested was prerequisite material for the material in the research to be conducted. IAM data is grouped based on the categories of high, medium, and low initial ability. The criteria for grouping IAM based on the average and standard deviation of students can be seen in the Table 1.

Based on the table above, it can be seen that there were 4 high IAM students with scores above 81.22, 16 students with medium IAM with scores between 63.01 and 81.22 , while 7 students with low IAM scored below. 63.01. Grouping students based on IAM is to see students' mathematical problem solving abilities based on their initial mathematical abilities.

Table 1. Student Grouping based on IAM

Criteria	IAM'S Category	Students
IAM $\geq 81,22$	High	4
$63,01 \leq$ IAM $< 81,22$	Middle	16
KAM $< 63,01$	Low	7

Based on the results of the pretest which was carried out on 27 students with Calculus material. The indicators used to measure mathematical problem solving abilities are using indicators based on polya procedures which consist of understanding the problem, planning a solution, implementing the solution plan, checking again. The following is a discussion of students' mathematical problem solving abilities when viewed from the initial mathematical abilities of the research subjects:

3.1 Understanding The Problem Step

Table 2. Student's IAM Based on Polya Steps

IAM'S Category	Sum of Students (Percentage)		
	2	**1**	**0**
High	2	2	0
	0%	50%	50%
Middle	1	6	9
	6,25%	37,50%	56,25%
Low	0	2	5
	0%	29%	71%

Students with high IAM are able to write down what they know in the questions on the indicator of understanding the problem, but some students still make mistakes while writing down the information that is requested in the questions. There were still 9 students at the medium IAM level who did not show the ability to understand the problem and there were still students with IAM who wrote down the information given in the questions incorrectly. Meanwhile, low IAM students are still unable to write down what they know and what is asked in the questions, even though some are able to write down the information provided, they still experience errors.

The reason why there are still many students who make mistakes and are even unable to write down the information they know and ask in questions is that students are less accustomed to solving questions in the form of story problems/application of calculus material in the real world. This is consistent with [17] which states that students should be able to select and identify pertinent conditions and concepts, look for generalizations, formulate a solution plan, and organize previously acquired skills in order to solve problems.

3.2 Devising a Plan

Table 3. Table Student's IAM Based on Polya Steps

IAM'S Category	Sum of Students (Percentage)		
	2	**1**	**0**
High	0	2	2
	0%	50%	50%
Middle	0	4	12
	0%	25%	75%
Low	0	0	7
	0%	0%	100%

Students at the three IAM levels were not yet proficient in creating plans or strategies that would be used to solve the challenges at hand during the planned solution stage. Most students do not write down the plans/strategies used to solve problems. The mistakes made by students are because there are still many students who still make mistakes at the stage of understanding the problem so that students are unable to determine the right strategy. This is in line with the opinion of [18] who states that in making a problem solving plan, look for relationships between the elements that have been found, relate the problem to what material and look for appropriate strategies or ways to solve the given problem.

3.3 Carrying out the plan

Table 4. Student's IAM Based on Polya Steps

IAM'S Category	Sum of Students (Percentage)			
	3	**2**	**1**	**0**
High	1	1	2	0
	25%	25%	50%	0%
Middle	1	3	10	2
	6,25%	18,75%	62,5%	12,5%
Low	0	0	5	2
	0%	0%	71,43%	28,57%

Students have attempted to answer the problem up to this point, but there are still a lot of errors in their solutions. The mistake lies in the fact that pupils perform calculations incorrectly and fail to answers the problem correctly. The most crucial activities for enhancing children's problem-solving skills is to reflect on or go over the steps that have been taken in the process [19].

3.4 Looking Back

Table 5. Table Student's IAM Based on Polya Steps

IAM'S Category	Sum of Students (Percentage)		
	2	**1**	**0**
High	0	3	3
	0%	25%	75%
Middle	0	2	14
	0%	12,5%	87,5%
Low	0	1	4
	0%	14,29%	85,71%

At the rechecking stage, no students reached this stage because the research subjects still made mistakes at the rechecking answer stage. The mistakes made were not writing down the conclusions of the results of the work, not checking the answers again and not carrying out the re-checking stages. The process of checking back in solving problems is a person's steps to check the answer or the results of planning or understanding to prove the procedures used are correct or the resulting answer has answered the problem[20].

4 Conclusion

From the analysis and recapitulation of the calculations that have been carried out, it can be seen that students' abilities in solving mathematical problem solving problems have not shown good results in each indicator for high IAM, medium IAM and low IAM students. The errors that have the largest percentage are found in the indicators for planning and looking back. This suggests that, based on the research samples, students' problem-solving skills are still deficient, particularly when it comes to the work stages involved in locating answers to the given problems.

The primary reason why students make mistakes is that they are not accustomed to working on non-routine
questions or real-world word problems. As a result, when working on them, students often struggle to comprehend the information provided in the problem and struggle to connect concepts to develop a strategy or plan for solving it. This leads to a lot of mistakes being made by students during the problem-solving process. Additionally, students often neglect to doublecheck their work. The achievement of mathematical problem solving abilities of the students studied is still lacking, as evidenced by the indicators used by Polya to analyze problem errors. Therefore, in order to develop students' critical thinking skills, it is necessary to get them used to being given problem solving ability questions (open-ended, real-word, or non-routine tasks).

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