

Analysis of Students Abilities in Solving Mathematical Problems on Quadratic Functions

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Abstract

Problem solving is one of the important competencies that students must master in learning mathematics, because it involves critical, analytical and logical thinking skills. The aim of this research is to describe problem-solving abilities and what factors cause students' errors in solving math problems on quadratic functions according to Polya. This research is a type of qualitative research with a descriptive approach. The research subjects consisted of 27 students of class X TJKT 2 Assalam SMK Assalam Depok with sample selection using sampling techniques *Stratified Random Sampling* (stratified random sample). For data collection, the instruments used were a test of mathematical problem solving abilities and an interview guide. The results of this research that 81% the students in class X TJKT 2 SMK Assalam Depok, fall into category of student with mathematical problem-solving skills in the subject of quadratic functions. Internal factors that influence include weak understanding of concepts, inappropriate strategy selection and limited analytical thinking skills and external factors that influence include lack of practice in solving various types of mathematical problems.

Keywords: Mathematic, problem-solving, Polya, quadratic functions.

1 INTRODUCTION

Education has a very important role in human life because education can develop the thinking power and skills possessed by every human being. One of the government's efforts to improve the quality of education in Indonesia is through mathematics learning. Learning mathematics involves mathematical concepts, formulas and techniques used to solve mathematical problems. In general, learning mathematics has three important aspects, namely concepts, skills and applications. 1) Concepts include basic concepts such as addition, subtraction, multiplication, division, geometry, trigonometry and so on. 2) Apart from concepts, students must also master skills in using mathematical formulas and techniques to solve problems. 3) Applications, in everyday life and various other fields of science, learning mathematics is also very necessary. Thus, mathematics is very important in everyday life because it can help people overcome various real problems that are complex and require logical and systematic problem solving. (Steen LA, 1990).

According to Minister of Education and Culture Regulation No. 22 of 2016, the aim of mathematics learning at school is for students to be able to solve mathematical problems which includes the ability to understand problems, develop mathematical solution models and provide appropriate solutions. (Augusta, 2021). There are still students who experience difficulties in learning mathematics, this is due to the students' low problem solving abilities. (Damiyanti & Afriyansyh, 2022).

Mathematical problem solving ability is the ability to identify, analyze and solve mathematical problems logically and systematically. The low problem solving abilities of students can be seen based on reports *Program for International Student Assessment*

(PISA) 2018 from *The Organization for Economic Co-operation and Development (OECD)* It is known that: (1) the average mathematics score achievement of Indonesian students is 379, with the highest percentage of students being in the category below level 1, and Indonesia is ranked in the bottom 6, (2) there is no significant change between the 2015 and 2018 in average student mathematics performance. (OECD, 2019). Referring to the PISA achievement report, the problem solving abilities of students in Indonesia are in the low category.

Problem-solving can also be seen as a means for individuals to appreciate the beauty of the mathematics, while simultaneously connecting their mathematical experiences to the meaningfulness of the subject they are learning (Alghadari, 2016).

Indicators of mathematical problem solving abilities are, identifying what is known, asked and the elements needed, making a solution plan, implementing the plan and checking or interpreting the results of problem solving. (Lestari, 2015).

Polya stated that there are 4 steps in solving mathematical problems (Polya, G. 2004), namely:

1. *Understanding The Problem*
2. *Devising A Plan*
3. *Carrying Out The Plan*
4. *Looking Back*

The results of observations in class Observations and interviews with students revealed several factors that could cause errors in solving mathematical problems, including external factors and internal factors. Internal factors include weak understanding of concepts, inappropriate strategy selection, limited analytical thinking abilities. Meanwhile, the external factor is the lack of practice in solving various types of mathematical problems. Based on this, researchers conducted research entitled "Analysis of Students' Ability in Solving Mathematical Problems on Quadratic Function Material" to describe problem solving abilities and what factors cause students' errors in solving mathematical problems on quadratic function material according to Polya.

2 RESEARCH METHOD

This research is a type of qualitative research with a descriptive approach. The data obtained must be accurate from the focus of the research, namely regarding students' abilities in solving mathematical problems according to Polya. According to Moelong, the source of qualitative data is the form of spoken or written words observed by researchers and objects that are observed in detail so that the meaning implicit in the document or object can be found. (Suharsimin Arikunto, 2013)

The population is all subjects who are the target of research. In this research, the population used was class X of Assalam Vocational School.

The sample is part of the population chosen to be the research subject. The sample used in this research was 27 students from class X SMK Assalam.

There are two types of data collection techniques in this research. The two types are: (1) a test of mathematical problem solving abilities using indicators proposed by Polya including understanding the problem, making a plan, implementing the plan and looking back. (2) interviews from 6 samples using sampling techniques stratified random sample.

The sampling technique is a method used by researchers to select individuals from the population who will be selected as samples in the research. This research uses sampling techniques stratified random sample. The sampling technique chosen was based on the results of the problem solving ability test which were divided into 3 categories (high, medium and low).

Table 1. Data Collection Techniques

DATA	Data Collection Techniques	Instrument	Data Source
Mathematical problem-solving skills	Written tes	3 test items	Students
	Interview	Unstructured interview guide	Students

The reference for grouping mathematical problem solving abilities is as follows:

Table 2. Reference for Grouping Mathematical Problem Solving Abilities	
Mathematical Problem-Solving	Score Range (S)
High	$X \geq (\bar{X} + SD)$
Medium	$(\bar{X} - SD) > X > (\bar{X} + SD)$
Low	$X \leq (\bar{X} - SD)$

The data analysis techniques used in this research proposed by Miles and Hubberman include data collection, data reduction, data presentation and drawing conclusions.

3 RESULT AND DISCUSSION

3.1 RESULT

Before the research was carried out, a test instrument was carried out on students' problem solving abilities, the questions were tested to determine the validity of the questions. After testing the instrument with valid results, you can then carry out research using questions about mathematical problem solving abilities. The following are the steps and explanation of the research results:

3.1.1 Intrument Validity Test

Tabel 3. Validity Test

Question	r_{xy}	r_{tabel}	Description
1	0,712	0,361	Valid
2	0,457	0,361	Valid
3	0,929	0,361	Valid

Table 3. Each question item has a value greater than the value $r_{xy} = 0.361$. Based on the criteria used, if $r_{xy} > r_{tabel}$, then the instrument tested is said to be valid so it is suitable for use in measuring mathematical problem-solving abilities.

3.1.2 Mathematical Problem-Solving Skills Test

Tabel 4. Mathematical Problem-Solving Skills Test

KPMM	Score Range
High	$\geq 47,02$
Medium	$35,94 < X < 47,02$
Low	$\leq 35,94$

Table 4. Based on the results of the mathematical problem solving ability test, the values for each mathematical problem solving ability criterion are shown.

3.1.3 Descriptive Data of The Problem-Solving Skills Test

Kategori KPMM	N	Score Range
High	1	$\geq 47,02$
Medium	22	$35,94 < X < 47,02$
Low	4	$\leq 35,94$
Amount	27	$\bar{x} = 41,48$

From table 5. It can be seen that the total sample was 27 students with an average score of 41.48.

3.1.4 Interview Subject Data from the Stratified Random Sampling technique.

Category KPMM	Subject Initials
High	JA
Medium	SM
Medium	ISP
Medium	NS
Low	EDP
Low	ARA
Amount	6

Table 6. It can be seen that the total sample was 6 students who were selected to be the interview sample.

3.2 DISCUSSION

Based on the results of research on mathematical problem solving ability data on quadratic function material, the results of mathematical problem solving ability tests were obtained which were grouped into three categories, namely high, medium and low categories.

Students who have high category problem solving abilities are able to fulfill three indicators of problem solving abilities according to Polya. Three problem solving ability test questions are provided. In the first indicator, namely understanding the problem, students who have high category problem solving abilities are able to understand these three questions even though of the 3 problem solving ability test questions there is 1 question that is not explained in the answer sheet but the subject understands the problem in that question. Furthermore, the second indicator is making plans. Students who have high problem solving abilities are able to make plans even though from the three problem ability test questions there are plans that do not match the problem. Next, the third indicator is carrying out plans. Students who have high problem solving abilities are able to carry out plans with correct calculation operations even though there are results that are not able to answer the problems in the questions. Next, the fast indicator is looking back at students who have high problem solving abilities who are able to recheck the results obtained by writing conclusions even though there are questions where conclusions are not written on the answer sheet, but these students are able to explain during the interview session. The internal factor is choosing an inappropriate strategy and anxiety in solving problems, while the external factor is the lack of practice in solving various types of mathematical problems.

Students who have moderate problem solving abilities, in this study, 2 students who had moderate problem solving abilities were taken to be interviewed. The results of the

three students' similarities in mathematical problem solving abilities meet two to three indicators of mathematical problem solving abilities according to Polya. In the first indicator, namely understanding the problem, three students who have medium category problem solving abilities, two of them did not write down the information contained in the problem, but as a result of the interview, the students understood the problem and were able to provide the information contained in the problem. Furthermore, the second indicator, namely making plans, the three students were said to be quite capable of making plans even though there were plans that did not match the problem in the question. Furthermore, the third indicator, namely carrying out plans, these three students can be said to be quite capable of carrying out plans with correct calculation operations even though only two questions received the appropriate answers. Next, the fourth indicator, namely looking back at the three students who had not been able to re-examine the results they had obtained by not writing conclusions on the answer sheet. Internal factors include weak understanding of concepts, inappropriate strategy selection and low self-confidence. Meanwhile, the external factor is a lack of practice in solving various types of mathematical problems.

Students who have low problem solving abilities, in this study, 2 students who had low problem solving abilities were taken to be interviewed. The results of the two students' mathematical problem solving abilities did not meet the four mathematical problem solving indicators. Internal factors include weak understanding of concepts, limitations in analytical thinking abilities. Meanwhile, the external factor is a lack of practice in solving various types of mathematical problems.

4 CONCLUSION

Based on the research results, it can be concluded that the ability of class Most of the mathematical problem solving abilities of X TJKT 2 SMK Assalam Depok are divided into three categories: high problem-solving ability, medium problem-solving ability, and low problem-solving. The majority of the mathematical problem-solving abilities of the class X TJKT 2 SMK Assalam Depok fall into the medium category, with a percentage of 81%. Ability possessed by class Of the 27 students, 1 student has high problem solving abilities, 21 students have moderate problem solving abilities and 4 students have low problem solving abilities.

Students who have high problem solving abilities show that these students are able to fulfill all three to four problem solving indicators according to Polya. The internal factor is choosing an inappropriate strategy and anxiety in solving problems, while the external factor is the lack of practice in solving various types of mathematical problems..

Students who have moderate problem solving abilities show that these students are able to fulfill the two problem solving indicators according to Polya. Internal factors include weak understanding of concepts, inappropriate strategy selection and low self-confidence. Meanwhile, the external factor is a lack of practice in solving various types of mathematical problems.

Students who have low problem solving abilities indicate that these students are not able to fulfill all the problem solving indicators according to Polya. Internal factors include weak understanding of concepts, limitations in analytical thinking abilities and low self-confidence. Meanwhile, the external factor is a lack of practice in solving various types of mathematical problems.

Based on the results of this research, several suggestions are given as follows: 1. The research results show that students need to take a motivational approach so that students are able to have better problem solving abilities. 2. Teachers are also expected to be able to apply various approaches to learning and should pay more attention to guiding students who have low problem solving abilities so that students feel cared for and have the enthusiasm to continue trying to improve their mathematical problem solving abilities.

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