An Analysis of Students' Errors in Solving Mathematical Problems on Trigonometric Materials

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Abstract

This article aims to describe the mistakes made by students in solving mathematical problems in trigonometric materials. This research is a descriptive study with the object of research is class X-MIA MAN 1 Padangsidimpuan with heterogeneous levels of ability. The instrument collects data using essay tests. Data analysis is carried out by reducing the data in the form of paragraphs and images, then drawing conclusions. The results of this study show that the common mistakes made by students in this study are more errors in understanding the problem, errors in planning problem solving, errors in doing calculations and errors in re-examining the answers, namely wrong in understanding the meaning of the question information, not fully understanding the formulas that must be used in doing the questions, errors in the calculation process and students did not find the results requested in the questions, and the error did not re-check the answer and did not carry out the stages of re-checking.

Keywords: *Problem Soving; Mathematical Problem Solving; Trigonometric.*

Abstrak

Artikel ini bertujuan untuk mendeskripsikan kesalahan yang dilakukan oleh siswa dalam pemecahan masalah matematika dalam materi trigonometri. Penelitian ini merupakan penelitian deskriptif dengan objek penelitian adalah kelas X-MIA MAN 1 Padangsidimpuan dengan tingkat kemampuan yang heterogen. Instrumen mengumpulkan data menggunakan tes esai. Analisis data dilakukan dengan mereduksi data dalam bentuk paragraf dan gambar, kemudian menarik kesimpulan. Hasil penelitian ini menunjukkan bahwa kesalahan umum yang dilakukan oleh siswa dalam penelitian ini lebih pada kesalahan dalam memahami masalah, kesalahan dalam merencanakan pemecahan masalah, kesalahan dalam melalukan perhitungan dan kesalahan dalam memeriksa kembali jawaban., yaitu salah dalam memahami maksud dari informasi soal, belum paham sepenuhnya rumus yang harus digunakan dalam mengerjakan soal, kesalahan dalam proses kalkulasi dan siswa tidak menemukan hasil yang diminta dalam soal, dan kesalahan tidak memeriksa kembali jawaban dan tidak melaksanakan tahapan memeriksa kembali.

Kata Kunci: Pemecahan Masalah; Pemecahan Masalah Matematika; Trigonometri.

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INTRODUCTION

Mathematics is one of the branches of basic sciences, plays an important role in developing students' thinking abilities, both thinking skills in mathematics and other fields. Sumanto said that mathematics as an active, dynamic and generative process through mathematical activities makes an important contribution to the development of reason needed in an effort to equip graduates who are able to think logically, critically, and carefully, as well as be objective and open in facing various problems, especially in solving problems related to mathematics (Susanti, 2013).

The ability to solve problems related to mathematics is an activity that requires a high level of thinking. Being able to solve problems that exist in mathematics, means that a person already has the ability to think mathematically. The ability to think mathematically is a thought process to involve the ability to collect information deductively and inductively, analyze information and make generalizations to develop understanding and acquire new knowledge (Lelya Hilda, 2020).

According to Killen (in Susanto, 2013), problem solving as a learning strategy is a technique where problems are used directly as a tool to help students understand the subject matter they are studying. Through solving this problem, students are faced with various problems that are used as learning materials directly so that students become sensitive and responsive to all problems faced by students in their daily lives.

According to Dahar (2011), problem solving is a human activity that combines previously acquired concepts and rules, and not as a generic skill. This understanding implies that when a person has been able to solve a problem, then that person already has a new ability. This capability can be used to resolve relevant issues. The more problems a person can solve, the more he will have the ability that can help him to navigate his daily life. Therefore, a person's ability to solve problems needs to be continuously trained so that a person is able to live a life full of complexity problems.

In general, it can be explained that problem solving is the process of applying the knowledge that has been obtained by students previously into new situations. Problem solving means participation in a task whose method of solving was not previously known (Wahyudin, 2008). Thus, problem solving is basically learning to use scientific methods or thinking systematically, logically, regularly and conscientiously (Syah, 2010). Solving a problem means finding a way, where the path has never been known before, finding a way out of difficulties, a way through obstacles, getting the final result not suddenly, re-cheking the answers with the right result. As an implication, problem-solving skills should be possessed by all children who learn mathematics.

But unfortunately, it is still found that students still have difficulties in learning mathematics, especially in terms of problem-solving ability. Where according to Polya (1973) there are 4 problem solving processes including: *First, we have to understand the problem; we have to see clearly what is required. Second, we have to see how the various items are connected, how the unknown is linked to the data, in order to obtain the idea of the solution, to make a plan. Third, we carry out our plan. Fourth, we look back at the completed solution, we review and discuss it.* In some stages of solving the problem it is still found that students have difficulty in solving the problem. As found by Martin Bernard, et al (2018), namely (1) students are still confused with the work on number operations, which is what must be done first between accretion and multiplication, (2) in understanding essential concepts it means that students have not been able to work or solve problems thoroughly, (3) have not been able to work on the processes and stages to solve problems and (4) students have not been able to apply material in other forms into real objects. Furthermore, in the research of daNofita Damayanti and Kartini, (2022) showed that the results of the analysis of students' mathematical problem-solving ability showed that as many as 75.3% of students already had the ability to understand the problems presented well. Meanwhile, only 15.70% of students did the interpretation of the results obtained.

During the learning process, many students are silent or passive due to ignorance of the material being studied and inability to express their opinions so

that the teacher does not know where the students' difficulties are in the material and the classroom atmosphere becomes quiet.

Students must be able to file conjectures and manipulate, it can be seen that the student's ability is still low. For example, when the teacher gives a question that is different from the previous example, it seems without thinking that they immediately ask the way of completion on the grounds that they do not understand the problem given even though they only need to relate to the material that has been studied before (Delyana, 2015).

Based on the findings of previous researchers above, it is considered necessary to analyze student errors in solving mathematical problems in trigonometric material. The students' mistakes are based on indicators or steps for solving Polya mathematical problems, namely understanding the problem, planning a solution, implementing a completion plan and re-examining the answers. The selection of trigonometric material, because according to Gur (2009) that Trigonometry is one of the learning subjects in mathematics where very few students like it, and experiencing confusion in learning it, students consider trigonometry to be more abstract than other materials.

RESEARCH METHODS

The method used in this research is descriptive research with a qualitative approach, which is research that seeks to describe, illustrate or describe a symptom of events and events systematically according to the circumstances that exist in a population. Thus, this study describes the ability to solve mathematical problems of class X MAN 1 Padangsidimpuan students in trigonometric material.

Agung stated that descriptive research can describe a situation only, but it can also describe the state in the stages of development (Agung, 2014). This study was conducted to describe a phenomenon that exists systematically with the object being studied are students in class X-MIA MAN 1 Padangsidimpuan with heterogeneous levels of ability.

The data collection instruments used in this study were tests and interviews. The test is made in the form of an essay which aims to find out

students' mathematical problem-solving ability in solving 5 math problems with trigonometric material. In the preparation of the test, a grid of questions is first compiled, which is followed by compiling the questions along with the answer key. Furthermore, for interviews, the interviews used in this research were structured interviews. The interview method is used to obtain data on students' ability to complete mathematical problem-solving ability tests given by researchers.

Furthermore, the data analysis technique used in this research is triagulation. According to Sugiyono (Sugiyono, 2011), triangulation technique means that researchers use different data collection techniques to obtain data from existing sources. The triangulation used in this study is a triangulation technique, which is to compare the results of student work with the results of interviews and then analyzed based on Polya steps.

RESULTS AND DISCUSSION

As stated in the previous section, to find out the mistakes made by class X-MIA MAN 1 Padangsidimpuan students in solving questions, a test will be compiled that will be given to students as many as 5 questions about Trigonometry material.

It will be presented in the form of a table of the results of the student's work in solving the problem based on Polya's problem-solving steps. The total number of students is 37 people.

Table 1. Classical Student Answer Percentage Results

Achievement indicators	Answer	Question				
		No. 1	No. 2	No. 3	No. 4	No. 5
Write down known and asked questions on trigonometry-related issues	complete and correct	14 person (37,84%)	28 person (57,68%)	35 person (94,59%)	34 person (91,89%)	37 person (100%)
	correct but incomplete	15 person (40,54%)	6 person (16,22%)	2 person (5,41%).	3 person (8,11%).	0 person (0 %)
	unanswered	8 person (21,62%)	3 person (8,12%).	0 person (0 %)	0 person (0 %)	0 person (0 %)
Write down the theory/method used to solve	complete and correct	6 person (16,22%)	8 person (21,62%)	21 person (57,76 %)	25 person (67,57 %)	16 person (43,24 %)
	correct but incomplete	31 person (83,78%)	29 person (78,38%)	16 person (43,24%.	12 person (32,43%.	21 person (56,76%.
	unanswered	0 person (0 %)	0 person (0 %)	0 person (0 %)	0 person (0 %)	0 person 0 %
Completing by doing calculations, measured by carrying out the plan that has been made and proving that the chosen step is correct	complete and correct	0 person (0 %)	0 person (0 %)	11 person (29,73%)	16 person (43,24%)	2 person (5,41%)
	correct but incomplete	5 person (13,51%)	14 person (37,84%)	24 person (64,87%)	20 person (54,06%)	35 person (94,59%)
	unanswered	32 person (86,49%)	23 person (62,16%)	2 person (5,40%)	1 person (2,70%)	0 person (0 %)
Perform proper checks by means of reverse flow or entering the data queried so that the known data becomes correct.	complete and correct	-	0 person (0 %)	10 person (27,03%)	14 person (37,84%)	-
	correct but incomplete	-	5 person (13,51%)	9 person (24,32%)	19 person (51,35%)	-
	unanswered	-	32 person (86,49%)	18 person (48,65%)	4 person (10,81%)	-

Description:

Questions No.1 to No.5 = In the form of Questions related to Trigonometry material

Based on the students' answer sheet, the following will be presented the process of completing the student's answer which concerns the mathematical problem-solving ability test. The following will be presented the results of the mathematical problem solving ability test on trigometry material.

❖ Question Point Number 1

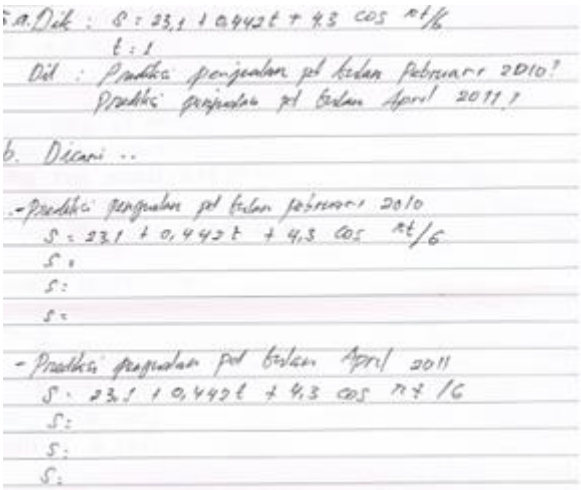

Figure 1. Answer to Question Item Number 1

From the results of the analysis of answer sheets, 14 people who could understand the mathematical problems of the questions correctly and completely (37.84%) and who understood the problem correctly but were incomplete were 15 people (40.54%) and who did not understand the problem at all as many as 8 people (21.62%). In the indicator of planning problem solving, 6 students were able to write down the methods used to solve the problem completely and correctly (16.22%) and 31 students who were able to write down how to solve the problem correctly but incompletely (83.78%). Whereas in the indicators of solving problems / doing calculations, there are absolutely no students who are able to apply problem solving completely and correctly, students who are able to solve problems correctly but incompletely as many as 5 people (13.51%) and do not do problem solving at all there are as many as 32 people (86.49%).

❖ Question Point Number 2

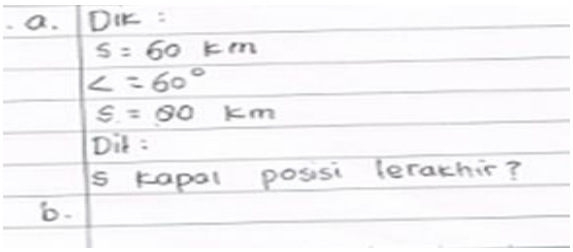

Figure 2. Answer to Question Item Number 2

From the results of the answer sheet analysis, 28 people (57.68%) were able to understand the mathematical problems of the questions correctly but were incomplete as many as 6 people (16.22%) and who did not understand the problem at all were 3 people (8.12%). In the indicator of planning problem solving, 8 students were able to write down the methods used to solve the problem completely and correctly (21.62%) and 29 students who were able to write down how to solve the problem correctly but incompletely (78.38%). Meanwhile, in the indicator of solving problems / doing calculations, there were no students who were able to apply the problem solving completely and correctly, students who were able to solve problems correctly but incompletely as many as 14 people (37.84%) and those who did not make problem solving there were 23 people (62.16%). Furthermore, for the indicator of rechecking the answers, none of the students rechecked the answers correctly and completely, the students who rechecked the correct but non-complete answers were 5 (13.51%) people and did not check the answers again at all as many as 32 people (86.49).

❖ Question Point Number 3

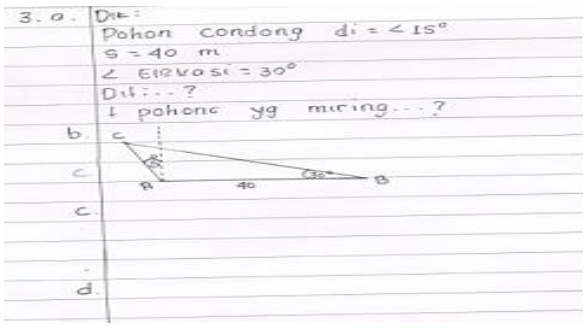

Figure 3. Answer to Question Item Number 3

From the results of the answer sheet analysis, 35 people (94.59%) were able to understand the mathematical problems of the questions correctly and completely (94.59%) and could understand the mathematical problems of the questions correctly but were incomplete as many as 2 people (5.41%). In the indicator of planning problem solving, 21 students were able to write down the methods used to solve the problem completely and correctly (57.76%) and 16 students who were able to write down how to solve the problem correctly but incompletely (43.24). Meanwhile, in the indicators of solving problems / doing calculations, students who are able to apply problem solving completely and correctly in the calculation as many as 11 people (29.73%), are able to solve problems correctly but incompletely as many as 24 people (64.87%) and those who do not make problem solving there are 2 people (5.40%). Furthermore, for the indicator of rechecking answers, students who rechecked the answers correctly and completely were 10 (27.03%) people, re-examined the correct but incomplete answers by 9 (24.32%) people and did not check the answers again at all by 18 people (48.65%).

❖ Question Point Number 4

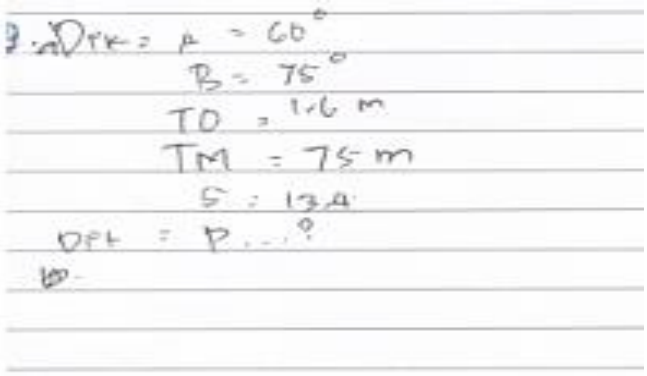

Figure 4. Answer to Question Item Number 4

Based on the students' answer sheet, it can be seen that all students answered the question quite well. From the results of the answer sheet analysis, 34 people (91.89%) were able to understand the mathematical problems of the questions correctly but were incomplete as many as 3 people (8.11%). In the

indicators of planning problem solving, 25 students were able to write down the methods used to solve the problem completely and correctly (67.57%) and 12 students who were able to write down how to solve problems correctly but incompletely (32.43%). Meanwhile, in the indicator of solving problems / doing calculations, students who are able to apply problem solving completely and correctly in the calculation are 16 people (43.24%), able to solve problems correctly but incompletely as many as 20 people (54.06%) and those who do not make problem solving there are 1 person (2.70). Furthermore, for the indicator of rechecking the answers, 14 (37.84%) people who rechecked the answers correctly and completely rechecked the answers were correct, 19 (51.35%) people rechecked the answers correctly and did not check the answers again at all by 4 people (10.81%).

❖ Question Point Number 5

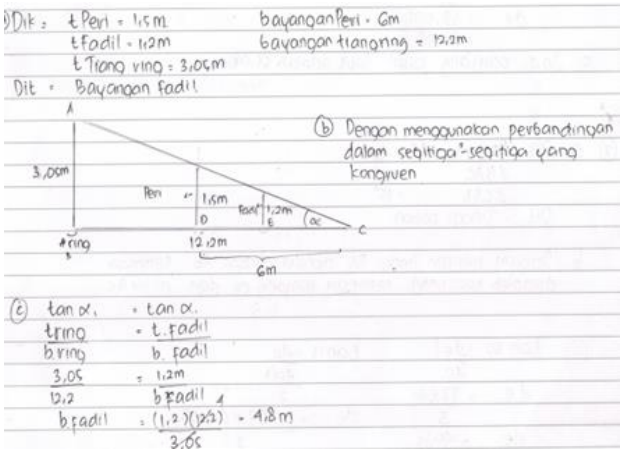

Figure 5. Answer to Question Item Number 5

From the results of the analysis of answer sheets, 37 people (100%) can understand mathematical problems from the questions correctly and completely. The first indicator of problem solving is understanding the problem, in this question number 5, students have no difficulty in understanding the problem. Students are able to write down the known and asked questions contained in problems related to trigonometry correctly and precisely and completely, so that for question number 5, students are not found to understand the problem. In the

indicator of planning problem solving, 16 students were able to write down the methods used to solve the problem completely and correctly (43.24%) and 21 students who were able to write down how to solve the problem correctly but incompletely (56.76%). In the second indicator, some students are able to plan problem solving correctly and correctly. Yet most are correct but incomplete. Students have difficulty in determining a problem-solving plan. The student's mistake in planning the problem solving on question number 5 is a mistake of principle. Meanwhile, in the indicators of solving problems / doing calculations, students who are able to apply problem solving completely and correctly in the calculation as many as 2 people (5.41%), are able to solve problems correctly but incompletely as many as 35 people (94.59%).

As for after analyzing the results of students' answers in solving problem solving questions in the trigonometric theorem material, the forms of errors made by students based on the Polya stage are as follows:

Stages of Understanding the Problem

In questions number 1 and 2, there are still students who are unable to understand the problem. Students have not been able to write down what is known and asked correctly according to the information in the question, and there are even students who do not write it at all. The cause of student error in at this stage is that the student is less able to understand the trigonometric material. Students do not understand trigonometric material so they misunderstand the meaning of the question information. This is in line with Lestanti, et.al (2016) who states that in solving problems, students are expected to understand the process of solving the problem and become skilled in selecting and identifying relevant conditions and concepts, looking for generalizations, formulating plans for solving them, and organizing skills that have been previously possessed.

Stages of Planning for Completion

At the stage of planning for completion, all students perform the role of answering completion. It's just that the role of the settlement that the student wrote

down is still incomplete. The error is that students still do not fully understand the formula that must be used in doing the problem. This is in line with Damayanti's opinion (2022) that in planning for completion, students must be able to plan problem solving by writing down formulas that will be used appropriately. In creating a troubleshooting plan, look for relationships between the information provided and the unknown to determine the formula to use.

Stages of Carrying out Completion

At this stage for questions number 1, 2, 3 and 4, there are still students who do not do calculations at all. Although some others have done calculations but they are still not complete and precise. The mistakes made by students at this stage are that students make mistakes in the calculation process and students do not find the requested results in the questions. This is in line with Ega Gradini, and Bettri Yustinaningrum, (2022) who stated that errors in applying procedures and algorithms cause students to be wrong in carrying out problem solving. Thinking about or reviewing the steps that have been taken in problem solving is a very important activity to improve children's ability to solve problems.

Stages of Rechecking

At the stage of recheking the answers, almost all students did not reach this stage on questions number 2, 3 and 4. Students still make mistakes at the stage of recheking the answers. The mistakes made by students at this stage are the mistakes of not recheking the answers and not carrying out the stages of recheking. This is in line with the Timbul's opinion (2018) that the mistake is not to write down the conclusions of the results of his work, not to re-check the answers and not to carry out the stages of recheking at this stage students should be able to criticalize the results by looking at the weaknesses of the solutions applied (such as: inconsistency or ambiguity or incorrect steps).

CONCLUSION

In the process of learning mathematics, it is obvious that students will find difficulties in solving problems. These difficulties cause students to experience errors in solving problems. Common mistakes made by students in this research are more errors in understanding the problem, namely misunderstanding the meaning of the question information, errors in planning problem solving, namely not fully understanding the formula that must be used in doing the problem, errors in doing calculations, namely students make mistakes in the calculation process and students do not find the results requested in the questions and errors in recheking the answers, namely students did not re-check the answers and did not carry out the stages of re-cheking.

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