Student Errors

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Students' Errors Analysis in Finishing a Problem Solving Test Based on Newman Procedures in Trigonometry Materials

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ABSTRACT

This study aims to describe the types of student errors in solving problems based on the Newman procedure, the causes of errors and solutions to resolve errors made by students in solving problems on Trigonometry material. In this study using qualitative methods. The instruments in this study were tests and interviews. The results of the research are written test data and information from interviews, and the results of the analysis of researchers obtained several conclusions. Mistakes made by students in completing problem-solving test questions on Trigonometry material ie students cannot receive information from the questions properly, students can model through sketch drawings but the information on the sketch does not match the problems in the questions, students are not able to choose what method or formula used to solve problems and lack of understanding of the method or formula chosen, students do not use all the information provided on the problem, as a result of previous mistakes, when the initial process is wrong the final result must be wrong and students are not used to writing conclusions at the end of the work question.

Keywords: problem-solving, student errors, Newman's procedure

ABSTRAK

Penelitian ini bertujuan untuk mendeskripsikan jenis-jenis kesalahan siswa dalam menyelesaikan soal *problem solving* berdasarkan prosedur Newman, penyebab kesalahan dan solusi untuk meminimalkan kesalahan yang dilakukan siswa dalam menyelesaikan soal cerita *Problem solving* pada materi Trigonometri. Dalam penelitian ini menggunakan pendekatan kualitatif. Instrumen dalam penelitian ini yaitu tes dan wawancara. Berdasarkan hasil penelitian yang diperoleh yaitu data hasil tes tertulis dan informasi dari hasil wawancara, serta hasil analisis peneliti diperoleh beberapa kesimpulan. Kesalahan yang dilakukan siswa dalam menyelesaikan soal tes *Problem solving* pada materi Trigonometri yaitu siswa tidak dapat menerima informasi dari soal dengan baik, siswa dapat memodelkan melalui gambar sketsa namun keterangan pada sketsa tidak sesuai dengan permasalahan pada soal, siswa tidak mampu memilih metode atau rumus apa yang digunakan untuk menyelesaikan permasalahan serta kurang paham dengan metode atau rumus yang dipilih, siswa tidak menggunakan semua informasi yang diberikan pada soal, akibat dari kesalahan sebelumnya, ketika proses awal salah otomatis hasil akhir juga pasti salah serta siswa tidak terbiasa dengan penulisan kesimpulan pada bagian akhir pengerjaan soal.

Kata Kunci: *problem solving*, kesalahan siswa, prosedur Newman

INTRODUCTION

Mathematics is the science of numbers, the relationship between numbers, and operational procedures used in solving numbers problems (Departemen Pendidikan dan Kebudayaan, 2008). An important mathematical ability to be possessed by students is the ability to problem-solving (Kaya, Izigiol & Kesan, 2017; Mustafia & Widodo. 2018, Adi Widodo et al, 2018; Argaw et al, 2016). In problem-solving, students are expected to be able to understand the problem-solving process and skilled in selecting and identifying relevant conditions and concepts, looking for generalizations, formulating a plan for solving and organizing skills that they have previously had (Turyanto, Agustito & Widodo, 2019; Rahman & Ahmar, 2016; Akben, 2020). One of the objectives of learning mathematics is to solve problems that include the ability to understand problems, design mathematical models, solve mathematical models, and interpreting the solutions obtained (BSNP, 2006).

In school mathematics problem solving is usually manifested in the form of story problems (Chapman, 2015; Permata, Kusmayadi & Fitriana, 2018). The story is one form of the question that presents problems related to everyday life in the form of stories (Hartini, 2008; Irvan, 2017). Not all story problems can be said to be a problem, as written in the National Council of Teachers of Mathematics (2010) and Amir (2015), some story problems are not problematic enough for students and hence should only be considered as an exercise for students to perform. NCTM (2010), mentioning that some story problems are not problematic enough for students and should only be considered as exercises for students. According to Rochmad (2011) and Adi Widodo et al (2018), a question or question posed to students is a problem for him if the question or problem cannot be immediately resolved by students with routine procedures but provides stimuli and challenges to be answered.

Students must have some competence in finding solutions to story problems to be solved. First, students must have the ability to understand questions and interpret them so that they can transfer into mathematical models or are usually referred to as verbal abilities (Tasni & Suanti, 2017; Wahyudin, 2016; Vendiagrys & Junaedi, 2015). Second, students must have the ability to determine the right algorithm in solving problems, the accuracy of calculations and the ability to conclude from the results of calculations that students do and relate them to the initial problem to be solved or usually called the ability of the algorithm (Ulya, 2016; Hartini, 2008; Cahyani & Setyawati, 2017). Because students' abilities are different, not all students have good verbal skills and algorithmic abilities (Chiang & Lee, 2016).

From an interview with one of the mathematics teachers, this also happened at MAN 2 Gresik. One example of a case that had occurred was the teacher found students making mistakes in solving Trigonometry problems when in the example case looking for the height of a wall where the distance between the lower end of the ladder and the wall was known, and the angle between the stairs and the floor was also known. Some students have difficulty when they have to decide which trigonometric comparison they should use to solve the problem. Besides, students do not know the purpose of the problem, even though the student has good algorithmic abilities. This shows there are still errors made by students in solving problems related to trigonometry, so it is necessary to analyze

the work of students. According to Junaedi (2012), the Newman procedure was chosen because this procedure is a diagnostic method and can be used to identify categories of errors against answers from a description test. Jha (2012) suggested that Newman suggested five specific activities, namely reading, comprehension, transformation, process skills, and encoding. To find out the variation of students' errors and the factors that cause the mistakes made by students, it is necessary to choose the steps of problem-solving by using the Newman procedure to analyze student errors in solving Trigonometry in material story problems. The types of errors according to the Newman procedure that students might do in solving mathematical problems, include student errors in reading problems, student errors in writing, student errors due to inaccuracies, students' transform errors, student errors in process skills, and student errors in understanding the problem (White, 2005).

Previous studies relevant to this research include research conducted by Khaidir & Rahmi (2016) that analyzes students 'errors in solving mathematical story problems based on the Newman, Mulyani & Muhtadi (2019) analyzing error methods of students' mistakes in solving Trigonometry types with Higher Order Thinking Skill types reviewed from gender, Ulfa (2019) analyzes student errors in solving linear program material questions based on Watson criteria, Sari (2018) examines Newman Analysis in Solving Statistics Questions Judging from Metacognitive Tacit Use, Maghfirah, Maidiyah, & Suryawati (2019) analysis of student errors in solving math story problems based on Newman's procedures. Besides, there is also research conducted by Maharani, Mulyanti, & Nurcahyono (2019) with the title analysis of student errors in solving trigonometric problems based on Newman's theory. From some previous studies that have been done by researchers previously, there has been no research aimed at analyzing student errors in resolve test problem-solving stories type based on Newman procedures on trigonometry material. There are some similarities between this research and previous studies, including the equation in taking trigonometric material, the equation in terms of analyzing story problems, or by using the Newman procedure. The difference between this research and some previous research is that here the researcher uses problem-solving story questions to further analyze student errors. There is a novelty that researchers do. This research is deemed necessary to be done so that educators can find out what mistakes are made by students in resolving test problem-solving stories type on Trigonometry material.

RESEARCH METHODS

This research uses a qualitative approach. According to Moleong (2005), with a qualitative approach, the researcher actively interacts privately with the research subject to find out matters relating to student mistakes (Moleong, 2005; Creswell & Creswell, 2017; Forman et al, 2008). This qualitative research was used to find out firsthand the causes and types of students' mistakes in solving mathematical story problems in Trigonometry material class X MIPA 1 in MAN 2 Gresik relating to aspects of problem-solving using the Newman procedure.

The instruments in this study consisted of the main instruments (researchers) and auxiliary instruments that is tests and interview guidelines. Tests on students is used to measure students' mathematical communication skills in writing. This test is a problem-solving story giving about Trigonometry material with 3 items. The test questions given are first validated by experts who are

competent in their fields. Basic Competence for this Trigonometry chapter refers to the BC that has been established. Researchers must be able to formulate indicators of achievement of competencies from basic competencies. Basic competency indicators for making test questions are adjusted to BC and competency achievement indicators. The following are BC and competency achievement indicators for Trigonometry material in Table 1.

Table 1. Basic Competencies and Indicators of Competency Achievement

Basic Competencies	Indicators of Competency Achievement
Explain the ratio trigonometry (sine, cosine, tangent, cosecant, secant, and cotangent) on the right triangle. Solve contextual problems related to trigonometric ratios (sine, cosine, tangent, cosecant, secant, and cotangent) on right triangles	Students can solve contextual problems related to the comparison of trigonometry in right triangles (sine and cosine) in problem-solving story problems.

To find out the level of students 'understanding in resolving test problem-solving stories type and measuring students' level of mathematical communication skills verbally, the interview guidelines used in this study were unstructured interviews. The problem-solving ability test was carried out on Wednesday, April 10, 2019, in MIPA 1 Class X. The test consisted of three questions carried out for 60 minutes and attended by 25 students. Before doing the test the researcher gives instructions and guidelines for the test to the students. After completing the information, students are welcome to take the test that was given. After the time is up, students are asked to collect the results of their tests to the researchers. The results of student work are corrected and then sorted by their score, which is from the largest score to the smallest score to determine the subject to be interviewed. Student scores that have been sorted earlier are then divided into three categories, namely the upper category, the medium category, and the lower category using standard deviations.

Table 2. List Of Results Determining The Subject Of Analysis Of Test Questions

No	Student's name	Mention of it
1	ADS	A1
2	ZHW	A2
3	AJ	A3
4	FDE	B1
5	AHR	B2
6	FIS	B3
7	ZK	C1
8	ENI	C2
9	MHEIM	C3

Group Information :
Top (A1, A2 dan A3)
Medium (B1, B2 dan B3)
Bottom (C1, C2 dan C3)

From the list of grade X students of MIPA 1 MAN 2 Gresik in resolving test problem-solving questions on Trigonometry material, 3 students were taken as subjects to be analyzed the results of

their work, namely from the upper group (A1, A2, and A3), 3 students from the middle group (B1, B2, and B3) and 3 students from the lower group (C1, C2, and C3). Taking 3 students in the upper, middle, and lower groups by taking the 3 lowest scores from each group. The total number of research subjects taken was 9 students of Class X MIPA 1 who had been selected according to the way the research subjects were taken which would then be presented and analyzed the results of their work in solving problem-solving test questions. A list of the results of determining the subjects for which the work results are analyzed is presented in Table 2.

From the list of results of the determination of subjects analyzed for the results of their work presented in Table 2, intensive interviews will be conducted. To find out the different levels of student errors in the upper, middle and lower groups, the results of the test questions of the 9 subjects will be interviewed based on the results of the wrong test work answers. Interviews were conducted using a hand phone as a tool for recording. The subject of the interview is presented as table 3.

Table 3. Interview Subject

Question Number	Interview Subject
1	A_1, A_2, A_3, B_1, B_2, B_3, C_1, C_2, C_3
2	A_2, B_1, B_2, C_1, C_2, C_3
3	B_2, B_3, C_1, C_2, C_3

RESULTS AND DISCUSSION

From the explanation and analysis of the problem-solving test questions about the error analysis of class X students in resolving tets problem-solving stories type based on the Newman procedure on Trigonometry material, it can be summarized into the recap of the types of errors made by students based on the Newman procedure as table 4.

Table 4. Recap The Types Of Mistakes Made By Students In Number 1 Based On The Newman Procedure

Error Type	Student Category	Number of Errors
Reading	-	-
Comprehension	B_3, C_3	2
Transformation	B_1, B_2, C_1, C_2, C_3	5
Process skill	A_1, A_2, A_3, B_1, B_2, B_3, C_1, C_2, C_3	9
Encoding	A_1, A_2, A_3, B_1, B_2, B_3, C_1, C_2, C_3	9

From Table 4, can be seen that the type of error that is mostly done by research subjects in working on problem number 1 is on the type of Process skill and Encoding errors each of 9 students. These mistakes were made by low, medium, and high ability students. Research subjects with a high ability category did not make the types of errors Reading, Comprehension, and Transformation in working on question number 1.

Table 5. Recap the types of mistakes made by students in number 2 based on the Newman procedure

Error Type	Student Category	Number of Errors
Reading	-	-
Comprehension	C_3	1
Transformation	A_2, B_2, C_2, C_3	4
Process skill	A_2, B_1, B_2, C_1, C_2, C_3	6

Error Type	Student Category	Number of Errors
Encoding	A_2, B_1, B_2, C_1, C_2, C_3	6

In problem number 2 this type of error is Transformation, Process skill, and Encoding is done by high, medium, and low ability subjects. Students with a low ability make the most types of mistakes. There are no types of Reading mistakes made by research subjects. A medium capable subject is making a mistake type of Transformation, Process skill, and Encoding error.

Table 6. Recap The Types Of Mistakes Made By Students In Number 3 Based On Newman's Procedures

Error Type	Student Category	Number of Errors
Reading	-	-
Comprehension	B_3, C_3	2
Transformation	B_2, B_3, C_1, C_2, C_3	5
Process skill	B_2, C_1, C_2, C_3	4
Encoding	B_2, B_3, C_1, C_2, C_3	5

The type of error most frequently made by the research subjects in number 3 is the type of Transformation and Encoding errors respectively at 55.5%. This result is different from the results of research conducted by Susilowati & Ratu (2018) which states that the type of error most frequently made by research subjects is the type of Process skill and Encoding errors. The type of research that is not carried out by research subjects is the type of Reading error. A total of 2 subjects or 22.2% of research subjects made a type of Comprehension error.

Based on the results of the recapitulation of the types of errors made by students in numbers 1, 2, and 3 can be summed the types of errors per question-based on the Newman procedure in Table 7.

Table 7. Percentage Of Errors In Numbers 1, 2 And 3 Based On Newman's Procedure

Question Number	*Reading*	*Comprehension*	*Transformation*	*Process skill*	*Encoding*
1	-	2	5	9	9
2	-	4	4	6	6
3	-	2	5	4	5
Number of errors	-	8	14	19	20
Percentage	0.00%	29.62%	51.85%	70.37%	74.07%

In Table 7 it can be seen that most types of Process skill and Encoding errors are made by the research subjects. These results are the same as the results of research conducted by Susilowati & Ratu (2018) which states that the type of error most frequently committed by subjects in their research is type 4 and 5 type errors namely Process skill and Encoding. If seen from the order of the magnitude of the percentage of types of errors made by research subjects can be sorted from the smallest to the largest is the type of error Reading, Comprehension, Transformation, Process Skills, and Encoding. These results are also in line with the results of research conducted by Susilowati & Ratu (2018).

From the results of the analysis of written test answers and interviews, obtained errors made by students in working on the Trigonometry Problem solving test questions based on Newman's procedure as follows:

1. Reading error
   There were no students who experienced reading errors;
2. Comprehension error
   Students cannot receive information from questions properly;
3. Transformation error
   Students can model through sketch drawings but the information on the sketch does not match the problem in the test;
4. Process skill
   Students are not able to choose what methods or formulas to use to solve problems and lack understanding of the method or formula chosen, students do not use all the information given from the test and students are in a hurry because the time is running out, so students directly solve without using settlement method, students do not write down the completion sequence due to previous mistakes when students are wrong in determining the completion method automatically the calculation will also be wrong;
5. Encoding error
   As a result of previous mistakes, when the initial process is wrong the final result is automatically wrong and students are not used to writing conclusions at the end of the work on the problem.

From the mistakes made by students in working on test questions as well as the results of the analysis of written test answers and interviews, found the factors causing the occurrence of student errors in working on the problem-solving test questioning trigonometry as follows:

1. Students are not accustomed to working on problem-solving questions and the questions given as exercises do not vary, almost the questions given in the same context;
2. There are no factors causing Reading errors because there are no students who experience reading errors in working on the Trigonometry problem-solving test questions;
3. factors causing Comprehension error because they do not understand the implied sentences contained in the problem and are not accustomed to working on the problem by using concepts known, asked and answered;
4. factors that cause Transformation errors because they cannot apply the information obtained from the problems into sketch drawings;
5. factors that cause Process skills due to confusion in choosing the right method or formula and not being able to understand the concept of formulas and processes and insufficient time to solve problems;
6. factors that cause encoding errors because they are not accustomed to writing final answers and conclusions when working on problems.

CONCLUSION

Based on the research results obtained which are written test data and information from interviews, and the results of the analysis of researchers obtained several conclusions. Mistakes made by students in completing problem-solving test questions on Trigonometry material, namely,

Students cannot receive information from questions properly, Students can model through sketch drawings, but the information in the sketch does not match the problems in the test. Students are not able to choose what method or formula used to solve the problem and lack of understanding of the method or formula chosen, students do not use all the information provided on the problem, As a result of previous mistakes, when the initial process is wrong the automatic results must also be wrong and students not accustomed to writing conclusions at the end of working on the problem. Researchers provide suggestions for further research to be done to improve the ability of problem-solving in mathematics subject matter and other levels of education.

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