

Analyzing students' errors in solving HOTS mathematics problems based on Newman theory

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Abstract

This research is motivated by the existence of the 2013 curriculum, students are required to have the ability to solve problems independently. In supporting this, the strategy in the 2013 curriculum is learning to apply HOTS type questions. This is also applied in the Muhammadiyah Boarding School Pleret. However, when students worked on HOTS questions, it was seen that students still made many mistakes in working on HOTS questions. This study aims to: (1) Know the types of errors made by students of class XI MBS Pleret in solving Higher Order Thinking Skills (HOTS) Mathematics questions based on Newman's error analysis (2) Know the factors that cause errors in class XI MBS Pleret students in solving problems Higher Order Thinking Skills (HOTS) Mathematics. This type of research is descriptive qualitative. The subjects of this study were students of class XI MBS Pleret, while the object of this research was HOTS (High Order Thinking Skill) type questions. Data collection methods are conducting tests and interviews with students. The instruments used in this study were test questions, interviews and documentation. The analytical method used in this study is data reduction, data presentation, and drawing conclusions. The results of this study were (1) Types of errors made by students of class XI MBS Pleret in solving HOTS questions on trigonometry equation material based on Newman's error analysis consisting of reading errors, understanding errors, transformation errors, skills errors, and errors in writing the final answer. Based on the student error percentage table, the most students made mistakes in the process skills of 98.8% and the errors in writing the final answer was 98.8%. Then for the transformation error of 90.4%, the error in understanding is 67.3% and the smallest error is a reading error which is 66.67%. (2) The causal factors are that students do not know the α symbol (reading errors), students are not used to writing and are known and asked questions other than story questions (comprehension errors), students forget the formula to work on HOTS questions (transformation errors), the result of previous mistakes students made process skill errors and mistakes in writing the final answer.

Keywords: Newmann theory, HOTS problems, students' errors

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INTRODUCTION

Mathematics is one of the basic subjects at all levels of formal education which is related to various other life sciences (Herdiyana, 2019:2). The importance of mathematics in everyday life, it is hoped that all students at every level of education can study mathematics in accordance with the applicable curriculum.

The 2013 curriculum currently in effect requires students to be more active in ongoing learning activities. In participant learning activities students are not

only equipped with formulas for solving problems but are also equipped with the ability for students to solve problems independently. This aims to enable students to think critically, logically, systematically, carefully, effectively and efficiently in solving problems (Permendiknas No. 22 of 2006). The problem solving process requires students to understand the problem, determine how to solve the problem appropriately and obtain a solution to the problem.

One of the learning strategies in the 2013 curriculum is learning that connects HOTS type questions. Higher Order Thinking Skill (HOTS) is the ability to manipulate, connect the knowledge and experience possessed by students in solving a new problem. In HOTS questions, students develop their ability to think into students' ability to be creative (creativity), ability to work together (Collaboration), students' ability to think critically (critical thinking), and the ability to communicate (Communication). In developing the 4 Cs, students can fulfill the HOTS thinking stages, namely the analyzing stage, evaluating stage and creating stage. With the existence of HOTS questions and the demands of students to think analytically, evaluate and create, it becomes a challenge for teachers to be able to create quality learning activities in order to minimize student errors.

However, the facts on the ground are that the results of the HOTS-based learning process are still far from expectations. This is in accordance with what Sucipto said in the Program For International Student Assessment (PISA) report, that Indonesian students are only capable of the second category of the six categories of thinking, namely the category of knowledge and understanding. This proves that the logical and rational thinking abilities of Indonesian students are still in the low category, so educators must improve further in creating fun, creative and innovative learning activities.

The mistakes made by each student are definitely different. The mistakes made by students in working on HOTS mathematics questions, we need to analyze the errors that occur. There are several ways to analyze student errors, one of which is Newman's theory or Newman Error Analysis (NEA). Error analysis according to Newman Error Analysis was introduced in 1977 by Annie Newman (Sari, Ferdiani & Yuwono, 2018). In Newman's theory there are five indicators of students' errors in solving mathematics problems, namely 1) Reading errors 2) Comprehension errors 3) Transformation errors 4) Process skill errors 5) Final Answer Writing Error (Endcoding Errors).

Based on an interview with Ustadz M. Nur Aji Lestahulu., S.Pd as a mathematics teacher for class critical and creative in solving problems. Apart from that, it was also found that many students still experience errors in working on mathematics problems related to analyzing, evaluating and creating. This is proven by the fact that students still make many mistakes which result in unsatisfactory grades. Based on observations, one of the mistakes made by class This is also supported by the results of an interview with one of the students, namely that the student had difficulty understanding the questions and was confused in determining and using formulas.

The results of the researcher's observations saw that the teacher had implemented innovative and creative learning methods or models. Apart from that, before entering learning activities the teacher also builds a good classroom atmosphere and motivates students to take part in learning activities. However, there are still many students who make mistakes in the process of solving contextual problems and drawing graphs in trigonometric equations material. These errors include errors in understanding the questions, errors in

understanding concepts, calculation errors, lack of thoroughness and accuracy in determining the final results, and not writing conclusions well.

The aim of a teacher in analyzing the mistakes made by students in solving mathematics problems, especially HOTS questions, is to know, find and classify the mistakes made by students as well as the factors that cause students to make mistakes. In mathematics subjects, one of the materials that is considered complicated in solving problems is trigonometry, especially trigonometric equations. Based on previous research, (Aini and Irawati, 2018) revealed that there are still many students who experience errors in solving trigonometry problems in story or contextual form. Based on the background description above, researchers are interested in conducting research with the title "Analysis of Student Errors in Solving High Order Thinking Skills (HOTS) Class XI Mathematics Questions Based on Newman's Theory at MBS Pleret".

RESEARCH METHOD

On this occasion the researcher took a type of descriptive research. Meanwhile, the research method itself uses qualitative research methods. This research was carried out at Muhammadiyah Boarding School Pleret. This research was carried out from 06 to 19 February 2023. The subjects of this research were class XI male and female students at MBS Pleret. The subjects in the research were 30 students consisting of 19 female students and 11 male students. Meanwhile, the object of this research is four questions that have been validated first. This question is of the HOTS type and is used to determine the types of errors made by students in the trigonometric equations material. The subjects in this research will be grouped based on the mistakes made by students on the answer sheet. There are three categories of student error scores in solving HOTS questions as follows (Table 1).

Table 1. Student Error Score Category in Solving HOTS questions

Student error score	Error category	Error category
$N \geq mean + 1SD$		Make lots of mistakes
$mean - 1SD \leq N < mean + 1SD$		Is making a mistake
$N < mean - 1SD$		Made a few mistakes

In this research, data collection techniques were used directly in class. Apart from that, this research also uses data analysis techniques in the form of error analysis methods according to Newman. The researcher himself is the main instrument in this research. Apart from that, other instruments used are observation, tests, interviews and documentation. The test instrument used in this research was in the form of a description test. This test consists of 4 questions that represent each sub-chapter in the trigonometric equations material. This test question is based on the HOTS question indicator.

Table 2. HOTS Question Indicator

Cognitive Level	Description	Operational Verbs
Analyzing	Specify aspects/elements.	Compare, criticize, sort, differentiate, determine.
Evaluate	Make your own decisions.	Evaluate, judge, refute, decide, choose, support.
Create	Create your own ideas or ideas	Construct, design, create, develop, write, formulate

Apart from that, for the interview instrument, the researcher used a semi-structured interview method. Semi-structured interviews are interviews conducted with questions that suit the problem-solving conditions of students. Interviews were conducted so that researchers could find out the factors that caused students to make mistakes in solving HOTS questions on trigonometric equations. The final instrument is documentation. Documentation is carried out when making observations, students working on questions and the results of students' work in completing HOTS questions.

In this study, the validity of the data was tested using triangulation techniques. The triangulation used is technical triangulation, namely triangulation carried out using different data collection techniques but from the same source. The technique used is the result of an error what students do on answer sheets and interview results on the same data source. If the results of the answer sheet analysis and the interview results have many similarities then the data obtained can be declared valid.

This research uses data analysis techniques which aim to determine the types of students' errors in solving HOTS questions. In analyzing student errors, researchers used Newman's error analysis theory. According to Miles and Huberman, the stages in analyzing data in this research are limited to using 3 stages (in Sugiyono, 2014:334), namely reducing data, presenting data and drawing conclusions.

RESULTS AND DISCUSSION

In this research, the data collected is in the form of student answer sheets which will be checked by researchers. Researchers analyzed the types of errors in solving HOTS questions on trigonometric equations material made by students based on Newman's theory. The results of the analysis of students' errors in solving HOTS questions on trigonometric equations based on Newman's theory are as follows (Table 3).

Table 3. The number of errors made by students in each type of error

Type of Errors	<u>About numbers</u>						Total	Percentage
	1a	1b	2a	2b	3	4		
Reading error	28	28	28	28	0	0	112	66,67 %
Misunderstanding	22	23	20	20	21	8	114	67,3 %
Transformation error	22	27	27	27	26	23	152	90,4 %
Skill errors	28	28	28	28	28	26	166	98,8%
Write down the final answer	28	28	28	28	27	27	166	98,8 %
Total	128	134	131	131	102	86	710	-

The research results obtained by researchers from research conducted at MBS Pleret, show that almost all students made mistakes in solving HOTS questions on trigonometric equations. So the researcher analyzed the types of students' errors based on Newman's analysis theory. This is to answer the problem formulation "What types of errors do class XI MBS Pleret students make in solving Higher Order Thinking Skills (HOTS) Mathematics questions based on Newman's error analysis?" The following is a discussion of mistakes made by research subjects.

Types of errors made by students in solving HOTS questions

Reading error

Reading is one of the abilities that every student must have in order to solve the questions given. The aim of this is to obtain information consisting of the contents of the question and understand the question so that someone gets information that was previously unknown.

Reading errors are made when students read the questions. This error occurs because students are not able to read the symbols as the main information of the questions so that students use this information in working on the questions and the students' answers do not match the meaning of the questions. Students can read the questions well and correctly but students cannot answer or complete the question. Based on interviews conducted with research subjects in this study, it was discovered that students did not complete or answer the questions because the students forgot, even though the students were able to work on the questions during the course material.

Comprehension error

In this understanding error, there are three types of errors, namely students write what is known correctly but do not write what is asked, write only what is known and do not write what is known or asked. Based on the results of interviews with participants, students were not used to it and thought it was not very important to write it on questions other than story questions. Even though writing is known and asked, it really makes it easier for students to solve problems. Apart from that, it is also because students are confused or have difficulty understanding the meaning of the questions given.

Transformation error

Misunderstandings made by students will influence students to make transformation errors. This is because students cannot understand the questions completely, so students will also find it difficult to determine what to use in solving the questions. Students are unable to change story problems into mathematical form. Besides that also, students do not write down the trigonometric identity formulas used.

Skill error process

The transformation stage is closely related to the skill stage. If students do not write down the method or initial steps in solving the problem, then students cannot complete this skill stage. This also results in students experiencing errors in writing the final answer.

Form an error in writing the final answer

In this case, students are able to write down the method used to solve the problem but do not write the final answer. This is because the students. There are also students who do not write down the final answer at all because the students do not write down the method that will be used to solve the questions and cannot complete the skills stage. Based on the results of the interviews, students forgot and students did not understand how to solve the questions.

Factors that influence students to make mistakes in solving HOTS questions

Students making mistakes in solving questions are not done intentionally, but this is influenced by several factors. The influencing factors come from internal

and external factors. Internal factors are factors that come from within the students themselves, for example physical and psychological factors. Meanwhile, external factors are factors that come from outside the student, for example family factors, school environment factors and the community environment.

Based on the results of interviews obtained from 28 students, it can be seen that all research subjects made mistakes on the questions given. The following are factors that influence students to make mistakes in solving HOTS questions.

Reading error

Almost all research subjects made reading errors when reading questions number 1 and 2. Meanwhile, for numbers 3 and 4, students did not experience reading errors. The cause of the subject making reading errors was a lack of familiarity with the symbols in mathematics.

Misunderstanding.

The causes of research subjects making mistakes in understanding the questions are as follows: (1) Not used to writing down what is known and what is asked other than story questions. (2) Confused about what to write as known and asked. (3) Difficulty understanding the questions.

Transformation error

The causes of research subjects making transformation errors are as follows: (1) Don't know the steps in solving the problem. (2) Don't know the trigonometric identity formula. (3) Lack of mastery of the steps in drawing graphs. (4) Students are incomplete in writing formulas.

Skill errors

The causes of research subjects making skill errors are as follows: (1) Be careless in writing down the steps in solving the problem. (2) As a result of students making previous mistakes.

Error writing the answer

The reasons why research subjects made mistakes in writing the final answer were as follows: (1) Not used to writing conclusions. (2) The consequences of previous mistakes.

Based on observations, there are several other factors that cause students to make many mistakes. These factors include: (1) Students do not pay attention to the teacher's explanation in learning activities. (2) Students still ask a lot of questions and have discussions so that the errors in solving questions are almost the same.

CONCLUSION

Based on the results and discussion in chapter IV, the following conclusions can be drawn.

The types of errors made by class

Based on the table of student error percentages, students made the most errors in process skills at 98.8% and errors in writing final answers at 98.8%. Then the transformation error was 90.4%, the understanding error was 67.3% and the smallest error was the reading error, namely 66.67%.

Factors that cause students to make mistakes

The cause of students making reading errors is that students do not know the mathematical symbols contained in the questions. The causes of students making errors in understanding are that students do not understand what they know and are asked questions about, students forget to write down information that they know and are asked questions about, and students are not used to writing down what they know and ask questions except for story questions.

The cause of students making transformation errors is that students are confused about determining the right first step in solving the problem, students don't know which formula to use to solve the problem, and students forget the trigonometry equation material.

The cause of students making process skills errors is that students just do calculations and the consequences of previous mistakes.

The cause of students making mistakes in writing the final answer is because students made previous mistakes, students forgot to write conclusions and students are not used to writing conclusions on the results of solving questions.

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