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Student Error Analysis in Solving Mathematical Problems

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Abstract Many factors influence and cause the learners feel difficult in resolving mathematical problems. One of these factors is the mistake of students when solving problems in mathematics. The research aims to analyze students' mistakes in working with mathematical diagnostic tests. The method used in this study is a quantitative descriptive where the data was taken through a diagnostic test result of 251 students. The instrument used in this research is a valid and reliable two-tier multiple-choice test instrument. The researcher later corrected student test results. Once fixed, the answer was later analyzed using Newman's theory based on four indicators, i.e. (1) Error understanding, (2) error transforming, (3) Error processing skills, and (4) Error writing answers and then described. Results in research shows the mistakes that students do in resolving mathematical problems in calculus material are largely due to errors in understanding, errors of transformation, and error in process skills. Based on the results of the study, researchers concluded that students have done mistakes in resolving mathematical problems in calculus material largely due to errors in understanding, error transformation, and error in process skills. To overcome the mistakes that students do when solving mathematical problems can be used by several scaffolding solutions, using a creative and innovative learning model and tell students what they are doing and instantly fix them.

Keywords Error Analysis, Mathematics, Diagnostic Tests

1. Introduction

Mathematics education has a significant role, because mathematics is a fundamental science that is used widely in various areas of life. Good education is capable of producing output or achievement and quality and has ability that can be beneficial for others (Santrock, 2011:53). Chambers (2008:9) mentions that mathematics is a science of abstract patterns that have characteristics as a tool to solve problems, as a foundation of scientific and technological studies, and can provide ways to model the situation in real life. As students learn math, students will know about the power of mathematics which will eventually develop the skills of learning to learn. The student's reasoned ability through the mathematical

learning process will increase students' readiness to become human beings who have a lifetime learner or a lifelong study.

It is clearly seen the importance of mathematics so that mathematics needs to be learned, understood, and mastered by students. But the results of the mathematics learning performed in schools are still not optimal, it can be seen from the number of students who are still experiencing difficulties in learning mathematics. The difficulties experienced by the students are explained in the research conducted by Yeo (2009), that from the results of the interview difficulties experienced by students in the understanding of mathematics is a lack of understanding of the problem caused, lack of knowledge to do strategies in resolving a problem, inability to translate problems into mathematics, and the inability of students to use true mathematics (Sidnyaev & Sobolev. 2018).

One of the mathematical materials that is considered difficult is calculus material. Calculus studied in schools include function limits, derivative functions, and integrals. Based on interviews conducted with some students, information that students have difficulty in calculus material due to abstract material that is difficult to find application in daily life and also explanation given by teachers in school is limited to explanation on how to do or administering the formula without further discussing what the real concept is about calculus.

Many factors influence and caused students feel difficult in resolving mathematical problems. One of these factors is the mistake of students when solving problems in mathematics. Difficulties in solving mathematical problems will not be detached from the mistakes he does. Mistakes are a deviation of the right things that are systematic, consistent, or incidental. For systematic errors are also consistent because of the level of mastery of material that is not optimal in students, such as students are wrong in understanding a concept of mathematics material or students wrong in solving mathematical problems. While the incidental error is an error that is not caused by the level of mastery of material but caused by other things, such as sloppy, less careful in reading or counting, working in haste, etc.

One way to diagnose or analyze the students' mistake is with a two-tier multiple choices. The two-tier multiple choice is a multiple-choice test that has two level (tier) options. The first stage is a multiple-choice question with five answer options while the second stage contains questions about the reason for the choice of answers in the first phase with a few reasons (Chandrasegaran, Treagust & Mocerino: 2007). The reason given consists of one correct answer and a distractor. The distractor's statements are the misconceptions derived from answers of the students, literature studies, interviews, or open-ended responses.

2. Method

This research is quantitative descriptive research. The research Data is obtained from a mathematics test that amounted to 15 questions. The samples of this study were students who numbered 251 students. Data is then collected through a two-tier multiple-choice diagnostic test. Students test results were later corrected by the researcher. Once corrected, the answer was later analyzed using Newman's theory based on four indicators i.e. (1) Error understanding, (2) error transforming, (3) Error processing skills, and (4) Error writing answers and then described.

3. Result

Findings from the research results were described based on an error indicator according to Newman theory to determine what the students were doing. There is also an overview of the general error findings in this study described as follows.

Figure 1. Student error percentage based on Newman theory

Based on Figure 1 of the results of the students' test answers, it shows the percentage of students who make mistakes on each item. As seen in Figure 1 that the mistakes students have done in completing the diagnostic test instrument two-tier multiple-choice calculus material is largely due to error understanding, fault transformation, and fault process skills. It is not much different from the results of the research done by Maheasy (2018:55) which reveals that the students' mistakes in resolving hots problems are largely due to mistakes in understanding the intent of the problems given, then the mistakes of transformation and process skills, thus leading to the writing of the final answer becomes wrong. The results of research obtained were also supported by the research results of Singh, Rahman, and Hoon (2010:270) as well as research by Ellerton and Clements (1996:191) which found that mistakes in mathematical processes or processing are more performed by students when answering mathematical questions.

Further explanation based on Figure 1 is for question number 1, number 2, and number 3 obtained that the most errors performed by the students is the error of process skills. As for the mistake of understanding and mistakes write down the answer of 0% respectively. Furthermore, the question number 4 is obtained that 58% of students are wrong in understanding the problem. Most students do not understand the intent of the question and what rules should be used to solve it. Then for a question number 5 can be seen that the student who did the error of understanding there 11%, the transformation error there is 15%, and the process skills error 17%. For the results of analysis of Number 6 obtained students who make mistakes understand there is 18%, error transformation there is 21%, error process skills is 9%, and error writing the answer there 8%. The mistake of understanding committed by students are doing is that students do not understand the meaning of angular velocity as a derivative as asked questions.

Then for a question the number 7 gained that many students have error understanding and error transformation which each is 48% and 45%. Problem number 7 is like in question number 5, students do not understand what is asked of the problem and students also do not understand the use of the information related to the question about how to resolve the problem.

Further to question number 8 can be seen that many students make mistakes. The highest mistake is on the process skill fault of 66%. Next to the question number 9 obtained error understanding 22%, error transformation 12%, error the process skills 20%, and error writing the answer 12%. The mistake of understanding that the student did at number 9 is that students do not understand the purpose of the bullish monotonous question that is in question. For analysis of Number 10 is obtained that not many students make mistakes. The error is a transformation error of 8% and the process skill error of 9%. For error understanding and error writing the answer does not happen because of the type of problem that is a routine question and students can understand what is asked in question appropriately.

Furthermore, the number 11 obtained that students make mistakes by 10%, error transformation 29%, error process skills 25%, and errors wrote down the answer 12%. Then for the number 12 obtained error results understand 0%, error transformation 12%, error process skills 26%, and error writing down the 0% answer. In question number 12 does not occur the mistake because every student comprehends what is asked of the question and also comprehend the symbol of the integral well. Further to the number 13 errors that occurred is a transformation error of 46% and the process skill error of 14%. For errors understand and mistake to write an answer does not occur

because as a reason in question number 12 because the type of question number 12 and number 13 is the same.

The result an analysis of number 14 obtained error understanding 45%, transformation error 49%, processing skills error 36%, and error writing the answer 20%. In question the number 14 mistake that most students do is error understanding and error transformation. The mistake of understanding happened because students did not understand what was asked of the question and also did not understand the information on the question to solve the problem. Next to number 15 obtained error understanding 20%, error transformation 25%, error process 9% processing, and error writing the answer 13%. The mistake of understanding is that some students cannot determine the relevant information and not the question, so that students do not use the gradient information to solve the problem.

4. Discussion

4.1. Comprehension Error or Error Understanding Problem

Comprehension Error or Error Understanding the problem is that students simply understand the problem but do not actually capture the information contained in the question so that the student cannot process further solution from the problem. It is supported by the statements of Abdullah, Abidin, and Ali (2015:136) stating that errors of understanding or comprehension errors occur when students can read questions but fail to understand what is asked and needed. Regarding comprehension error or error understanding that students do as seen in Figure 2 that most students make mistakes understanding in Question No. 4 of 58%, Question No. 7 by 48%, Question No. 8 by 39%, and about number 14 of 45%. This is due to the type of question on the numbers 4, 7, 8, and 14 is a matter of not routine that students are rarely typed in the class so that Shiva cannot understand well the problem is given.

4.2. Transformation Error

Based on the picture 11 above, it can be seen that in every item there are students who have wronged the transformation. Transformation error or transformation error is students fail to understand the problem to be transformed into true mathematics. Students also tend to directly use mathematical procedures without analyzing whether the procedure is needed or not or students can also use procedures or concepts that are not related to the problem given.

Transformation errors which is done by lot of students in this study is that students cannot change the problem into the form of mathematical models and in addition students cannot determine the right concept or procedure to solve the problem given. It is in accordance with the research conducted by Wijaya, Heuvel-Panhuizena, Doormana, and robitzschc (2014:577) which shows that in error of transformation obtained as many as 68% of students are wrong in determining the mathematical concept used to solve the problem.

4.3. Process Skill Error

Process skill errors or error processing skills, in this type of error students use rules or rule solving the problem correctly, but make mistakes in computation and computing. Based on image 8 obtained information that students most often mistake process skills on numbers, 1, 2.3, and 8 consecutives by 42%, 69%, 51%, and 66%. In question number 1.2, and 3 because of the same type of question then most of the mistakes of the process skills performed are the same.

4.4. Encoding Error or Error Writing an Answer

Encoding error or error writing the answer is that students cannot interpret correctly the answer obtained. Based on picture 9 obtained that error the most answer happened to question number 8 and number 14 in a row by 21% and 20%. In question number 8, there are a lot of students who cannot continue the process of solving the problem and cause students cannot determine the right solution so that students cannot understand the meaning or the relationship between the solutions obtained with the questions asked of the problem. Then for number 14, many students do not write the final conclusion of the answers gained.

5. Conclusions

Based on the results of the study, researchers concluded that students have done mistakes in resolving mathematical problems in calculus material largely due to errors in understanding, error transformation, and error in process skills. To overcome the mistakes that students do when solving mathematical problems can be used by several scaffolding solutions, using a creative and innovative learning model and asking students what they are doing instantly fix them.

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