UJME 9 (3) 2020: 211-217
UNNES JOURNAL OF MATHEMATICS EDUCATION
https://journal.unnes.ac.id/sju/index.php/ujme/
ISSN: 2252-6927 (print); 2460-5840 (online)

Analysis of students mistakes in solving open ended question based on Newman's procedures on Treffinger learning model

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ARTICLEINFO

Article history:
Received 18 October 2020
Received in revised form 29 October 2020
Accepted 17 November 2020

Keywords:
Open-Ended Questions;
Geometry;
Newman's Procedures;
Trefinger

Abstract

The purpose of this study was to determine the types of errors and causes of student errors in terms of the Newman procedure in solving open-ended questions on geometry and to determine the quality of learning using the contextual-based Treffinger model and achieving classical completeness. This research is a mix methods research. The design used in quantitative research is the Pre-Experimental Design with the type of One-Shot Case Study Design.The population in this study was 8th grade of SMP Muhammadiyah 8 Semarang with a sample of 8th U1 grade. Six students were selected as research subject. The data were taken by observation, interview, test and analyzed by using classical and descriptive qualitative learning mastery test. The results showed that an error in understanding the problem was carried out by one subject in the medium group and all subjects in the lower group, a transformation error was carried out by one subject in each group, an error in processing ability was carried out by all subjects in the upper group and one subject in the medium or medium group, then writing errors were made by all subjects in the upper group and one subject in the medium group. The cause of misunderstanding the problem is that students do not understand the problems listed on the questions. The cause of the transformation error is that students do not know the strategy used. The cause of processing ability errors is that students cannot determine the calculation correctly. Writing errors were caused by students not being careful in writing answers. The quality of learning in the contextual-based Treffinger model and the students' ability to solve open-ended questions on geometry using the contextual-based Treffinger model achieve classical learning completeness.

1. Introduction

Education is one of the factors that influence the progress of a country. If Indonesia wants to improve the quality of its human resources, it must have a high commitment to continue to develop the quality of education, because the current condition of Indonesian education is still worrying in various fields. This can be seen from data from international studies that the ability of Indonesian children aged 15 years in the fields of mathematics, science, and reading is still low compared to other children in the world. Based on the results of the 2018 Program for International Student Assessment (PISA) survey, Indonesia's position is very low, which is ranked 72nd out of 78 countries for math scores, 70th out of 78 countries for science scores, and 72nd out of 77 countries for reading score. The results of the international survey Trends in International Mathematics and Science Study (TIMSS) 2015 are still low, Indonesia is ranked 44th out of 49 countries, which means Indonesia is in the fifth lowest rank of all countries that join. Mathematics score of 397, puts Indonesia in 45th out of 50 countries. In the field of Science, with a score of 397, Indonesia ranks 45th out of 48 countries. This indicates that there is a problem that must be solved from the education process in Indonesia, especially in the field of mathematics and the quality of learning. The quality of learning mathematics can be seen in two aspects, namely the quality of the process and the

To cite this article:
Haryanto, C. & Pujiastuti, E. (2020). Analysis of students mistakes in solving open ended question based on Newman's procedures on Treffinger learning model. *Unnes Journal of Mathematics Education*, *9*(3), 211-217. doi: 10.15294/ujme.v9i3.41299

quality of the results (Rizki, 2013: 152). In addition, to know the quality of a mathematics lesson, it must be seen from the quality of the lesson planning itself.

Nasser & Carifio (1993) stated that for many years errors in mathematics were considered as a form of procedural or computational errors. In the last decade, the focus of attention is not only on procedural errors but rather on conceptual errors and misconceptions. So that the forms of student error in solving math problems are very diverse, be it procedural, computational, conceptual, and misconception errors. If investigated further, many students were unable to answer the questions correctly because of errors in solving the questions, especially the description questions.

Students' mistakes in working on questions need to be analyzed to find out what mistakes were made by students and why these mistakes were made. Error analysis is an assessment tool used to determine areas of instructional need (Fleishchner & Manheimer, 1997). It can be interpreted that error analysis is an assessment tool used to determine the location of instructional needs. This means that error analysis can be used to see the extent of students' mistakes in making assignments. The ability of a teacher must use supporting facilities in learning that can bring up students' creative ideas, one of which is giving Open-ended questions. In Open-ended problems, there are more than one correct answer or contain various ways to get the right answer. So, analyzing student errors using open-ended questions is highly recommended to find out the extent to which the knowledge is absorbed by students and in developing students' logical, analytical, systematic, critical, and creative thinking. Open-ended problems challenge students to think critically, broadly, and openly so that students are trained to solve problems related to students' daily lives. Learning material that is related to students' daily lives is the core of one of the contextual learning models (Karina, 2013: 107).

The Newman error analysis method was first introduced in 1977 by Anne Newman, a mathematics teacher in Australia. In solving a problem, Newman divides it into five steps or stages of solving a problem, namely: (1) reading the problem, (2) comprehension, (3) transformation, (4) process skills, (5) encoding. The selection of steps or stages of problem solving using the Newman procedure to analyze student errors in solving open-ended questions is expected to find out variations in student errors and their causes. White (2005) classify and categorize of Newman's procedural errors is reading errors, misunderstanding problems, errors in transforming problems, processing skills errors, and errors in writing answers. The Newman procedure was chosen because it is for analyzing the errors of a test blurb.

Based on the results of an interview with a mathematics teacher at SMP Muhammadiyah 8 Semarang, it was stated that the Newman procedure had never been used to analyze student errors in solving essay questions, especially open-ended questions. In addition, only what percentage of students are able to solve open-ended questions because the students' conceptual understanding of mathematics problems is indeed not good so that when they are given open-ended questions, students are still classified as lacking. From the results of the preliminary study questions of one of the 9^{th} grade students of SMP Muhammadiyah 8 Semarang, it showed that there were still many mistakes made in solving open-ended questions on geometry material taught in 8^{th} grade semester 2. Furthermore, based on statistical results, it shows that the percentage of students' absorption of the ability to solve problems related to the application of the area formula in calculating the area of a room is still low, namely for the educational unit level 26.45, city/district level 39.61, provincial level 32.89, and national level 31 , 31. So it can be concluded that students' understanding of the application of the formula solid area is less than 50%. From the results of the interview, the teacher also stated that the students' understanding of the surface area of the prism and pyramid was still low. Therefore we need a learning model that can improve students' problem solving abilities and creativity, one of which is the Treffinger learning model. Learning mathematics using the Treffinger model of creative learning can train students to express their ideas creatively so that in the end students will be able to find the most effective way to solve a problem. In addition, this model also involves affective aspects of problem solving which enable students to understand the situation and conditions of a problem. In a study conducted by Pomalato (2006) it was proven that the Treffinger model learning in mathematics learning made a positive contribution to increasing students' mathematical creativity in learning mathematics.

Based on these problems, the purpose of this study is to determine the quality of mathematics learning using the contextual-based Treffinger learning model, to test whether students' abilities in solving open-ended questions on geometry material in contextual-based Treffinger learning can achieve classical learning completeness, knowing the types of errors, and the cause of the error of 8^{th} grade students of

SMP Muhammadiyah 8 Semarang in solving open-ended questions on geometry using the Newman procedure.

2. Method

This study uses a combination of qualitative and quantitative research methods (mix method). The qualitative method is used to show more accurately the students' misconceptions in working on open-ended questions on the surface area of the prism and pyramid with the Newman procedure guide, while the quantitative method is used to test students' ability to solve open-ended questions in the Treffinger model learning.

The population in this research were 8^{th} students of SMP Muhammadiyah 8 Semarang in the 2019/2020 academic year consisting class 8^{th} U_1, 8^{th} U_2, 8^{th} A, and 8^{th} B. The sampling technique was taken by random sampling technique. This technique is carried out because the members of the poll are considered homogeneous by paying attention to characteristics, including: students who are the object of the research sit at the same class level, students receive material based on the same curriculum, the same learning resource books, and there are no superior classes. In this study, one class was randomly selected from the population as the sample, namely class 8^{th} U_1 with 24 students.

Furthermore, several research subject were selected from class 8^{th} U_1. After obtaining a valid research instrument. The research instrument was then tested on one of the samples of class 8^{th} U_1. The first step taken to determine the research subject is that the results of student work are corrected and then sorted based on the score, namely from the largest score to the smallest. The scores of the students who had been sorted were then divided into three groups, namely the upper group, the medium group, and the lower group. Then 2 students were taken as research subjects from the upper group (S_1 and S_2), 2 students from the medium group (S_3 and S_4), and 2 students from the lower group (S_5 and S_6). So, the total number of research subjects taken was 6 students. The selection of research subjects selected from different groups is more intended to capture complete information.

The data collection technique used in this study was to collect quantitative data using open-ended posstest questions. The posstest is given in the form of open-ended questions about prism and pyramid material. Whereas for qualitative data using observation, interviews, written tests, and documentation. Observation is used to determine the quality of mathematics learning by using the contextual-based Treffinger learning model, interviews are used to obtain descriptions of errors in solving open-ended questions on geometry material and the causes of these errors from each research subject, written tests are used to obtain data about student errors in solve open-ended questions on geometry material. Meanwhile, documentation is used to obtain data on the names of students who are members of the sample and research subjects as well as pictures of the results of the open-ended test questions.

The research instruments used in this study included researchers, written tests, interview guides, and learning tools consisting of lesson plans, student worksheets, student assignments, syllabus pieces. Researchers in this study went into the field themselves, both in the grand tour question, focused and selection stage, conducting data collection, analysis and making conclusions. The test instrument used is in the form of a description because it can measure the ability of students to solve problems that require higher thinking skills which are characteristics of open-ended questions. The interview guide is used to obtain data directly about the types of errors that students make in working on open-ended questions based on the Newman procedure and the causes of these errors.

The analysis carried out includes quantitative analysis and qualitative analysis. The quantitative analysis used was the mastery test based on the minimum mastery criteria (MMC) using SPSS 21 software through the One-Sample T Test and classical learning mastery test with the z-test. Qualitative data analysis used data reduction, data presentation, triangulation, and conclusions.

To determine the validity of the data, an inspection technique is needed based on a number of certain criteria, namely triangulation. Technique and time triangulation was carried out by comparing the results of the final open test on the Treffinger model of learning with the data from interviews of researchers with research subject.

3. Results and Discussion.

3.1. Results and Quantitative Discussion

The normality test is used to determine whether the data obtained comes from a population that is normally distributed or not. The final data tested came from the results of the students' open-ended tests. This normality test uses the Shapiro-Wilk test with the help of SPSS 20.0 which shows that the final data is normally distributed. Hypothesis 1 test in this research includes completeness based on the minimum mastery criteria (MMC) and classical mastery test. Mastery based on the minimum mastery criteria (MMC) is used to find out the average value of the posstest open-ended questions in class 8th U1 whether or not it meets the minimum mastery criteria (MMC) completeness. The completeness test based on the minimum mastery criteria (MMC) uses SPSS 21 software through the One-Sample T Test. Based on the calculation results, the significance value for the experimental class is sig = 0.000 < 0.05. Based on the test criteria, H_0 is rejected. This shows that the average ability to solve open-ended questions on geometry material for eighth grade students of SMP Muhammadiyah 8 Semarang using the Treffinger model achieves the specified MMC.

To find out learning through the Treffinger model with open-ended questions, a one-party proportion test was carried out, namely the right side. Based on the calculation results obtained z_{count} = 1.93. The value of z_{table} with α = 5% and dk = 24 - 1 = 23 is 1.64. Because z_{count} = 1.93> z_{table} = 1.64, so H_0 is rejected. So, the percentage of students in the experimental class reached the limit of actual completeness in proportion to the open-ended mathematics test of geometry material in the Treffinger model learning of more than 75%.

Based on the results of the hypothesis test above, students experience completeness based on the minimum mastery criteria (MMC) and classical in solving open-ended questions on geometric material in contextual-based learning of the Treffinger model. These results are in line with research conducted by Irvana (2019) which shows that the ability to think creatively in 8th grade students who are taught through Treffinger learning in solving open-ended problems with the phythagorean theorem material can achieve learning completeness.

3.2. Results and Qualitative Discussion

3.2.1. The Quality of Learning Mathematics Using the Contextual-Based Treffinger Model

The quality of learning consists of three aspects, namely learning planning, learning implementation, and learning outcomes. Planning carried out in this study is to make learning tools consisting of a syllabus and a lesson plan. The results of the syllabus validation assessment and the lesson plan validation assessment showed that the syllabus and lesson plans were in good criteria and each score was 78.75% for the syllabus assessment and 77.26% for the lesson plan assessment.

The implementation of the Treffinger learning process is assessed based on observations of teacher activities and student activities. Based on the results of the final score of teacher activity and student activity in Treffinger learning, it was found that the teacher's activity and student activity were in very good criteria with 89% and 87.75%, respectively. This means that the implementation of the Treffinger learning process has been carried out very well.

Assessment of learning outcomes carried out in this study is by means of formative tests. Based on the researcher's analysis, it was found that 75% of students fulfilled the minimum mastery criteria (MMC) that had been set on the formative test, namely 65 of the total score of 100.

From the results and discussion above, it shows that the quality of contextual-based Treffinger learning is good.

3.2.2. Types and Causes of Student Errors

Based on the results of the final test which consisted of four open-ended questions, the research subjects were taken by making a ranking based on the scores obtained by students, then divided into three groups, namely the upper, middle, and lower groups. Subjects were taken randomly in each group. The group consists of research subject 1 (S_1) and research subject 2 (S_2). The medium group consisted of research subject 3 (S_3) and research subject 4 (S_4). The lower group consisted of research subject 5 (S_5) and research subject 6 (S_6).

One question is selected from the results of the research subject's work to be analyzed, then from the results of the analysis, reinforcement is given through triangulation based on the results of the interview.

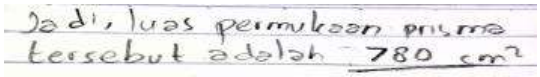

Figure 1. Excerpts of errors resulting from S_1 work

Based on the results of the analysis, it was found that the error made by S_1 was a writing error. The writing error occurred because S_1 did not read the questions carefully and only focused on the word in the question, which was in the form of a prism.

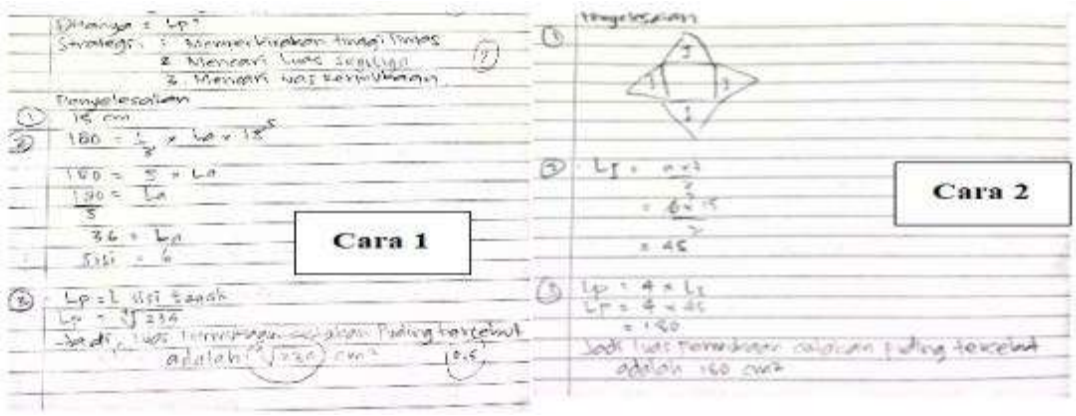

Figure 2. Excerpts of errors resulting from S_2

Based on the results of the analysis, it was found that the error made by S_2 was a transformation error resulting in processing errors and writing errors. The transformation error occurred because S_2 was in a hurry to work on the problem so that it was not careful in determining the formula to be used. In processing errors S_2 misunderstood the multiplication between integers and irrational numbers because S_2 was never given an explanation of the correct and incorrect writing of the writing method of the multiplication between integers and irrational numbers.

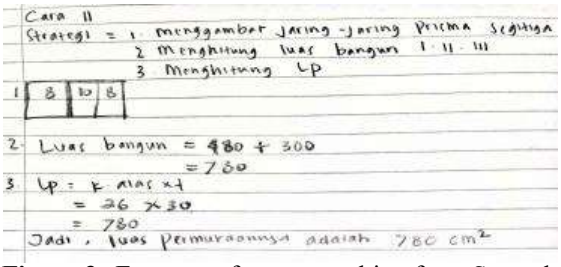

Figure 3. Excerpts of errors resulting from S_3 work

Based on the results of the analysis, it is found that the errors made by S_3 are transformation errors and writing errors. Transformation errors occur because S_3 sees the answer from his friend and has no more concentration in solving problems. Meanwhile, writing errors occurred because S_3 was in a hurry to write down the answers so that the final answer was incomplete.

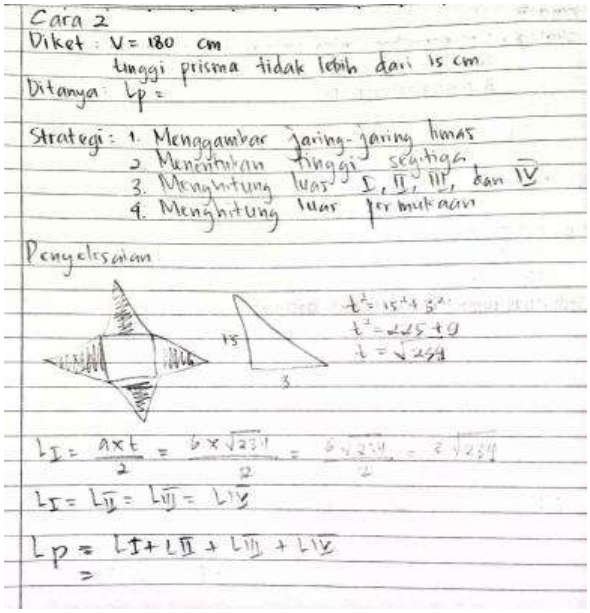

Figure 4. Excerpts of errors resulting from S_4 work

Based on the analysis, it was found that the error that S_4 made was an error in processing ability. The ability to process is because S_4 is still confused and does not understand how to operate the addition of radical numbers so that S_4 experiences difficulties in performing calculation operations.

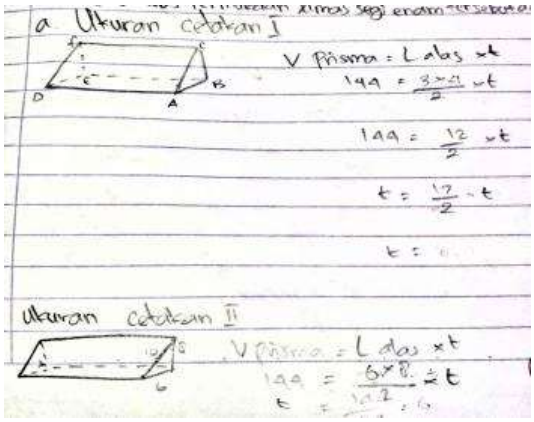

Figure 5. Excerpts of errors resulting from S_5 work

Based on the results of the analysis, it was found that the errors made by S_5 were errors in understanding the problem and the ability to process. The error in understanding the problem was caused by S_5 not understanding the problem in section 2 part b. Meanwhile, the processing ability error is due to S_5 unable to determine the algebraic operation or the correct calculation in calculating the size of the print height in question number 2 part a.

Based on the results of the work of the research subject S_6, it is known that S_5 did not do at all for numbers 2 and 4. After analyzing one of the missing question numbers, it is found that the error that was made by S_6 was a misunderstanding of the problem. The error in understanding the problem is because S_6 does not understand the method used to solve the problem in number 2. This is because S_6 does not know how to find the print size using the volume size and does not remember the numbers on the pythagorean triple. From the explanation of the research results above, in general there are four types of errors made by the research subjects, that is comprehension, transformation, process skill, and encoding. Likewise, based on the results of research conducted by Sekar (2015) regarding the analysis of student errors in solving open questions based on the Newman method on square and rectangular subjects at SMPN 11

Jember, it was found that students' errors in comprehension errors were found. Furthermore, Tuti Haryati (2016), in her research it was found that there were transformation errors, process skills errors, and encoding errors in the upper group category. The group category is experiencing transformation errors, encoding errors, and carelessness. The lower group experiences comprehension errors and transformation errors.

4. Conclusion

Based on the results of research and discussion, the following conclusions are obtained. (1) Contextual-based learning of the Treffinger model with good quality assessment criteria. (2) Contextual-based learning of the Treffinger model with open-ended questions achieves classical completeness. (3) The types of errors made by the research subjects, that is comprehension, transformation, process skills, and encoding. (4) The cause of the comprehension of the problem is because students do not understand the problems listed in the transformation error because students do not know the steps used, the process skills error is because students cannot determine algebraic operations, and encoding because students do not be careful in writing down the answers.

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