An Analysis of student’s improvement learning outcome and student’s errors based on new man using M-APOS learning approach

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Abstract. The low learning outcomes of students in solving story questions was indicate the occurrence of problems in students. That problem is caused one of them by the mistakes of students in working on story problems. This study will see an increase in student learning outcomes and the types and causes of student errors. This type of research is a mixed method with the research design is sequential mixed method. The results of this study indicate that the probability value is 0.000 so that Ho is rejected or in other words there is a significant increase after learning is given using the M-APOS approach. The results of the error analysis based on the Newman procedure consist of understanding errors, transformation errors, process errors and writing error answers. Then found another error in this study is an error in writing the unit.

1. Introduction

Problem solving in mathematics at school is usually realized through story problems. In solving story problems, students must first be able to understand the contents of the story questions, and then draw conclusions from the objects that must be resolved and solve them with mathematical symbols, to the final stage, which is completion. Until now, thinking skills and solving mathematical problems are still quite low. The question of the story is still difficult problem for some students [1].

Based on the results of observations at school, it appears that when researchers give story questions many students make mistakes in working on problems. The test results were corrected and many of them scored below the KKM set by the school. Therefore, to find out the reasons that cause students to make mistakes in working on the problems, it is necessary to do an error analysis.

The Newman error analysis method was first introduced in 1977 by Anne Newman, a teacher in mathematics in Australia. In this method, he suggested give specific activities to help find where the mistakes that occur in the work of students when solving a problem in the form of story problems. Parakitipong and Nakamura [2] divide the stages into five namely, the stages of reading, understanding, transformation, process skills and writing answers. In this method, there are five specific activities that can help find the cause and type of students' mistakes when solving a problem in the form of a story problem. The five activities listed in the Newman error analysis interview guide [3] are: (1) please read the question. If you don't know a word, just leave it. (2) Tell me what the question asks you to do (3) Tell me how you will find the answer. (4) Show me what you will do to get the answer. "Say it out loud" that you did, so that I can understand how you think. (5) Now write down the answer to that question.

In addition is analysing the types and causes of errors, one of the things that must be considered is the learning process that can overcome students' mistakes in solving problems with the story. According Hoodoo [4] the problem solving skills in story problems must be possessed by students. These skills will be owned by students if the teacher teaches how to solve effective problems to their
students. One way to teach problem solving in story problems is by learning that is appropriate to the needs of students.

Learning that is expected to be applied in analysing and overcoming students' mistakes is the Modification of Action, Process, Object and Schema approach or better known as M-APOS. M-APOS theory is an approach that has the characteristics of analysing mental construction in understanding a concept, learners learn in small groups and learning by using the ADL cycle (Activities, class discussions and exercises) [5]. The activity phase begins with the teacher giving recitation assignments that must be done by students at home to construct their understanding before the material is explained by the teacher which is the action stage on APOS theory. Giving a recitation task can develop students' understanding and mathematical skills. The discussion phase encourages students to be more active and open in studying and exploring a concept that is learned, so that through this discussion forum, students' understanding of a concept is getting better. Besides that through this class discussion the mistakes of students that might occur can be monitored and can be corrected.

2. Methods

The type of this research was mixed methods. According to Creswell [6] mixed research is a research approach that combines qualitative research with quantitative research. The research strategy chosen was sequential mixed methods, especially sequential exploratory strategies. The first stage is collecting and analysing qualitative data in the form of an analysis of students' Then the second stage, collecting and analysing data in the form of student learning outcomes after being given learning using the M-APOS approach. Furthermore, analyzing qualitative data to find out the types of errors of students and their causes in answering the problem of building a flat side space based on the Newman procedure after being given the M-APOS approach. The subjects of this study were selected three students who made the most mistakes so they could represent each type of student error. This research was conducted at junior high school in Indonesia.

3. Results And Discussion

Based on the results of tests and interviews conducted by researchers on research subjects there are types of student errors and their causes.

A. Student mistakes included in the type of misunderstanding (C) include:

1. Mistakes in making mathematical models
   Some of the causes of these errors include:
   a. Students do not write mathematical models of what is asked because they directly work on existing problems by entering numbers into solutions. This is because students feel confused when they have to make a mathematical model.
   b. Students do not know that the way to work on problems must be done by modeling the mathematics first.

2. Mistakes in writing what is known.
   The cause of student errors in writing what is known is students forget.
   Based on the results obtained by the researchers above, it is also in line with what was stated by Jha and Singh [7] a comprehension error is a mistake caused because students cannot: 1) understand the overall meaning of a problem; 2) write down and explain what is known from the problem; or 3) write down and explain what is asked from the problem.
B. Student mistakes are included in the Transformation (T) type error is:
   1. Not writing a formula
      The cause of this error is students do not understand what is the problem.
   2. Error applying formula.
      The cause of students 'mistakes in applying the formula is students' understanding of the problem.

Several types and causes of errors for the T type found by researchers during the study are also directly proportional to what was stated by Jha and Singh [7]. According to him the transformation error is an error caused by students not being able to: 1) determine the formula to be used to solve the problem; 2) determine the mathematical operation or series of operations to solve the problem in the problem appropriately; or 3) identify operations, or series of operations.

C. Student errors that are included in the Process error (P) type:
   Error in calculation
   Some of the causes of these errors include:
   a. Students do not understand the problem well.
   b. Students do not run the procedure correctly even though the formula used is correct.
   c. Students are not thorough.

Researchers have found several causes for errors in the process skills above where one of the causes is similar to the one mentioned by Jha and Singh [7]. That one of the causes of process skills is that students cannot carry out procedures correctly even though they are able to determine the mathematical operations used correctly.

D. Student mistakes included in type error E
   Student mistakes included in type error E is Error writing answer. Some of the causes of these errors is students are not careful and student’s unknown.

E. Error in math’s writing unit
   The last mistake that researchers found in the study of building material is the student's error in writing units, both units of area and units of volume. This error is caused by several reasons including students forgetting to write and students not knowing the unit for area or volume.

Data from this study were processed using SPPSS for windows 15.0 and presented in the form of a table below. It can be seen on table 1.

| Table 1. Kolmogorov-Smirnov test of preliminary test and final test | Kolmogorov-Smirnov(a) | Shapiro-Wilk |
|---------------------------------------------------------------|-----------------------|-------------|
| Categories | Statistic | Df | Sig. | Statistic | Df | Sig. |
| Pretest | .260 | 21 | .001 | .759 | 21 | .000 |
| Posttest | .278 | 21 | .000 | .817 | 21 | .001 |

By using a significance level of 0.05, it can be seen that the probability value of the results for the pretest and posttest are 0.001 and 0.000, respectively. Both of these probability values are less than 0.05 so H0 is rejected in other words the two data are not normally distributed. Next Wilcoxon test results are presented which can be seen in table 2 below.

| Table 2. Wicolxson test of Pretest dan posttest |
|------------------------------------------------|
| posttest - pretest | Statistic | Asymp. Sig. (2-tailed) |
| Z | -4.025(a) | .000 |
| Asymp. Sig. (2-tailed) | .000 |
Based on the table, it can be seen that the probability value is 0.000, which means less than 0.05, resulting in Ho being rejected or in other words there is a significant increase from pretest to posttest.

This study begins with the giving of preliminary test in junior high school to find out the mistakes made by students before applying M-APOS learning. From the test results show a data where the average is only 6.95 of the ideal score of 60. Whereas if seen for each type of error, it is obtained for the type of error types C, T, P and E, respectively 12.2%, 7.14%, 15% and 8.47%. Departing from this situatioan M-APOS approach was given to improve student learning outcomes. final test is given at the end of learning to find out the extent of improvement in learning outcomes after giving M-APOS. The results of the test showed the average was 38.52. While the percentage for each type of error C, T, P, and E are 83.1%, 52%, 66% and 38.1%, respectively. This shows that the M-APOS approach contributes to students' mistakes.

This contribution was clearly seen when the learning was taking place. In learning M-APOS students work on the problems given by the teacher in groups. Students discuss with classmates in working on problems 1 and 2 in the Student Work Sheet, while for recitation assignments students work on them at home.

From the statistical test, it was found that there was an increase from the preliminary test score to the final test score. The results obtained are very reasonable because the M-APOS model presents a preliminary activity or activity phase in the form of simple problems that can encourage students to practice so that students have the stock to be able to solve further problems that are more complex in class discussion.

Furthermore, the class discussion phase encourages students to be active and open in studying and deepening a concept being learned. Students get wider access to discuss with friends and get guidance from the teacher if there are difficulties in working on problems. Besides that through this class discussion student mistakes that might occur can be monitored and can be corrected [5].

In learning M-APOS students are trained to be able to better understand the concept by giving the final project at each meeting or called the recitation task. This recitation task helps students to strengthen their understanding at home. According to Nurlaelah [5] Giving a recitation task will provide an opportunity for students to find all the information needed by themselves so that by giving this recitation task can help improve student learning outcomes.
Based on the description above it can be concluded that the provision of learning using the M-APOS approach can overcome the mistakes of students. This is also in line with the results of research conducted by Wahyuningtiyas, et al [8]. He stated that learning M-APOS with the Activities, Class Discussions, Exercise Questions cycle can overcome student mistake.

4. Conclusion
The conclusion of this study is that the M-APOS approach can improve student learning outcomes on the material to build flat side spaces. Learner mistakes include (1) misunderstanding, the types of mistakes are errors in making mathematical models and errors in writing what is known. (2) transformation errors, the types of errors do not write formulas and errors in applying formulas. (3) process errors, the types of errors are errors in calculating. (4) mistakes in writing answers, the type of error is students are not careful in writing the final answers.

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