AN ANALYSIS OF STUDENTS' ERRORS IN SOLVING MATHEMATICS WORD PROBLEMS RELATED TO LINEAR EQUATION

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Abstract

In solving mathematics task, students often do errors. Students do an error when they did inappropriate mathematics problem solving to its correct solution. *Newman's Error Analysis* is used in this research including reading errors, comprehension errors, transformation errors, process skill errors, and encoding errors. Students' error may be due to several causes which related to the previous knowledge or concept that have been learned. One of the topics in odd semester of school year 2016/2017 is linear equation in eleventh grade in senior high school. The understanding of this topic is important because this topic is needed for comprehending the next complex topic. In this research, students are given mathematics word problem for identifying the students' errors in their problem solving. Mathematics word problems related to linear equation are used through this paper based test. The research purpose is to describe (1) What students' error in solving mathematics word problems related to linear equation and (2) What students' error causes in solving mathematics word problems related to linear equation. The researcher used descriptive qualitative research design. The data were taken at SMAN 1 Pandaan Pasuruan. Seven subjects of this research were chosen from XI-MIA 3 and XI-MIA 7. The researcher used test and interview for drawing data. Data reduction, data display, and conclusion will be used to analyze the data. The result of the research shows that the students do errors in solving mathematics word problems related to linear equation including reading, comprehension, transformation, process skill, and encoding errors. These errors happened because they do not understand perpendicular lines and key word in problems, do not understand about the problem, cannot determine linear equation, cannot use a right procedure of calculating, do not understand about the meaning of gradient, and careless in encoding.

Keywords: *Reading error, Comprehension error, Transformation error, Process skill error, Encoding error.*

INTRODUCTION

Linear equation is one topic that is taughtt to senior high school students in grade XI for the odd semester in school year 2016/2017. Linear equation concept understanding is needed for solving linear programing questions. Besides that, linear equation understanding for students is important because this concept is also used in economics and physics.

Based on the teacher's information, students often have difficulty in understanding the mathematics word problem so they cannot complete mathematics word problem task. Students have to be guided in solving the mathematics word problem well. Based on the experience of the researcher during PPP (Program of Learning Management) many students still have difficulties of working on or understand in the mathematics word problem. Hart (1996) argues that students have difficulty in transforming the word problems to mathematics representation. In line with Ahmad et al., (2010) a student's difficulty is lying in making mathematics representation of mathematics word problem. The difficulties experienced by students in mathematics word problem is in modeling the problem.

Mathematics word problem is a mathematics task related to applications in real life (Choirotunnisa ', 2016). Adams as cited by Sepeng and Sigola (2013) defines the mathematics word problem as being related to real life. Orton (2004) defines "a mathematics word problem is a question which requires the application of mathematics knowledge in order to reach a solution". According to the above opinion, a mathematics word problem is the application of mathematical knowledge related to real life in order to find an answer.

Efforts in improving student learning can be reached by analyzing the students' error in solving the mathematics word problem and also the factors causing them. This is done in order to prevent the students' error in next learning of linear equation and learning objectives are achieved.

Mistakes are often found in the students when they are solving mathematics problem. It could be assumed that students experience difficulties to solve the questions. This is also said by Pomalo (2015) that the students' difficulties experienced when they solve the problem can lead to mistakes in final answer or the process.

Pomalo (2015) stated that "students' error in solving questions is a kind of deviation which are systematics and consistent." While according to Wijaya and Masriyah (2013) "error is a kind of deviation to some things that is considered true or a deviation to something that have already been decided before". According to those statements, researcher defined error in mathematical problem solving as an incompatible answer done by the students in answering or solving the mathematical questions.

According to Newman (1977, 1983) (in White, 2010) there are five stages to solve math story that is read, comprehension, transformation, process skill, and encoding the answers. In helping teachers for finding the errors done by students in solving mathematics word problem analyzed by Newman's error analysis. In a study conducted by Zakaria et al., (2010) it was found that many error done by students were in transformation and process skills error.

Newman as quoted by White (2005) states the following students' errors.

1. Reading error
   a. Cannot read the keywords.
   b. Cannot read the symbol.
2. Comprehension error
   a. Cannot understand the meaning in question.
3. Transformation error
   a. Cannot use the phase of operation or operation that have chosen correctly.
4. Process skill error
   a. Cannot use the procedure that have chosen correctly in solving the question.
5. Encoding error
   a. Cannot write down the answer as the instruction correctly.

Wijaya, Heuvel-Panhuizen, Doorman, and Robitzsch (2014) categorize the indicator of Newman's error analysis as follows.

1. Comprehension error
   a. Not understanding what the problem asking.
   b. Not understanding the keyword.
   c. Choosing the wrong information.
2. Transformation error
   a. Using the wrong mathematics concept.
   b. Treating a graph as a picture (Student focus on the shape of graph not the properties).
3. Process skill error
   a. Doing an error in algebra.
   b. Doing an error in arithmethic.
   c. Wrong in referring to the graph.
   d. Calculation error.
   e. Incomplete answer.
4. Encoding error
   a. Cannot writing down the answer as the instruction correctly.

Based on some opinions above, in this study is used several indicators of students' error into five categories of Newman's Error Analysis in solving the problem.

No	Error	Error indicators
1.	Reading	1.1 Not knowing the symbol. 1.2 Not knowing the term. 1.3 Read incompletely.

2.	Comprehension	2.1 Cannot identify the information.
		  2.1.1 Not writing down the information.
		  2.1.2 Wrong in writing down the information.
		  2.1.3 Incomplete in writing down the information.
		2.2 Cannot identify the question.
		  2.2.1 Not writing down the question.
		  2.2.2 Wrong in writing down the question.
		  2.2.3 Incomplete in writing down the question.

3.	Transformation	3.1 Cannot make a mathematics representation from the problem (Cannot make a new representation). 3.2 Wrong in making a new representation 3.3 Incomplete in making a mathematics representation from the problem (Cannot make a new representation).matematika (kurang lengkap mengubah satu representasi ke representasi yang lain). 3.4 Wrong in using a mathematics concept.
4.	Process skill	4.1 Not using calculation procedure correctly. 4.2 Incomplete in calculating. 4.3 Incorrect in drawing the graph.
5.	Encoding	5.1 Cannot write the answer correctly.

No	Error	Error indicators
		5.2 Incomplete in write down the answer.

The error cause can be derived from the difficulty experienced by students when completing a problem. Factors of difficulty students may come from outside or inside the students, such as the condition of the students or the environment around students. Centeno (Batanero et al., 1994) explains that the knowledge and understanding of the students on the material being studied and the prerequisites material required students to not take a long time to complete and understand the problem without experiencing obstacle and correct in the solution. The concept of such content, learning methods, knowledge of students, or the ability of the student can be a factor for students experiencing obstacle in completing and understanding the problem.

The research purpose is to describe (1) What students' error in solving mathematics word problems related to linear equation and (2) What students' error causes in solving mathematics word problems related to linear equation.

METHOD

This study used descriptive qualitative research design. The data were taken at SMAN 1 Pandaan Pasuruan in XI-MIA 3 and XI-MIA 7. The students were given test then chosen seven subjects to interview for drawing data. Data reduction, data display, and conclusion will be used to analyze the data. The result of the research shows that the students do errors in solving mathematics word problems related to linear equation including reading, comprehension, transformation, process skill, and encoding errors.
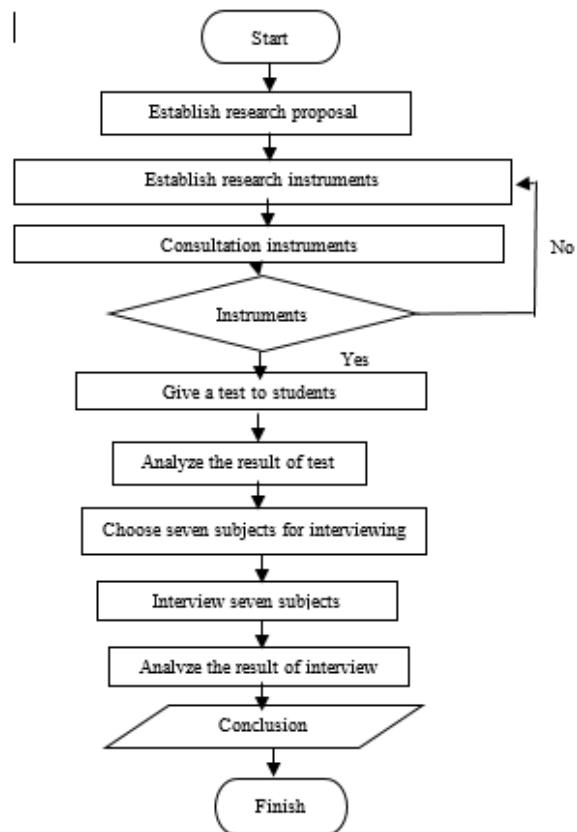

Figure 1. Stages of research

RESULT AND DISCUSSION

The students are given three mathematics word problem related to linear equation which is done in 90 minutes. Based on test results, we chosen 7 students which have these errors as follows.

Table 1. Subject error

No.	Label of name	Error						Label of subject
		1	2a	2b	2c	3a	3b	
1.	AP	E	P	C,E	T	C, T, P	-	SP1
2.	GW	E	P	E	T	T,P	-	SP2
3.	NI	E	T	-	-	E	-	SP3
4.	SF	E	-	-	-	C,E	-	SP4
5.	AS	E	T	E	E	R,C,T	-	SP5
6.	LB	C,E	C,T,E	E	T	C	-	SP6
7.	ND	E	C	T,E	P	R,C	-	SP7

Statement:
R : Reading error
C : Comprehension error
T : Transformation error
P : Process skill error
E : Encoding error

Based on the analysis of the test results and interviews with the subject, we presented a summary of the errors and cause students error in solving a mathematics word problem related to the linear equation as follows.

Tabel 2 Summarry SP1 error

No.	Error	Error cause
1	Encoding	Cannot write down the answer as the instruction.
2	Comprehension	Cannot understand the question
	Transformation	Forget in using the right strategies that appropriate in linear equation
	Process skill	Forget and careless in deviding the algebra and also in calculating the positive and negative number.
3	Comprehension	Cannot understand the meaning of problem
	Transformation	Does not understand the linear equation concept

Tabel 3. Summarry SP2 error

No.	Error	Error cause
1	Encoding	Cannot write down the answer as the instruction
2	Transformation	Forget in using the right strategies
	Process skill	Forget amd in a hurry in calculating algebra
	Encoding	Does not understand the meaning of gradient in the problem
3	Transformation	Does not understanding the concept of linear equation

Tabel 4. Summarry SP3 error

No.	Error	Error cause
1	Encoding	Cannot write down the answer as the instruction
3	Transformation	Does not understanding the material of linear curve and ignore the information in problem for drawing a graph
	Encoding	Less understanding an equation in form $y = mx + c$.

Tabel 5. Summarry SP4 error

No.	Error	Error cause
1	Encoding	Cannot write down the answer as the instruction
	Reading	Careless and in a hurry in reading the problem
3	Encoding	Careless and in a hurry in solvig the problem

Tabel 6. Summarry SP5 error

No.	Error	Error cause
1	Encoding	Cannot write down the answer as the instruction
	Transformation	Ignore the information in problem for drawing a graph
2	Encoding	Does not understand the meaning of gradient in the problem and not usual make a conclusion in mathematics word problem
	Comprehension	Cannot identify the information which inform the coordinates points in the problem for drawing linear curve in cartesius plane
3	Transformation	Cannot determine an appropriate formula with the problem for determining a linear equation and confused the properties of perpendicular or parallel line

Tabel 7. Summarry SP6 error

No.	Error	Error cause
1	Comprehension	Cannot read the graph in a rifht procedure and adding inappropriate data
	Encoding	Uncertain in answering

Tabel 7. Summarry SP6 error

No.	Error	Error cause
2	Comprehension	Cannot understand the information in the problem
	Process skill	Less skilled in calculating much number
	Encoding	Cannot understand the meaning of gradient in the problem
3	Encoding	Careless in writing down the answer

Tabel 8**.** Summarry SP7 error

No.	Error	Error cause
1	Encoding	Cannot write down the answer as the instruction
2	Reading	Cannot understand the meaning of word in mathematics word problem
	Comprehension	Cannot understand the information.
	Transformation	Does not understand the concept of linear equation
	Process skill	Less skilled in dertemining the right operation
	Encoding	Cannot understand the meaning of gradient in the problem
3	Reading	Cannot understand the meaning of word in mathematics word problem
	Comprehension	Cannot understand the meaning of the problem
	Transformation	Does not understanding the concept of linear eqauation such as how to determine the formula of linear equation and and the properties of perpendicular line and also cannot make a mathematics

No.	Error	Error cause
		representation from the problem.

In this study, there are some weakness or mistakes which should be discussed as follows.
1. The instruments used in this research are less precise in question number 2 which is located on number 2a that sentence is "assumes the relationship between costs and clothes that are produced can be described as straight lines on Cartesius plane".
2. In interviewing, researchers did not ask further question for example on question number 1, researchers didn't ask whether students really understand the meaning of average by asking students to explain the meaning of the word.
3. The data obtained is not optimally for all indicators that are created as on the students not knowing the symbol on the problem.

CONCLUSION

Based on the result of students' error analysis in solving mathematics word problem related to linear equation, it can be conclude as follows.
1. Students' error in solving mathematics word problem are as follows.
    a. Reading error
        1) Not knowing the term in word problem.
        2) Incomplete in reading the problem.
    b. Comprehension error
        1) Cannot identify the information in the problem such as read a graph by estimating it (determine the value of a point by a ruler then estimate its value) or add the data that does not correspond to the information in question).
        2) Cannot identify the question.
    c. Transformation error
        1) Cannot make a mathematics representation from the problem such as cannot assuming a variable.
        2) Wrong in making a new representation such as in making a graph from the algebra representation (linear equation into a graph) or making a graph from the mathematics word problem.
        3) Wrong in using mathematics concept such as in using the formula of $y=mx+c$ that have the equal c in all equation, using inappropriate formula for determining the linear equation, changing a negative point into positive point in drawing a graph, and using an equal gradient although it is a perpendicular line.
    d. Process skill error
        1) Cannot use right procedure in calculating such as in calculating

$$\frac{y-3750000}{13950000-3750000}=\frac{x-100}{400-100}$$ then $\frac{y-37500}{102000}=\frac{x-1}{3}$ and wrong in calculating positive and negative numbers.

e. Encoding error
1) Wrong in writing down the answer
2) Not writing down the answer such as cannot transforme the mathematics solution into an appropriate solution of the problem.
3) Incomplete in writing down the answer such as not wring the answer in form $y=mx+c$.

2. Error cause in solving mathematics word problem related to linear equation are as follows.

a. Reading error cause
1) Not knowing the term in word problem.
2) Not knowing the symbol of perpendicular.

b. Error cause comprehension
1) Not understanding the meaning of question.
2) Not understanding the problem.
3) Wrong in reading the graph such as
4) Cannot identify the information that inform point coordinates in the problem such as determine the value of a point by a ruler then estimate its value) or add the data that does not correspond to the information in question.

c. Transformation error cause
1) Forget in using a right strategies in solving the problem by using a concept of linear equation.
2) Not understand the concept of linear equation such as using the formula of $y=mx+c$ that have the equal c in all equation, Cannot determining the linear equation with gradient m and one point, or using inappropriate formula in linear equation.
3) There is a dominate knowledge in drawing the graph which is a negative can be changed into positive point and the other way.
4) Ignore the information for drawing the graph.
5) Use inappropriate information in drawing a graph.
6) Cannot determine the right formula in the problem in determining the linear equation.

7) Confused in understanding the properties of perpendicular or parallel line.
8) Cannot make a mathematics representation from the problem suvh as in assuming variable.

d. Process skill error cause
1) Forget in calculating algebra.
2) Careless in calculating algebra.
3) Careless in calculating positive and negative number.
4) In a hurry in calculating algebra.
5) Less skilled in calculating much number.
6) Less skilled in determining the right operation.

e. Encoding error cause
1) Not understanding the term in problem.
2) Not understanding the meaning of gradient in problem.
3) Less understanding linear equation in form $y = mx + c$
4) Careless in writing down the answer.
5) Not usual in making conclusion in word problem.
6) Uncertain in writing down the answer.

SUGGESTION
Based on the results of this study, we suggest for the next researcher as follows:
1. The instrument in this study should be validated.
2. Doing detail interview such as giving a detail question.
3. Getting subjects that doing errors in indicators.

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