Student Errors in Solving Story Problems on Systems of Linear Inequalities Based on Newman Error Analysis (NEA)

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Abstract
This paper aims to describe the types of errors and causes of students' errors in solving mathematics story problems on the main material of systems of linear inequalities based on Newman's Error Analysis (NEA). The linear inequalities system material was chosen for this study because the linear inequalities system has components that students must understand so they can easily determine the error made by student. This study is a qualitative descriptive. The subjects of this study were taken using a purposive sampling technique and obtained 10 students in the 5th semester of math education study program, Muhammadiyah University of Tangerang. This research was divided into three stage, namely the preparation of research instrument, implementation and colection of data study and data analysis. The instrument used in this research is a description of 3 questions. Based on data analysis, the factor that led to student error in solve math story question on the subject matter of the system of linear inequalities based on NEA were inaccurate, unable to read questions, unable to understand the question, and unable to carry out procedure or steps that would used to problem solving. This study contributes to providing information on errors that are commonly made by student in solve math story questions on the subject matter system linear inequalities based on NEA.
Keywords: Math error, Newman's Error Analysis, story questions, system of linear inequalities

Introduction

In general, every individual cannot be separated from various kinds of problems, both problems related to math and problems of everyday life. In math, students often face problems in the form of question related to subject matter (Emanuel, Kirana, & Chamidah, 2021; Gafoor & Kurukkan, 2015). Students often experience difficulties in solving these problems because they are not used to honing problem solving skills (Adianto & Rusli, 2021). According to Winarso & Toheri (2021) students tend to memorize formulas without understanding the concept and work on math problems at random. Students prefer to use short methods without paying attention to the correct completion process. The learning atmosphere also affects students problem solving abilities (Silalahi, Azhari, & Ramadhani, 2021).

Mathematical problem solving is one of the basic skills that must be master by students because it is considered the heart of mathematics (Nursyahidah, Saputro, & Rubowo, 2018; Yani, Rosma, & Helmanda, 2022). Problems in mathematics are usually presented in

the form of description question. Problems like this are still quite difficult for most students to solve. Students who have difficulty completing a question can make error in solving the problem of the question. The error made by student in problem solving can be explained using NEA (Newman's Error Analysis) (Ningsi, Nendi, Jehadus, Sugiarti, & Suryani, 2022). Error analysis *(Newman Error Analysis /NEA*) was first introduced by Newman in 1977, according to Newman errors in working on math problems divided into five types of errors, namely (1) reading errors (2) misunderstanding (misunderstanding), (3) transformation error (error in transformation), (4) process skill errors (error in process skills), (5) coding errors (error in notation) . NEA procedure is a method for analyzing error in problem solving. NEA is design as a simple dianostic procedure in solve math word problem (Seng, 2020). Singh, Rahman, & Hoon (2010) argues that there are five steps needed in solve mathematical problem, namely reading problem, understand problem, transforming problem, process skills and writing answers or encoding. Farihah & Nashihudin (2014) and White (2018) said that the NEA provides a framework for considering the underlying reasons students experience difficulty with math word problems and a process that helps teachers to determine where misunderstandings occur. White (2018) also added that NEA can provide guidance to teachers to determine effective teaching strategies to overcome them.

The classification of the types of error made by students in problem solving is as quoted from Putra et al. (2018) including reading, coprehension, tranformation, process skill and inference error. In line with these data, in the preliminary research carried out, it was obtained the results that students still experience difficulty in determining adequacy unsure about resolving the problem, specify the right strategy to solve it problems and carry out reviews (Dewi, 2019). This corresponds to research conducted (2013) which states that the difficulties experienced by students in completing the problem is when students understand the problem, determine the strategy to find solutions and determine patterns that can be used is the difficulty experienced by students in the solving process problem. Other research conducted Gordah & Fadillah (2014) also concluded that most students experience difficulty when expressing mathematical ideas in the process of solving mathematical problems. Research findings obtained by Prabawanto (2013) also concluded that few students have done review of the correctness of the settlement problem that is one step problem solving skill. Inference error occur when students cannot identify the problem and collect all the information to solve the problem.

repeat the truth in solving problems Based on this explanation, the authors are interested in conducting an error analysis study based on the NEA procedure on the subject matter of a system of linear inequalities. With this paper, it is hoped that it can describe the types of error that are commonly made by students in solving math story questions on the subject matter system of linear inequalities based on NEA along with the causes of these errors.

Research Method

This type of research is descriptive research with a qualitative approach. The qualitative approach is a research procedure carried out by obtaining descriptive data in the form of written or spoken words from the surrounding environment which is thoroughly observed (Gunawan, 2014). Research subjects were taken using purposive sampling. According to (Sugiyono, 2013) purposive sampling was taken by considering certain objectives.

The research subjects were 5th semester students, class 5B1, Mathematics Education Study Program, Muhammadiyah University, Tangerang with a sample of 10 students. The reason for choosing class 5B1 is because it tends to have more students with scores below 70. The data collection instrument used in this research is a description test question which consists of 3 questions containing a system of linear inequalities. In this case the test aims to determine the location of student error based on the NEA stage.

NEA technique is used to analyze the location of student error in problem solve, which consist of error: reading, comprehention, transformation, process skill, and encoding. The result of student test answer are corrected based on the answer key. The researcher gave a little guidance about the process. When the test will be given, students are given the freedom to work according to their respective abilities. In data analysis, the researcher analyzed test data from all students who took the written test, analyzed by the researcher to find out student error. Furthermore, the answers of students who were analyzed were wrong answers and those who did not answer. Students who do not answer directly have made the maximum mistake, namely making five error indicators based on the NEA stage.

Results and Discussion

This study aims to analyze student error in completing the test on description a system of linear inequalities based on the NEA indicator. NEA technique is used to analyze the location of student error in solve questions consisting of error: reading, comprehention,

tranformation, process skill, and encoding. Table 1 is a guide for scoring students' abilities in solving questions based on NEA indicators.

Table 1. Scoring Guide for Students' Abilities in Solving Questions

No.	Newman's Levels of Analysis	Students' answers to the questions given	Score
1.	Reading error	Identify mathematical information and symbols completely	3
		Correctly identify mathematical information and symbols	2
		Wrong in identifying information and mathematical symbols	1
		No answer	0
2.	Comprehention error	Write correctly what is known and what is asked	3
		Write what is known but does not match the question	2
		Wrong in writing what is known and what is asked	1
		No answer	0
3.	Transformation error	Write a complete mathematical model	3
		Wrote a mathematical model but it is incomplete	2
		Wrong in writing the mathematical model	1
		No answer	0
4.	Process skills error	Use the correct process and correct answers	3
		Using the correct process and incorrect answers	2
		Using the wrong process and wrong answers	1
		No answer	0
5.	Encoding error	Correct conclusion	3
		The conclusion is not correct	2
		Wrong conclusion	1
		No answer	0

In Table 2 is data related to the percentge of student error based on the NEA indicator.

Table 2. Number of Students who Make Error based on Newman's Theory

Question number	Reading	Comprehention	Transformation	Process skill	Encoding
1.	1	2	9	2	3
2.	2	2	4	2	5
3.	0	5	7	4	2
Total	3	9	20	8	10
Percentage	10%	24,6%	44,7%	17,9%	22,3%
Average			24%		

To analyze the error made by students in solve the material test questions for the system of linear inequalities, a more in-depth analysis of each question is carried out on the type of error made by student based on the NEA indicator. Identification of student errors in working on test questions describing the system of linear inequalities theory is obtained as follows:

Reading Error

Based on the data from student answer, the authors analyzed the error made by students in each of the questions that had been worked on. The following is the percentage of errors in *reading error* for each question presented in Table 3.

Table 3. Reading Error

Question Number	Reading Error	Percentage
1.	1	6,7%
2.	2	13,4%
3.	0	0%
Average		10%

The P-2 student subject was chosen as an example of the error made by student in working on the material description test questions for the system of linear inequalities shown in Figure 1. Errors in question number 2 were made by several students. Based on student answers to question number 2, there were students who made mistakes, namely error in reading the main information contained in the question.

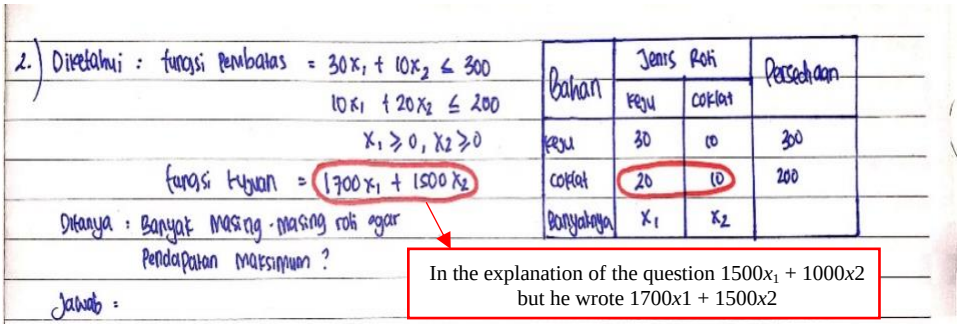

Figure 1. Student error in reading

From the student answer in Figure 1 above, it shows that P-2 students are less careful in read the information written in the question. This is shown by answer of student P-2 which looks wrong in making the math model, because the information in the question is $1500x_1 + 1000x_2$, but the student instead writes it $1700x_1 + 1500x_2$. Therefore, the answer stated that the P-2 student was wrong in reading the information in the question. This is in line with the results of the study Ma'rifah et al. (2020) that students make mistakes at the stage of reading the information written in the questions caused by the students being less thorough and in a hurry in reading the questions resulting in these students having difficulty understanding the problems contained in the questions.

Comprehention Error

Based on the data from student answer, the authors analyzed the error made by student in each of the questions that had been worked on. The following is the percentage of error in the comprehetion error for each question presented in Table 4.

Table 4. Comprehention Error

Question Number	Comprehention Error	Percentage
1.	2	20,1%
2.	2	20,1%
3.	5	33,5%
Average		24,6%

The P-3 student subject was chosen as an example of the error made by student in working on the material description test questions for the system of linear inequalities shown in Figure 2. Error in question number 3 were made by several students. Based on the student answers to question number 3, there were students who made error, namely mistakes in understanding the problem contained in the questions.

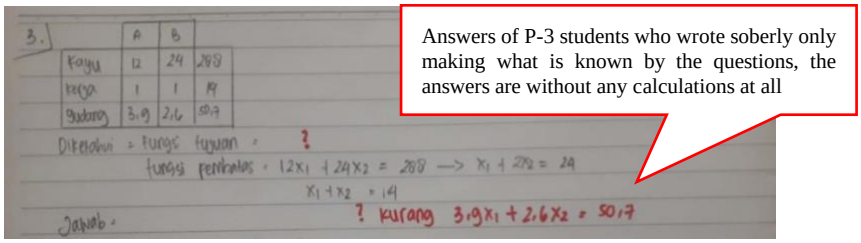

Figure 2. Student mistakes in understanding

From the student answer in Figure 2 it shows that P-3 students had difficulty understanding the questions. This is shown by the answers of P-3 students who write soberly only making what is known by the questions, the answers are without any calculations at all. P-3 students seem not to understand the purpose of the question, because the student does not write down what is asked of the question at all so that it will be difficult for students to continue in answering the question. Therefore, based on the student's answer, it is stated that the student concerned has difficulty understanding the problem in the question. This is in line with the results of the study Darmawan, Kharismawati, Hendriana, & Purwasih (2018) that one of the causes of its occurrence *comprehention error* because students cannot mention what is known in full from the question.

Transformation Error

Based on the data from student answer, the authors analyzed the error made by student in each of the question that had been worked on. Here is the percentage error on *transformation error* for each question presented in Table 5.

Table 5. Transformation Error

Question Number	Transformation Error	Percentage
1.	9	60,3%
2.	4	26,8%
3.	7	46,9%
Average		44,7%

The subject of the S-6 student was chosen as an example of the error made by student in working on the material description test question for the system of linear inequalities shown in Figure 3. Error in question number 1 were made by several students. Based on student answers to question number 1, there were students who made mistakes, namely mistakes in transforming questions into math forms contained in questions.

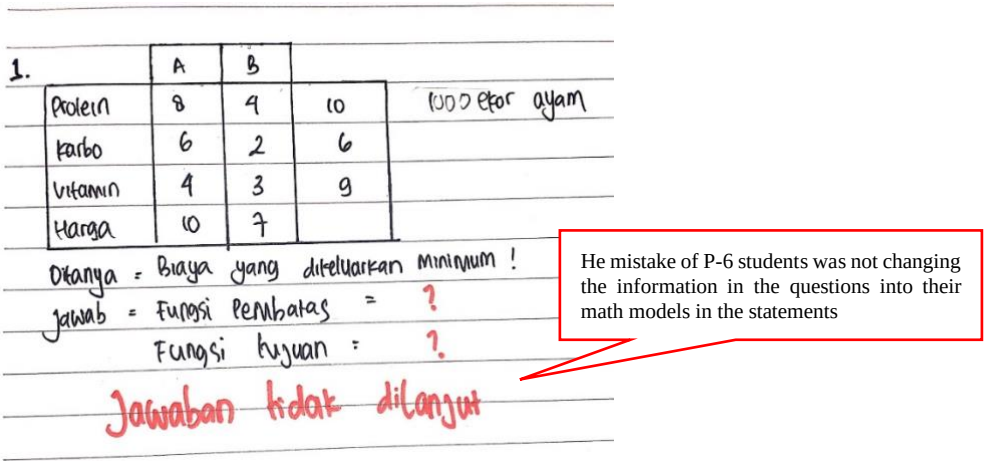

Figure 3. Student mistakes in transforming

From the student answer in Figure 3 it shows that P-6 student have not been able to transform questions into math form. The mistake of P-6 students was not changing the information in the questions into their math models in the statements. Therefore, in these answers it was stated that P-6 students were unable to transform questions into mathematical form. This is in line with the results of the study Singh et al. (2010) that the transformation error occurs when students understand what is wanted from the question but cannot identify operationally or the sequence of operations needed to solve the question. Another possible

cause of transformation errors is that student are not careful in determining information about what is known and asked in questions (Manibuy, Mardiyana, & Saputro, 2014) and unable to translate question sentences into sentences or math models (Wijaya & Masriyah, 2013).

Process Skills Error

Based on the data from student answer, the authors analyzed the error made by student in each of the question that had been worked on. Here is the percentage error on *process skill error* for each question presented in Table 6.

Table 6. Process Skill Error

Question Number	Process Skills Error	Percentage
1.	2	13,4%
2.	2	13,4%
3.	4	26,8%
Average		17,9%

The P-4 student subject was chosen as an example of the error made by student in working on the material description test questions for the system of linear inequalities shown in Figure 4. Error in question number 3 were made by several students. Based on student answers to question number 3, there were students who made mistakes, namely errors in process skills when working on questions.

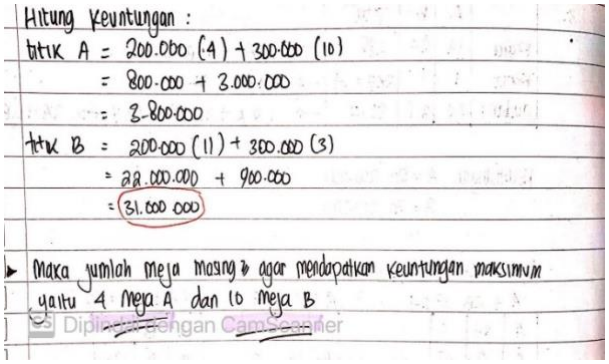

Figure 4. Student eror in process skills

From the student answer in Figure 4 it shows that P-4 students are weak in process skills because student are wrong in writing the results obtained from the multiplication of the substitution results that have been written before. The P-4 student's mistake was not being able to carry out the addition operation process corectly. Therefore, the answers stated that P-4 students were weak in process skills. This is in line with the result of the study Hidayanto, Subanji, & Hidayanto (2017) that *process skill error* is because students make

misconceptions, lack of background knowledge, reasoning and error in calculating basic operations.

Encoding Error

Based on the data from student answer, the authors analyzed the mistake made by student in each of the question that had been worked on. Here is the percentage error on *encoding error* for each question presented in Table 7.

Table 7. Encoding Error

Question Number	Encoding Error	Percentage
1.	3	20,1%
2.	5	33,5%
3.	2	13,4%
Average		22,3%

The P-8 student subject was chosen as an example of the mistakes students made in working on the material description test questions for the system of linear inequalities shown in Figure 5. Error in question number 2 were made by several students. Based on student answers to question number 2, there were students who made mistakes, namely mistakes in concluding from the answers they got.

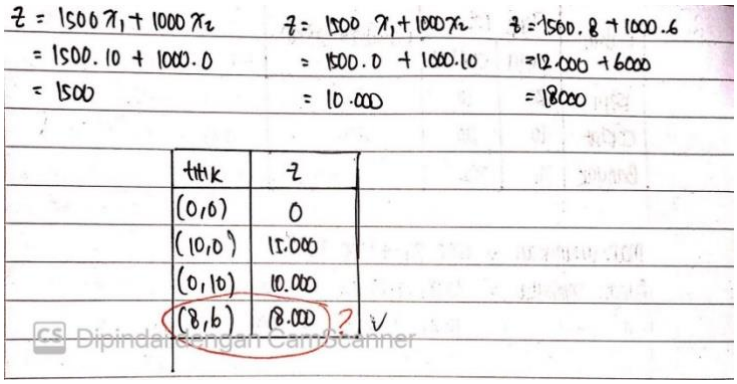

Figure 5. Student mistakes in writing

From the student answers in Figure 5 it shows that P-8 students were wrong in concluding the final results. This is shown by the answers of P-8 students who wrote down the final answers. The answer is wrong or inaccurate in concluding the final result. Therefore, P-8 students are still unable to conclude the final results referred to by the question. In line with the results of the study Abdullah, Liyana, Abidin, & Ali (2017) and Satoto, Sutarto, & Pujiastuti (2013) which stated that the student made a mistake in the final

answer cause the student did not write down the final result acording to procedure or steps used.

Table 8. Analysis of errors and motives for errors

No.	Newman's Levels of Analysis	The motive for the error
1.	Reading error	Students lack accuracy in reading the questions given so they fail to write down the instructions correctly in solving the questions
2.	Comprehention error	Students do not have the ability to think abstractly or think logically well, which results in hampered ability to understand questions correctly
3.	Transformation error	Students have difficulty designing or changing word problems into mathematical models due to lack of ideas, creativity and experience in solving many mathematical problems
4.	Process skills error	Students experience difficulties in implementing problem solving strategies due to their lack of problem analysis skills in the mathematics problems given
5.	Encoding error	Students lack the competence to review all possible answers to questions that could occur

Based on this data, errors in answers to all questions were found. This shows that most students have errors in the state of the concept of the subject system of linear inequalities. Error analysis can be used for individual or classical remedial teaching, and further used as a means to support the development of students' mathematical pedagogical knowledge. The results of this research indicate that errors in solving algebra problems (linear inequalities) made by teacher education students as prospective teachers are a reality that needs to be resolved.

Conclusion and Suggestion

The majority of students' mistakes in solving story questions about systems of linear inequalities made transformation and comprehension error. Transformation error because students are not able to write down the information on the questions into their math models. The mistakes made by students were not changing the information in the questions into their math models and many students had changed the information in the questions but did not write down full information. Furthermore, majority of students do comprehension error because students write soberly only make up what is known by the question, the answer is without any calculation at all. Students seem not to understand the purpose of the question, caused student do not write down what is ask of the question at all so that students will find it difficult to continue in answering questions. Based on the findings in this paper, the solution to be able to minimize student errors in solving linear inequalities system questions

is that students need to get reinforcement regarding knowledge about systems of linear inequalities.

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