Error Analysis Of Students Working About Word Problem Of Linear Program With NEA Procedure

D.A. Santoso[1], Farid. A[2], and B. Ulum[3]
Postgraduate, Semarang State University, Indonesia

E-mail: farid.akhmad01@gmail.com, denni_santoso@yahoo.com

ABSTRACT. Evaluation and assessment is an important part of learning. In evaluation process of learning, written test is still commonly used. However, the tests usually do not following-up by further evaluation. The process only up to grading stage not to evaluate the process and errors which done by students. Whereas if the student has a pattern error and process error, actions taken can be more focused on the fault and why is that happen. NEA procedure provides a way for educators to evaluate student progress more comprehensively. In this study, students' mistakes in working on some word problem about linear programming have been analyzed. As a result, mistakes are often made students exist in the modeling phase (transformation) and process skills (process skill) with the overall percentage distribution respectively 20% and 15%. According to the observations, these errors occur most commonly due to lack of precision of students in modeling and in hastiness calculation. Error analysis with students on this matter, it is expected educators can determine or use the right way to solve it in the next lesson.

1. Introduction

In designing mathematics learning, there are four important elements, ie who learned what was taught, how teaching, and how to evaluate it [1]. One important element in learning is evaluation. Without a thorough evaluation of the overall learning process will not be up in the process and outcome.

Evaluation has a very important role for learning in general and mathematics in particular. Kartono [4] stated that the measuring is an integral part of the learning process, students' performance-based measurements used to assess the student's ability to apply knowledge. In evaluating the necessary equipment / instrument specific for the purpose of evaluation and information to be extracted can be obtained accurately. Furthermore, Isman [1] states the evaluation and assessment tools play an important role because of that educators can find important information about the achievement of learning objectives and whether the student has successfully achieved or not.

In carrying out the evaluation, any curriculum, a written evaluation (paper and pencil test) is often used because it is relatively economical and relatively fast in the process of doubling and correction. However, the process often just end up in the stage of assessment and evaluation is not exhaustive. Whereas the matter of writing and analyze students' mistakes, we bids get the information that many of the students and the success of the learning process.

One does not go out of the assessment process is error analysis of the work done by the students. According Jabeen [2] the error analysis on student is to provide a deep understanding of the learning process. Errors students is an important tool to diagnose the difficulties experienced by students who require direct handling.

One of the analytical procedure that has been developed is NEA method. NEA analysis method (Newman Error Analysis) developed by Newman [7] and [8]. NEA procedure is designed as a simple diagnostic procedure. Newman [7] and [8], Prakitipong and Nakamura [9] states that when students try to solve the problems about the story written, so students must be able to reach certain levels. The levels are as follows: Level 1 Reading (Reading or Decoding), Level 2 Thorough understanding (Comprehension), Level 3 Modeling (Transformation), Level 4 Skills process (Process skills), and Level 5 Write down the answers (Encoding). When completing word problems there is the possibility of students to undertake processing errors and there were some who made a mistake in writing the final result.

Here are the details of the five stage of the procedure according to the NEA. Phase Reading (decoding), which is the stage where students read and understand the sentence in question. Errors that can occur because the students are not able to read and understand the terms in question, or not knowing what is known in terms of capital. This error characterized by the inability of students to write what they know. Stage of understanding (comprehension), is the next stage, ie when the student decides to understand the problem in question. This error characterized by the inability of students to write what was asked or errors in part on what is known. At this stage of modeling (transformation), the students demanded to be able to use methods, strategies, or the right formula to solve the problems. Error is observed when students are not able to use appropriate means and strategies or mistakes in using what is known into its strategy, it corresponds to a term introduced by Polya which device a plan for solving it. On the stage of process skill is the stage where students solve problems that have been modeled with the rules, procedures, or the appropriate algorithm although it has been able to write a mathematical model according to the questions asked.

The final stage of the procedure is to write down the answers NEA (encoding). This stage is the stage where students write the answers correctly and with the full unit or attribute is supposed to have the answers. Often at this stage of process skills, students have conducted a series of procedures and the exact algorithm, but are not able or less careful in rewriting what was requested or settlement in the matter of the story. Mistakes like these that will be observed in this study. If the last stage has been passed by the students, the students expressed absolutely perfect in solving the problem.

2. Problem on this research
Problem will be discussed on this article are as follows.
1) Based on the procedures NEA, what are common error made by the students and how they were distributed?
2) Why do these errors happen?
3) What is the theoretical solutions that can be done to solve it?

3. Research purposes
This study aims to provide information about various errors experienced by students in the work on the word problems task and common mistakes that is experienced by students. It is expected that educators or researchers can have this information and determine appropriate solutions to overcome the errors made by the students so that learning process becomes more effective and efficient. However, in this study deeper analysis on the cause or source of error are not included.

4. Method
In analyzing the problem in this research, descriptive analysis method is being used. It is used because we tries to convey is what is experienced by the subject of research in the form of behavior, perception, motivation, action, and others, in a holistic manner and by way of description in the form of words and language, in a specific context in which the natural and the using various scientific methods [6].

This study was conducted in SMK 1 Pekalongan in the academic year 2016/2017. The subjects were students in grade 11 as many as 32 students. Data is collected in the subject of

mathematic when the topics is "linear programming". The data collection was done by tests, rubrics assessment, interview, and literature pertaining to this study. Rubrics assessment be a type of fault experienced by students and a description of the students' mistakes. Problem given test consists of three items a story that intends to explore the understanding of students. Problem 1, given a narrative and students are required to write / model of the narrative becomes a function constraints and objective function. On question 2, students are given a system of inequality and be required to determine the solution area. Problem 3, students are given a system of inequalities and the objective function in order to determine the optimum solution of system. It is assumed that question 1 is the easiest and 3 are the most difficult problems.

The results of the work students are then analyzed and classified by the NEA procedures. Data types of mistakes students then collected and tabulated to look overall data distribution. Of each type of error, then the error description is being reduced by process includes the selection process, simplification and abstraction in order to obtain a specific description of how poses the occurrence of errors of each type of error types. This reduction activities resulting classification is based on the type of error according to the procedure NEA.

5. Research Result

Here is ordered occurrence of mistakes made by the student for each of the items. It can be seen in question 1 that is assumed to be easiest, perfectly turned out students who answered only 19%, while the most common error is an error of type 3 that modeling (transformation). At about 2 and 3, students correctly answered respectively 59% and 41% when the matter is assumed to be more difficult than about 1. For the types of the most common mistakes made students is error type 4 is a skill process (process skill). In general the most common mistakes that students do is type 3 and 4, which experienced a 20% overall and 15% of the students.

Table 1. Distribution of the type of student errors

Student	question 1	question 2	question 3	Student	question 1	question 2	question 3
1	1	5	4	17	3	6	6
2	0	6	6	18	3	6	6
3	3	4	4	19	6	5	5
4	4	6	5	20	2	2	2
5	6	6	4	21	0	6	2
6	2	4	6	22	3	6	2
7	6	6	6	23	6	6	6
8	4	6	6	24	3	6	6
9	1	3	6	25	0	2	0
10	3	6	0	26	3	6	6
11	6	4	3	27	0	2	3
12	3	4	4	28	3	6	4
13	3	5	5	29	2	3	2
14	3	6	4	30	3	6	6
15	3	4	4	31	3	6	5
16	6	6	6	32	3	6	6
Information							

0: Students do not work
1: Error phase 1 Reading (Reading or Decoding)
2: Error stage 2 Thorough understanding (Comprehension)
3: Error stage 3 Modeling (Transformation)
4: Error stage 4 Skills process (Process skills)
5: Error stage 5 Write down the answers (Encoding)
6: Done correctly
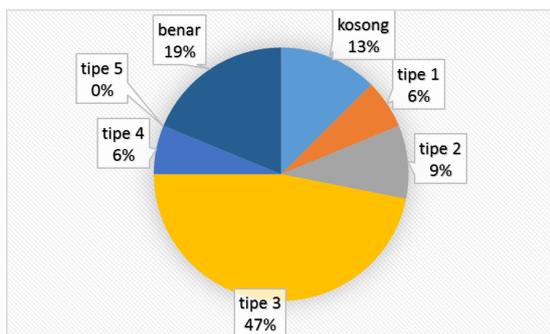
Figure 1
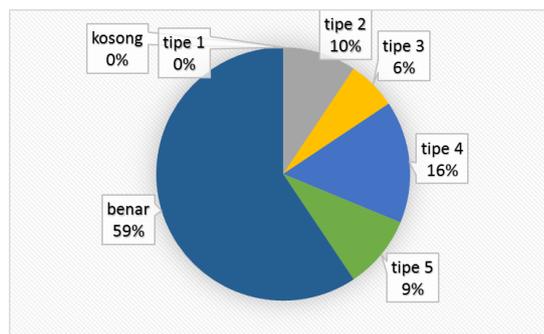
Figure 2
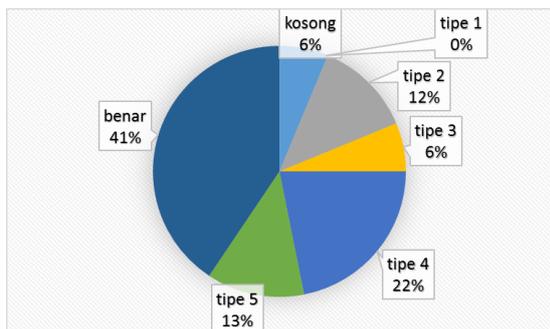
Figure 3
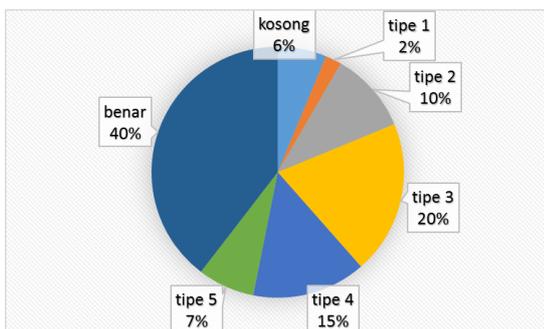
Figure 4

Information
Figure 1. Distribution of errors students to question 1
Figure 2. Distribution of errors students to question 2
Figure 3. Distribution of errors students to question 3
Figure 4. Distribution of errors students to question 4

Generally, error type 1 experienced only by 2% of the students. This error is only observed in question 1 error experienced by many as less conscientious students in reading about or even do not understand at all what is meant in the matter. Although a bit, it turns out, this type of error is experienced by students with higher grades. It shows the student hasty in reading the questions. Examples below are students who are mistaken in classifying information indicating students' mistakes in reading the questions correctly.

Figure 5. examples of student error type 1

Error type 2 experienced by 10% of students. Although the frequency of these errors is few, but it was observed in all items, which means an error occurs incidentally. In this type of error is generally the student fails to understand the problem as a whole and the students are less careful in sorting information. In the example below, the students reversed in letting variables known. This indicates an error in understanding about the students as a whole.

Figure 6. examples of student error type 2

Error type 3 happens most often when the research. This error occurs in a lot of students who have average grade but occur in all questions given. This means that this fault is a major barrier for the students. From the observation, this error is occurred because students are less conscientious, less careful, writing errors, and the rush of time. Specifically at students who have a high value, mistakes often occur because of a typing error. This is unfortunate because if these errors avoided, the work of these students is perfect.

Figure 7. examples of student error type 3

Error type 4 is also very common. This error is observed on all question and performed by the students who have lower, average or higher grade. It is observed that the error occurred because of miscalculations, incorrect use of formula, or use of the inappropriate procedures. This means that the fault is not due to the incident, but it was an error processing of students.
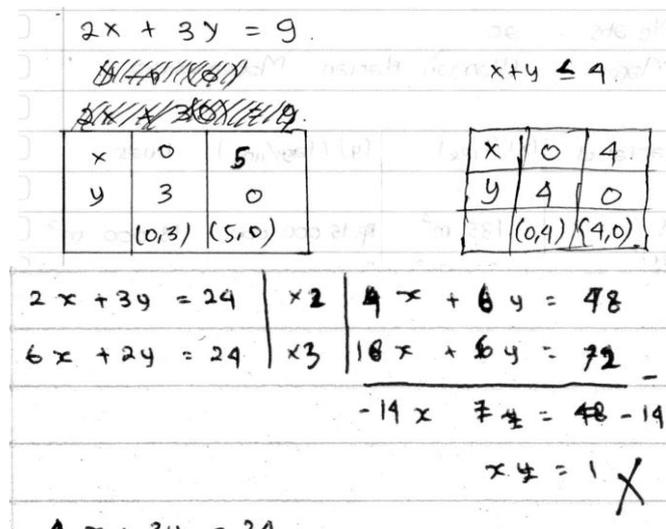
Figure 8. examples of student error type 4

Error type 5 occur quite infrequently with the frequency of occurrence of 7%. This error is very unfortunate because the student has successfully reached the stage of data processing but failed to write the final solution. These errors occur because of clerical errors and less understand students about issues in question.
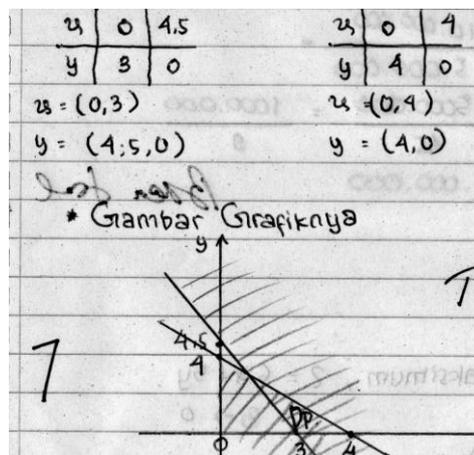
Figure 9. examples of student error type 5

One of the interested thing is the amount of the empty answer more than the type 1 error. The empty answers only contained in question 1, which is assumed about the story is the easiest for little calculation process. Although few, there are students who have a medium value but does not work on the matter. Based on the observations, students are lack of time due to an error in doing another matter that it took time to correct it.

6. Discussion

Sequentially, the most common mistakes made by students is 3rd stage that are modeling (transformation), process skills, thorough understanding (comprehension), 5th stage write down the answers (encoding), and phase 1st reading (reading or Decoding). This result is not too different from the research that has been done before in India (Kumar Jha) [5] and Malaysia (Singh) [10] . According to the findings Kumar Jha and Singh, mistake often made on the first three stages. They argued stage reading and comprehension as the most common mistakes. However, this is caused by the use of English as an language of math problems in their research, since in both countries the most widely used language is the local language. So, if the language factor ruled out errors were found to be similar to the findings in this study.

In another study conducted in Indonesia by Junaedi [3], the result is a little different. Junaedi find the most common errors is at the stage of encoding and comprehension. But it is natural to happen considering the studies were conducted at different levels of education. The occurrence of these errors are generally less rigorous because students will be writing, students will be less rigorous calculation, and the haste students in doing. These results are similar to results of research conducted [3].

These findings suggest still weak ability of students to understand and resolve the matter of the story. This shows students' literacy skills are lacking. As stated by Wardono [11] that mathematical literacy is the ability to formulate, implement, and interpret mathematics in a variety of situations including the ability to perform reasoning and use concepts, procedures, and facts to illustrate or explain a phenomenon. In his experiments, Wardono successfully tested the RME as a solution to improve this ability.

7. Conclusions and recommendations

Common error made by students consecutively are Transformation, Process skills, Comprehension, Encoding, and Reading (Decoding). Error of reading (decoding) mostly did by lower rank students. Error of comprehension and process skill were observed in entire group of students. Error of transformation and encoding mostly did by higher rank students.

Mistakes made by student are occurred due to hasty behavior, misclassify, misread, and misunderstand about task given. This suggest student are unable to understand the task and solving problem given. As stated above, to increase students understanding and reduce occurrence of error in student, Realistic Mathematics Educations (RME) may be the good solutions.

Deeper observations need to be done in order to know what treatment can reduce each of these errors. We recommend teacher to make an error analysis to understand what is the most error experienced by student and make accurate treatment on that problem.

References

[1] Isman, Aytekin. 2011. Instructional Design In Education: New Model. *The Turkish Online Journal of Educational Technology*. Vol 10(1). PP: 136-142

[2] Jabeen, Ahmad. 2015. The Role of Error Analysis in Teaching and Learning of Second and Foreign Language. *Education and Linguistics Research*. Vol. 1,(2). PP: 52-61 Macro Institute. doi:10.5296/elr.v1i1.8189

[3] Junaedi, Iwan. 2015. Disclosure Causes of Students Error in Resolving Discrete Mathematics Problems Based on NEA as A Means of Enhancing Creativity. International Journal of Education. Macrothink Institute. Vol 7 (4). PP: 125 – 133

[4] Kartono. 2011. *Efektivitas Penilaian Diri Dan Teman Sejawat Untuk Penilaian Formatif Dan Sumatif Pada Pembelajaran Mata Kuliah Analisis Kompleks*. Prosiding Seminar Nasional Matematika Prodi Pendidikan Matematika, Universitas Muhammadiyah. Surakarta, 24 Juli 2011

[5]   Kumar Jha, Shio. 2012. Mathematics Performance of Primary School Students in Assam (India): An Analysis Using Newman Procedure. *International Journal of Computer Applications in Engineering Sciences*. Vol 2(1). PP: 17-22

[6]   Moleong, L.J. 2009. *Metodologi Penelitian Kualitatif.* Bandung: Remaja Rosdakarya

[7]   Newman, M. A. 1977. An analysis of sixth-grade pupils' errors on written mathematical task. *Victorian Institute for Educational Research Bulletin*. Vol 39. PP: 31-43

[8]   Newman, M. A. 1983. *Strategies for diagnosis and remediation*. Sydney: Harcourt, Brace

[9]   Prakitipong, Natcha dan Nakamura, Satoshi. 2006. Analysis of Mathematics Performance of Grade Five Students in Thailand Using Newman Procedure. *Journal of International Cooperation in Education*. CICE Hiroshima University

[10] Singh, Parmjit *et al*. 2010. The Newman Procedure for Analyzing Primary Four Pupils Errors on Written Mathematical Tasks: A Malaysian Perspective. *Procedia Social and Behavioral Sciences*. PP: 264-271. doi:10.1016/j.sbspro.2010.12.036

[11] Wardono *et al*. 2015. The Realistic Scientific Humanist Learning With Character Education To Improve Mathematics Literacy Based On Pisa. *International Journal of Education and Research (IJERN)*. Vol 3 (1). PP: 349 – 362