Analysis of student error in solving story problems in linear program materials

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Abstract. The purpose of this research was to determine the percentage of student errors in solving story problems on the linear program material. The errors noted were misunderstandings of questions, errors in mathematical modeling, errors in calculating / solving, and errors in drawing conclusions. The research was conducted on class XI MIPA students of SMA Negeri 1 Langowan. The results showed that all students made mistakes solving story problems with the material of the linear program. There were 38 errors (23.89%) at the question understanding stage. There were 5 errors (3.14%) at the mathematical modeling stage. There are 90 errors (56.60%) at the computation / completion stage. There were 24 errors (15.09%) at the conclusion stage. There were 2 other errors (1.25%) made by students.

1. Introduction
Mathematics is a subject that is taught at all levels of education. In achieving the learning objectives, students will not only be able to understand concepts, but also solve questions about those concepts, including questions about everyday life. Hence, mathematics plays a very important role in solving everyday problems.

The achievement of the math learning objectives can be seen in the math learning outcomes of the students. Student learning outcomes are benchmarks used to determine student success in identifying and understanding a subject. These are usually expressed by values in the form of letters or numbers. Student learning outcomes in terms of skills, values and attitudes after the student has experienced the learning process. Through the teaching and learning process, students are expected to acquire certain intelligence and skills, as well as changes in themselves.

Students' learning outcomes will be given to students after performing learning activities. Sudjana argues that student learning outcomes are the skills students have after receiving their learning experience [1]. In the meantime, Slameto argues that learning is a business process carried out by a person in order to achieve an entirely new behavioral change based on their own experience in dealing with their surroundings [2].

Students' learning outcomes are indicated by their learning performance, which is an indicator of changes in student behavior. The learning process is expected to ensure that students achieve good learning performance in accordance with the specific teaching objectives set prior to the learning process. One way to determine learning success is to use tests. This test is used to assess the learning outcomes students achieve in studying the subject provided by the teacher in school.
According to Gagne, student math learning outcomes are the skills the students will have after receiving their math learning experience, or it could be said that student math learning outcomes are changes in student behavior that take the form of changes in knowledge, behavior, attitudes, observed and measured, and skills after studying mathematics. This change is defined as the occurrence of improvements and developments for the better.

There are two factors that can affect student learning outcomes, namely internal and external students. Internal factors of the students in the form of interests, talents, intelligence level, motivation, cognitive skills and so on. Meanwhile, external factors of the students in the form of teaching, teachers, facilities, facilities and management that apply in schools [3].

In fact, many students still cannot meet the curriculum learning objectives. The poor performance of these students in math learning shows that there are both internal and external factors that students face [4]. Most of the students were still unable to answer the questions asked as a test of learning outcomes, especially questions in the form of stories.

For some people, solving story problems is seen as more difficult because they need to transform the problem into a mathematical model in the form of a story. Modeling the story problem can be difficult because each type of problem has a different model [5]. Hence, students also have difficulty working on problems related to story form questions [6].

There are several types of mistakes students can make in solving math problems, namely language/translation errors, answer/conceptual errors, and strategy/problem-solving errors [7]. Based on research by Widyaningrum [8], it was found that students are unable to retell the meaning of questions in their own language, are less able to convert sentences into a mathematical model (sentence) and do not understand the concepts used. As a result, students have a hard time figuring out which formula to use. Even if they found the right formula, the students couldn't use the formula correctly. In other words, there is a bug in replacing the elements known in the formula that results in the students not being able to solve a problem properly.

To understand the material, students must be able to master mathematical concepts and their relationships in order to apply those concepts to solving a problem. Mathematics is usually synonymous with different numbers and symbols that represent different things from real contexts. To find out how to use it in everyday life, mathematical problems are presented in the form of a story problem. Storytelling questions can help students understand the practical benefits of math in everyday life. Mathematical story problems are problems related to everyday life to find solutions using mathematical theorems that include numbers, arithmetic operations, and relationships [9].

More steps are required to solve math story problems. Polya suggests four structured steps to be able to solve math problems: understand a problem, create a solution plan, create a final plan and re-examine its solution [10]. With this in mind, Soedjadi also suggested steps for solving story problems, namely reading questions carefully to understand the meaning of each sentence. Separating and expressing the questions, calculating the requirements; create mathematical models; solve mathematical models; Returns the answer to the mathematical model to the answer to the original problem [11]. In addition, according to Sukarno, in order to be able to solve a story problem, the ability is required: decide what is known in the problem, decide what to ask in the question, build a mathematical model, do calculations (calculation ) and interpret the answer to the model in the original problem [12].

The results of interviews with math teachers and students of XI MIPA SMA Negeri 1 Langowan showed that learning math in the classroom often does not go as expected. There are still many students who have difficulty during the learning process, including learning linear program material. This difficulty of the students led to student errors in solving the material questions of the linear program, which were mostly asked in the form of story questions. Many students are confused about seeing long questions, making mistakes when creating mathematical models, not being careful when calculating (calculating), and having difficulty drawing conclusions. This difficulty shows up in the results of daily tests where there are many students who did not meet the Ketuntasan Belajar Minimum (KBM).

Based on the facts found, a deeper knowledge is required to find out the cause of the problem. In order for student math outcomes to increase, the causes of student learning difficulties and mistakes
must be resolved as soon as possible. Students will always find it difficult in learning if the mistakes previously made have not been corrected, especially when later students are faced with questions with the same characteristics.

2. Methods

This research was carried out using a quantitative approach with descriptive methods. The purpose of descriptive research using this quantitative approach is to describe or explain events or circumstances currently taking place when the research is conducted in the form of meaningful numbers, as well as to investigate the causes of certain symptoms. This research was carried out at the SMA Negeri 1 Langowan in the even semester of the academic year 2019/2020 with all students of class XI MIPA who made mistakes as research topics.

The data was collected through tests and interviews. Test questions are asked in the form of questions asked in the form of story questions on the subject of the linear program given to all research topics. The test results are then used to see the mistakes the students made in solving the story questions. From the results of these tests, research topic interviews were conducted to determine the causes of the mistakes made by the students.

The data analysis technique used in this study is to have experts test the validity of the questions and then calculate the percentage of mistakes made by the students. To test the validity of the questions used in this study, namely the content validity test. A test has substantive validity if it measures certain specific goals that are parallel to the material or object provided. In order to assess whether the content of a test should be valid, the assessment is usually carried out by experts or examiners.

3. Results and discussion

In general, all students in class XI MIPA from SMA Negeri 1 Langowan made mistakes when completing the test questions. For example, 25 respondents collected the percentage of student errors in certain phases, namely 24.20% errors at the question understanding stage, 3.18% at the mathematical modeling stage, 57.32% at the computation stage, 15.29% at the conclusion stage. The description of the student errors can be seen in Table 1 below.

Table 1. The description of the student errors.

| Type of error                  | Number of errors in the problem | Total | Percentage |
|-------------------------------|---------------------------------|-------|------------|
|                               | No. 1                           | No. 2 |            |
| The question understanding stage | 0                               | 38    | 38         | 28.36     |
| The mathematical modeling stage | 1                               | 4     | 5          | 3.73      |
| The computation stage         | 0                               | 67    | 67         | 50.00     |
| The conclusion stage          | 0                               | 24    | 24         | 17.91     |
| **Total**                     | **3**                           | **156** | **157**   | **100.00** |

Source: Processed data

From the analysis of the test results and the interviews with all respondents in this study, it emerged that the students made mistakes in processing the questions in the form of the linear program material, which is divided into four aspects.

3.1. Understanding questions stage

The number of student errors at the question comprehension stage was 38 errors. The errors of the students in understanding the questions consisted of: writing incompletely the information contained in the questions in the table, not making mathematical models, not writing objective functions and not writing conclusions.

After tracing the interviews, the researcher found that the factor behind these errors was that the students did not see long questions and that the students did not read the questions carefully, therefore they could not correctly understand the questions. questions, which prevented students from knowing the known information and asked questions, were not able to determine which values are appropriate to
make a mathematical model, were not able to determine which values to use for objective functions and did not write any conclusions. The description of the question understanding error can be seen in Table 2 below.

**Table 2.** Description of student errors at the question understanding stage.

| Error Indicator                                         | Quantity |
|---------------------------------------------------------|----------|
| It is not complete to write down the information in the questions into the table | 8        |
| Not making a mathematical model                         | 4        |
| Do not write the objective function                     | 7        |
| Not to write a conclusion                               | 19       |
| **Total**                                               | **38**   |

Source: Processed data

3.2. Mathematical modelling stage

The number of student errors in the mathematical modeling stage was 5 errors. Student errors in the mathematical modeling stage include students who do not make mathematical models and make mistakes when creating mathematical models. After conducting the interview, the researcher found that the factor causing the error was that the students did not understand the material given, so that when the questions were asked, the students did not understand, which made it difficult for students to determine what value. suitable for creating mathematical models and the habit of students looking at sample questions while working on the questions asked makes students wrong and even unable to create correct mathematical models. The description of the mathematical modeling errors can be seen in Table 3 below.

**Table 3.** Description of student error at the mathematical modeling stage.

| Error Indicator                                   | Quantity |
|---------------------------------------------------|----------|
| Not create a mathematical model                   | 4        |
| Incorrect mathematical model                      | 1        |
| **Total**                                         | **5**    |

Source: Processed data

3.3. Computation stage

The number of errors in the calculation step is 90 errors. Mistakes made by students at the computation stage include not writing the objective function, not drawing a graph of an area of solution, not determining the angle point, incorrectly determining the point of angle, not to calculate the optimal value of the objective function, and incorrectly determine the optimal value of the objective function.

After plotting interviews, the researcher found that the factor behind these errors was due to students' lack of understanding of the steps or methods to be followed in solving story problems. In addition, the students who were in a hurry to solve the questions asked caused the students to be less careful and no longer verify their answers. The description of student error at the computation stage can be seen in Table 4 below.

**Table 4.** Description of student error at the computation stage.

| Error Indicator                                           | Quantity |
|-----------------------------------------------------------|----------|
| Don't write objective functions                           | 7        |
| Does not draw a graph of visible areas                    | 15       |
| Does not specify the corner point of the visible area     | 18       |
| Incorrectly determining the corner point of the visible area | 4        |
| Does not calculate the optimum value of the objective function | 19       |
| Incorrectly determining the optimum value of the objective function | 4        |
| **Total**                                                 | **67**   |

Source: Processed data
3.4. Conclusion stage
The number of errors in drawing up the conclusions is 24 errors. Mistakes students make when drawing conclusions, such as not writing conclusions and writing wrong conclusions. After plotting interviews, the researcher found that the factors behind these errors were students who did not read the questions carefully and were in a hurry to resolve the questions, which caused the students to write badly. false conclusions and some who did not even write a conclusion. Another thing that causes errors for students when writing conclusions is due to errors made by students at the computation stage. The description of student error at the conclusion stage is presented in Table 5 below.

Table 5. Description of student error at the conclusion stage.

| Error Indicator               | Quantity |
|------------------------------|----------|
| Do not write conclusions     | 19       |
| Wrong conclusion             | 5        |
| **Total**                    | **24**   |

Source: Processed data

4. Conclusion
Based on the results of the research and discussion, it can be concluded that there are 4 types of student errors when working on the Linear Program material story problems, namely student errors at the question understanding stage of 24.20%, mathematical modeling 3.18%, computation 57.32%, and conclusion 15.29%.

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