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Analysis of Student Errors in Solving Mathematical Literacy Problems Based on the Components of the Mathematical Literacy Process

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Abstract

The low PISA Mathematics score of Indonesia was a strong background in this study. The results of the 2018 Mathematics PISA Indonesia scored 371, lower than the 2015 score of 386. This study is a qualitative study that aims to describe student errors in solving mathematical literacy problems on linear program material. The methods used documentation in the form of answer sheets, observations, and interviews. The validity of the data was obtained by using triangulation techniques from the three methods used. The research sample was taken by 25 students of class X SMA Negeri 4 Purworejo. The results of the research include: (1) as many as 20 students, or 80% of students, have not been able to formulate problems mathematically. Students have not been able to make an example of the problem correctly. (2) as many as 23 students, or 92% of students, have not been able to use mathematical concepts and, have not been able to write mathematical symbols (facts) correctly, have not been able to solve problems with correct mathematical principles and procedures. (3) as many as 22 students, or 88% of students, have not been able to make conclusions and evaluate the problems given. From these results, it can be said that 80% or more of students have not been able to solve math problems from the lowest stages of the literacy process.

1. Introduction

Program for International Student Assessment (PISA) in the form of an assessment of student achievement in schools in an international scope. PISA is a periodic assessment every three years. PISA measures more mathematical literacy skills in the form of reasoning, arguing and solving problems in everyday life (Ojose, 2011; Draper, 2002; and Wong, 2005). The characteristics of PISA questions include contextual substance, demanding reasoning, argumentation and creativity in solving them (Brewley, 2012). While the PISA components include three things, namely: (1) the content component, namely in the form of school mathematics material studied by students; (2) process components, namely in the form of steps in solving mathematical problems; (3) the context component, namely in the form of a situation described in a problem (OECD, 2010).

The background of this research is inseparable from the results of PISA 2018, where Indonesia is ranked 72nd out of 78 PISA participating countries. Compared to other PISA participating countries, Indonesia is at the bottom of the list. The results of the mathematical literacy ability of students in Indonesia scored 379, below the average score of 458.3 (OECD, 2019). This has decreased compared to the 2015 PISA mathematical literacy score, where Indonesia received a score of 386. As for science literacy and reading skills, Indonesia also decreased compared to 2015. So that in 2018 the three literacy assessments in Indonesia decreased. PISA scores are low and tend to decline is a strong factor behind this study. The results of Indonesian students' mathematical literacy in 2012, 2015, and 2018 are shown in Figure 1 below.

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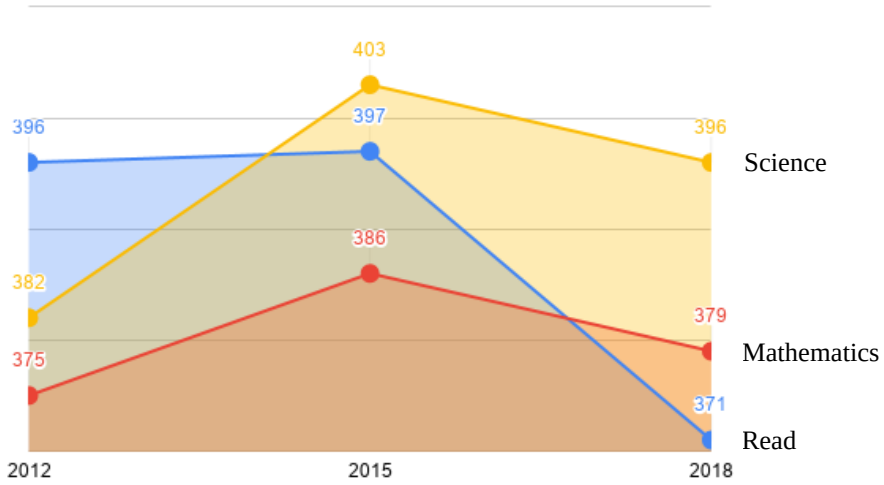

Figure 1. Comparison of Indonesian PISA Results

Various efforts to improve students' mathematical literacy skills, one of which is by training students to think at a higher level (Suryapuspitarini, Wardono, & Kartono, 2018). Therefore, students need to be trained to solve analytical problems to create. Through this literacy question, students can also see how their mathematical thinking process is (Dinni, 2018). Not only that, the teacher's factor is very influential on students' mathematical literacy skills. Teachers must be able to design their teaching materials that lead to mathematical literacy (Pangesti, 2018). Teachers need to give questions in stages from easy to difficult and not get stuck with something that everything has to be difficult.

This research has been preceded by previous studies that discuss the analysis of student errors in solving math problems. There are several mistakes made by students, especially in solving math problems. The results of Aulia & Kartini's (2021) research show that understanding the wrong concept results in errors in doing math problems. Not only that, procedural errors are also the dominant cause in solving problems (Sofianingsih & Kusmanto, 2021). Likewise, students' carelessness in working on questions is the main cause of errors in solving questions (Nurianti, Halini, & Ijudin, 2015). The results of the study from Mahdiansyah & Rahmawati (2014) also revealed that there are a number of factors that play a major role in realizing the achievement of mathematical literacy, namely personal factors, instructional factors, and environmental factors.

This study attempts to analyze student errors in solving mathematical literacy problems in terms of the components of the mathematical literacy process including: (1) the ability to formulate problems mathematically, (2) the ability to use concepts, facts, procedures, and mathematical reasoning, and (3) the ability to interpret, apply, and evaluate the results of a mathematical process (OECD, 2010). The research focused on linear program material for class X SMA, because it was considered that this material was very appropriate to be brought into the context of everyday problems.

From the description above, this research takes the formulation of the problem, namely how to describe the errors made by students in solving mathematical literacy problems based on the components of the literacy process. While this study aims to describe student errors in solving mathematical literacy problems, especially in linear programming material in terms of the components of the mathematical literacy process.

2. Methods

This research was a descriptive qualitative research, where the researcher tries to describe qualitatively the actual situation (Sugiyono, 2012). The description in question was the mistakes made by students in solving mathematical literacy problems in terms of the components of the mathematical literacy process. This study took the research subjects of class X SMA Negeri 4 Purworejo, totaling 25 students. The material chosen for the research is a linear program, because this material considered very relevant and easy to carry into the context of everyday problems.

The methods used in this research were documentation in the form of written tests, observations and interviews. The instrument used was a written test of mathematical literacy in linear program material, which consisted of 5 description questions, observation notes, and a list of interview questions. The research procedure starts from observations in class during the learning process, which is then used as material for comparison with the results of the written test. The second stage is giving a written test to the research subject. The test consists of 5 questions about the description of the linear program material with a processing time of 90 minutes. From the results of the test answer sheets, the students' errors in solving problems were analyzed in terms of the three components of the mathematical literacy process, namely (1) the ability to formulate problems mathematically, (2) the ability to use concepts, facts, procedures, and mathematical reasoning, and (3) the ability to interpret, apply, and evaluate the results of a mathematical process (OECD, 2010). The last stage was interviewed with research subjects to explored further a description of how students made mistakes in solving the literacy questions. Furthermore, the validity of the data was obtained by using triangulation techniques from the three methods used. Researchers try to clarify the results of the study based on the three methods used, then conclude the results. However, because this is a descriptive qualitative research, the main instrument is the researcher.

3. Results & Discussions

3.1. Results

Overall the results of the written mathematical literacy test of 25 students are shown in Table 1 below.

Table 1. Description of Errors from the Literacy Process Components

Literacy Process Components	Error Description	Number of Students
1. Ability to formulate problems mathematically	• Students do not make mathematical examples or models of problems. • Students make a mistake in making an example (mathematical model) so that it results in mistakes in the next stage, namely making the constraint function and the objective function of the problem.	20
2. Ability to use concepts, facts, procedures, and mathematical reasoning	• Students are wrong in making strategies or sequences in solving problems. • Students wrote the wrong mathematical symbols. • Students have not been able to determine the settlement area of the formulated constraint function. • The student made a mistake in performing algebraic arithmetic operations. • Students miscalculated the value of the objective function.	23
3. Ability to interpret, apply, and evaluate the results of a mathematical process	• Students have not been able to determine the optimum value (maximum or minimum) of the objective function so that it results in wrong conclusions in making conclusions and answering questions. • Students have not been able to re-check the maximum or minimum value of the objective function.	22

3.2. Discussions

Based on the results of the research above, it can be discussed that some of the students' errors in solving math problems were reviewed based on the components of the mathematical literacy process. The following shows examples of student errors (taken samples of 4 students from 25 research samples). The main error found was that students did not make mathematical equations or models correctly, as shown in Figure 2 below.

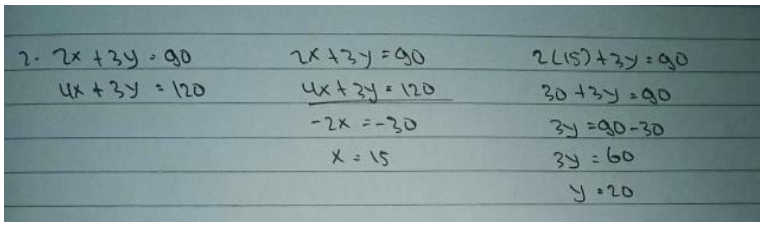

Figure 2. Problem Formulation Error

From Figure 2 above, it appears that students are not able to make an example of the given problem, even though in the question they are asked to make an example so that it is easy to complete the next step. This is in accordance with the results of research from Aulia & Kartini (2021) that the wrong formulation results in errors in doing math problems. Of the 25 students studied, as many as 20 students or 80% of students have not been able to formulate problems mathematically. Based on the results of interviewed with 25 students, the majority of students admitted that they forgot to write examples and made mistakes in writing mathematical models. From the observations, only 5 students were able to formulate the problem perfectly. 20 students have not been able to make an example of the problem correctly.

The next results that are often encountered are errors in making problem-solving strategies, errors in carrying out procedures and reasoning as shown in Figure 3 below.

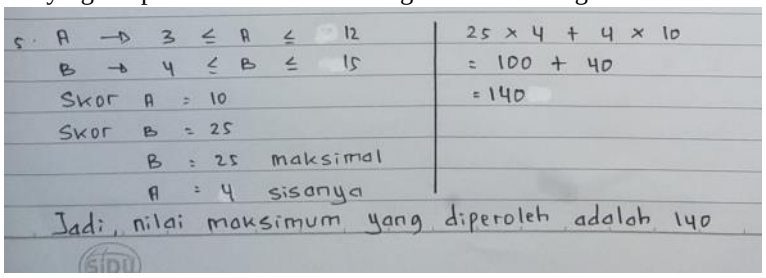

Figure 3. Misconceptions, facts, procedures and reasoning

Figure 3 above shows that students really do not understand and are unable to formulate problems, are unable to write mathematical symbols correctly (facts), students do not make problem solving procedures correctly, and finally are unable to make correct reasoning. Therefore, the result or conclusion obtained is wrong. Based on the results of 25 sample interviewed, many students admitted to making mistakes: wrong in made strategies or sequences in solving problems, wrong in wrote mathematical symbols, wrongly determined the settlement area, wrong in performed algebraic operations, wrongly calculated the value of the objective function. From the observations, only 2 students were able to answer perfectly. From the results of the study, 23 students or 92% of students have not been able to use mathematical concepts and have not been able to write mathematical symbols (facts) correctly, have not been able to solve problems with correct mathematical principles and procedures. This is in accordance with the opinion of Sofianingsih & Kusmanto (2021) that procedural errors are the most committed by students.

Another thing that is often encountered is that students are not careful in solving questions, resulting in incorrect answers to questions. Figure 4 below is an example of inaccuracy in solving problems.

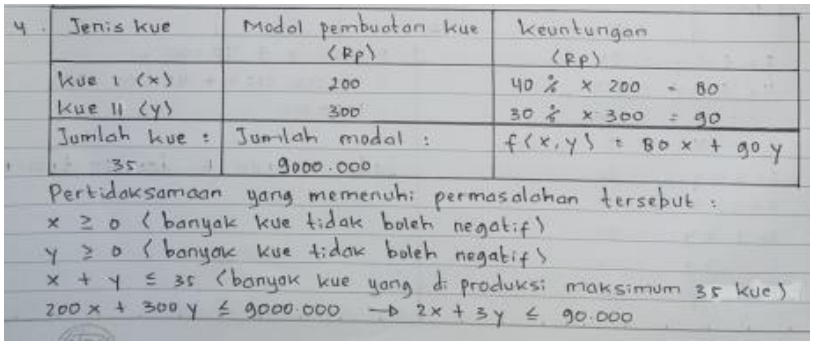

Figure 4. Inaccuracy in Problem Solving

Figure 4 above shows that students have been able to formulate problems, have been proven to be able to make examples of questions, are able conceptually, but are still wrong in carrying out mathematical procedures. This is in line with the results of research from Nurianti, Halini, & Ijudin (2015) that students are not careful in working on questions, which is the main cause of errors in solving problems. From the results of 25 sample interviewed, some students admitted that they were not careful in calculated, as a result the final results obtained were wrong. Observation results also show the same thing.

The last error made by students is an error in making conclusions or interpreting and evaluating the results. Often it is found that students have been able to formulate problems by doing mathematical procedures correctly, but are wrong when making conclusions or interpreting the answers obtained. Although this last step is considered quite easy, it turns out that many students do it. This is in accordance with the results of research from Farida (2015) who argues that many students are not able to make conclusions correctly which results in errors in answering questions. As shown in Figure 5 below.

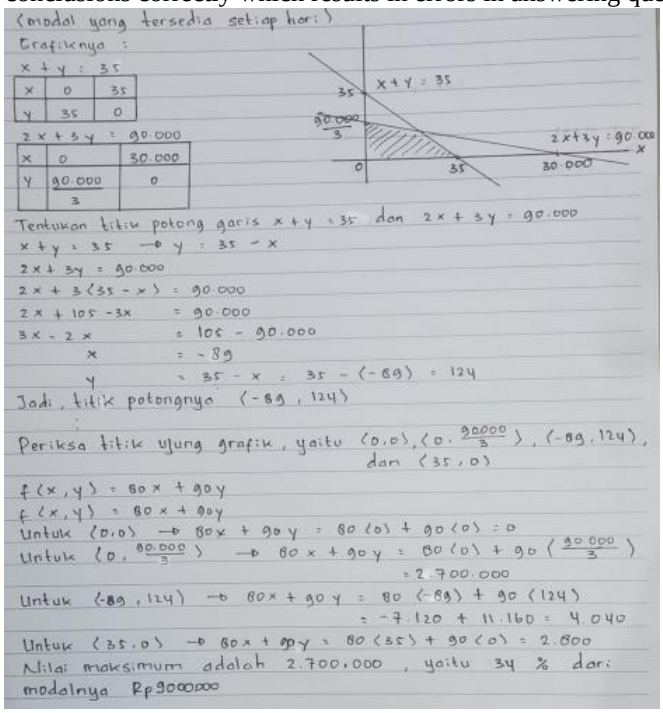

Figure 5. Result Interpretation Error

Based on the results of interviewed with 25 students, they admitted that they forgot to make interpretations and conclusions. There are also those who misinterpret the answers and do not check the final results. Therefore, the final stage of the literacy process cannot be completed perfectly. The results of the observations showed that only a few students were able to complete this stage of the literacy process perfectly. From the results of the study obtained as many as 22 students or 88% of students have not been

able to make conclusions and evaluate the problems given. From these results, it was concluded that 80% or more students had not been able to solve math problems from the lowest stages of the literacy process.

The results of this study were inseparable from the limitations of the researcher, (1) the study was limited to 25 students as the research sample and the subjectivity of the researcher. This research was very dependent on the researcher interpretation of the meaning implied in the interviews and observations. Further research should be carried out by taking more and wider research samples.

4. Conclusion

Based on the results of the research and discussion above, it can be concluded, among others: (1) as many as 20 students or 80% of students have not been able to formulate problems mathematically. Students have not been able to make an example of the problem correctly; (2) as many as 23 students or 92% of students have not been able to use mathematical concepts and have not been able to write mathematical symbols (facts) correctly, have not been able to solve problems with correct mathematical principles and procedures; and (3) as many as 22 students or 88% of students have not been able to make conclusions and evaluate the problems given. From these results it can be said that 80% or more students have not been able to solve math problems from the lowest stages of the literacy process.

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