

The Difficulty of Students' Reflective Thinking in Problems Solving of Linear Program

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Abstract

The identification in this study with the aim is to describe how difficult it is for students to think reflectively when solving math problems, especially in linear programming material. Based on the purpose of this study, the type of research is qualitative with a descriptive exploratory approach. Data collection techniques used are: (1) test instruments; (2) interview instruments, and 3) documentation. Analysis of research data namely: (1) research data reduction, (2) data exposure, (3) data triangulation, and (4) drawing conclusions. The subjects in this study were 24 high school students. Then 2 students were selected as subjects for each category (high, medium, and low). The results of the study show that students with high mathematical abilities have difficulty in reflecting, namely, 1) difficulty connecting new information with previous understanding, so they are not careful when identifying stories in the form of mathematical models, 2) difficulties in aspects of finding relationships and formulating solutions, students mistake the sign of linear inequality two variables, 3) difficulty in evaluating aspects of the completion process, students find it difficult to recall the function graph material to solve problems using the graphical method. Students with moderate mathematical abilities, namely: 1) difficulties in the aspect of connecting new knowledge with previous understanding, students need to be careful in solving contextual problems, 2) difficulties in aspects of finding relationships and formulating solutions, students have difficulty recalling function graph material, difficult to shade the area of settlement, 3) difficulties when students evaluate the completion process. Students find it difficult to prove whether the answer is correct or not by using the graphical method. Students with low mathematical ability, 1) difficulties in the aspect of connecting new knowledge with previous understanding, students find it difficult to translate story problems into mathematical models, it is difficult to recall the material of a two-variable linear inequality system, 2) difficulties in the aspect of finding relationships and formulating solutions, students have difficulty finding coordinates, drawing graphs, finding intersection points, substituting corner points into the objective function. 3) difficulties in evaluating aspects of the completion process, students find it difficult to prove the correctness of the answers obtained by the graphical method. The difficulties experienced by students in reflective thinking were caused by students not remembering previous material related to linear programming, as well as students' difficulties in the dimensions of fact, concept and procedural knowledge.

Keywords: mathematical reflective thinking difficulties, students' mathematical abilities, linear programming material

1. Introduction

Education plays an important role in human life, with education and technological advances as well as the current developments; education is needed in all aspects. Along with the advancement of technology and the development of the times, it demands an increase in human resources in order to achieve an advanced and prosperous nation. Tatang (2012, p. 14) Education is an effort that is carried out deliberately and systematically to motivate, foster, assist, and guide a person to develop all potential so that he achieves better quality himself. This is in accordance with the law on the National Education System.

Republic of Indonesia Law Number 20 of 2003 concerning the National Education System Chapter 1 Article 1 Paragraph 1, education is a conscious and planned effort to create an atmosphere of learning and learning so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, and skills needed by himself, society, nation and state in an effort to develop his academic

potential. Learning is one of everyone's activities to get changes in behavior, both in the form of knowledge, skills, attitudes and positive values as an experience from various materials that have been studied. It is often found that students who find it difficult to learn material at school are in mathematics. Mathematics is one of the subjects that play an important role in the world of education. According to Chotimah (2016, pp. 99-100), mathematics is one of the subjects taught at every level of school, both at the elementary, secondary and higher education levels. Hudojo (Ariestyan, 2016, p. 96), the process of learning mathematics occurs as a thinking process, because someone is said to think if they do mental activities. One of the thinking processes that help students to recall previous material in order to solve a given problem is reflective thinking. Sezer (Suharna, 2018, p. 6), states that reflective thinking is awareness to know what information will be used in solving problems. Utami et al. (2020, pp. 36-37), students are said to have high reflective thinking skills if they meet the criteria of reflective thinking indicators including: 1) Being able to link new knowledge with previous understanding. 2) Be able to find relationships and formulate solutions. 3) Evaluate the completion process.

Based on the results of the interviews that the researchers conducted with the mathematics teacher as well as the homeroom teacher for class XI IPA 1, the results of the interviews obtained that in learning mathematics, especially in linear programming material, students had difficulty translating story problems into mathematical models which caused students to be unable to solve the problems, given on the other hand if the mathematical model is known there are still students who find it difficult to make graphs, determine the area of the set of solutions, and find it difficult to find the optimum value. Widdiharto (Firiani, 2018, pp. 140-141) states that difficulties in mathematics are characterized by not remembering one or more terms of a concept. It is necessary to pay attention to the difficulties experienced by students in solving the given linear programming problems. It is hoped that by knowing the difficulties experienced by students in every aspect, namely the aspect of connecting new knowledge with previous understanding, the aspect of finding relationships and formulating solutions and aspects of evaluating the completion process. Students experience difficulties when solving linear programming questions because there are several difficulties experienced by students namely, in the dimensions of factual knowledge, conceptual and procedural knowledge dimensions

2. Research Method

This type of research is a qualitative descriptive research. According to Bogdan and Taylor (Prastowo, 2016, p. 23), qualitative methodology is a research procedure that produces qualitative descriptive data in the form of written or spoken words from people and the observed behaviour. Next to determine the level of mathematical ability based on criteria. This grouping of reflective thinking difficulties is based on students' mathematical abilities acquired, so that the grouping is based on the criteria used by Marurotulaily, Horbi, and Suharto (Utami et al., 2020, p. 37), namely three levels.

Table 1. Criteria for students' mathematical ability level

Value Range	Qualification
$0 \leq \text{TKM} \leq 60$	Low
$60 < \text{TKM} \leq 75$	Currently
$75 < \text{TKM} \leq 100$	Tall

The data collection techniques in this study were test instruments, interviews and documentation, as well as the analytical techniques used, namely data reduction, data exposure, data triangulation, and drawing conclusions.

3. Results and Discussion

Based on the results of students' mathematical reflective thinking difficulty tests based on the mathematical abilities of 24 students in class XI IPA 1 SMA Negeri 5 Ternate City, it was shown that students who obtained the lowest scores were (7.14) and students who obtained the highest scores were (92, 85). This study analyzed the difficulties experienced by students with high, medium and low mathematical abilities according to the indicators of mathematical reflective thinking, namely connecting new knowledge with previous understanding, finding relationships and formulating solutions and evaluating the completion process.

I) Students' Mathematical Reflective Thinking Difficulties in Solving Linear Program Problems Based on Mathematical Ability in the High Category.

a. Difficulties in the aspect of Linking New Knowledge with Previous Understanding.

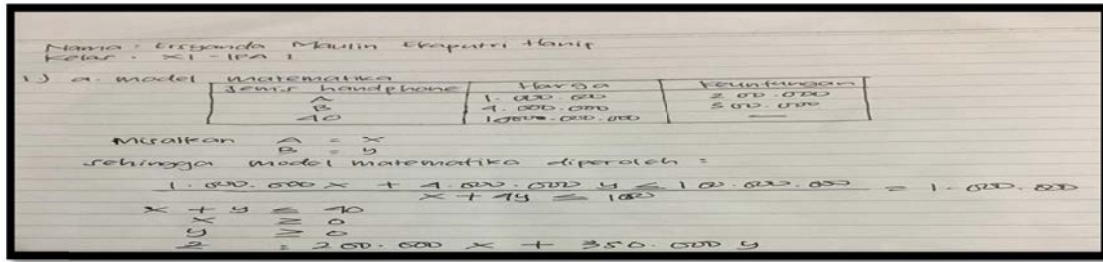


Figure 1. Student work results T1

Based on the work of T1 students, it can be explained that T1 students can connect previous knowledge about linear inequalities material with contextual problems so that they can make mathematical models and formulate objective functions as the completion of linear programs. Student T1 makes an auxiliary table by assuming that x is a cellphone of type A and y is a cellphone of type B, as a way of obtaining two inequalities and an objective function. But in the results of the interviews the students felt difficulties in making an example of the word problem to get a mathematical model, student T1 said that it was necessary to be careful to change the story problem into a mathematical model. The accuracy referred to by T1 students is that if a story problem is wrong in making a mathematical model, for example, an inequality sign error is less than equal to (\leq) and more than equal to (\geq), errors in making examples, and errors in formulating mathematical models, then the next step it's already wrong because it's already had an error before.

b. Difficulties in Aspects of Finding Relationships and Formulating Solutions

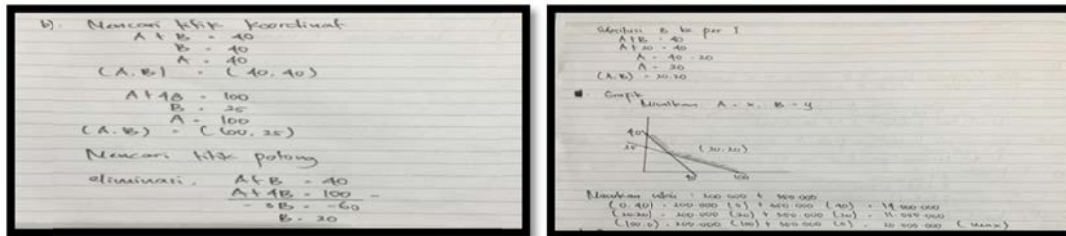


Figure 2. Student work results T1

Based on the work of T1 students, it shows that these students experience conceptual difficulties in the aspect of finding relationships and formulating solutions, students' reflective thinking difficulties in the conceptual knowledge dimension, namely T1 students having difficulty recalling the material of the two-variable linear equation system (SPLDV), systems of linear inequalities and variables (SPtSLDV), as well as function graphs for finding coordinate points and intersection points of inequalities obtained in the mathematical model as well as new knowledge, namely students looking for the maximum score on a given problem. The difficulties experienced by T1 students were conceptual difficulties, students were confused with the sign of inequality so that when drawing a graph T1 students were difficult or experienced errors when shading the set of settlement areas on the graphs made, it can be said that students did not understand the concept of graphs.

c. Difficulties in the Aspect of Evaluating the Completion Process

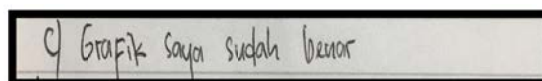


Figure 3. T1 student work results

Based on the results of the work it can be seen that T1 students experienced procedural difficulties in the aspect of evaluating the completion process. Subject T1 believes that the graph obtained is correct but cannot prove the correctness of the answers obtained. Initially, this T1 student had difficulty with the graphical concept which prevented the student from solving problem number 1c using the graphical method test. T1 students find it

difficult to recall previous material regarding systems of inequalities and graphs of functions to solve the problems given.

II) Students' Mathematical Reflective Thinking Difficulties in Solving Linear Programming Problems Based on Mathematical Ability in the Moderate Category.

a. Difficulties in the Aspect of Linking New Knowledge with Previous Understanding

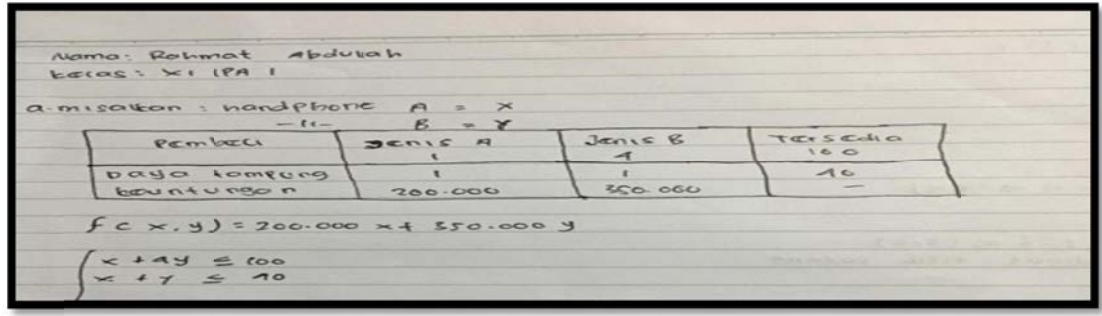


Figure 4. Work results of undergraduate students

Judging from the results of student work, it can be seen that S1 students, on the aspect of connecting new knowledge with previous understanding on the dimension of factual knowledge. Undergraduate students relate previous material regarding systems of two-variable linear inequalities to solve contextual problems by assuming x is a mobile phone of type A and y is a mobile phone of type B and makes auxiliary tables to formulate a mathematical model with objective functions. Even though when interviewed students said that it was difficult to make an example in word problems, the student had tried to make an example using auxiliary tables to solve contextual problems in order to get a mathematical model.

b. Difficulties in Aspects of Finding Relationships and Formulating Solutions

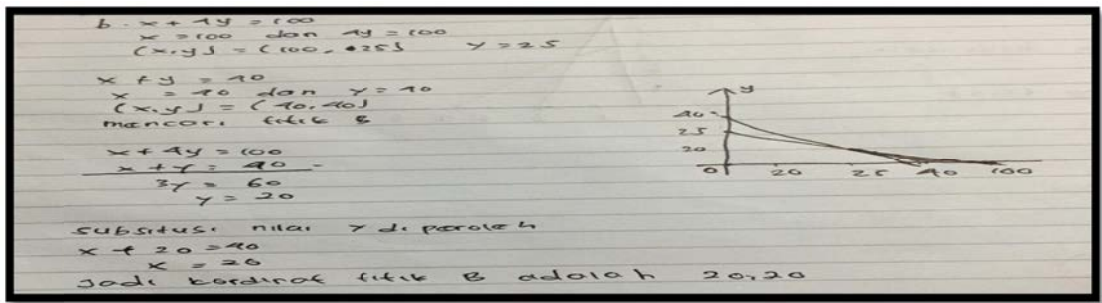


Figure 5. Work results of undergraduate students

Based on the results of undergraduate students' work on the aspect of finding relationships and formulating solutions, undergraduate students completed problem number 1b by finding coordinate points and intersection points where the student looked for intersection points by eliminating then substituting so that the intersection points of the two dissimilarities were obtained. Difficulties in the aspects of finding relationships and formulating solutions show that undergraduate students have conceptual difficulties because undergraduate students find it difficult to recall material on function graphs, which makes it difficult for these students to shade the graph and determine the settlement set area on the graph that has been drawn by undergraduate students. Based on the interview results, these students experience difficulties in the concept of graphing, especially determining the shaded area makes S1 students unable to determine what points fulfill the settlement set area. Therefore it is difficult for students to find the maximum value of the questions given.

c. Difficulties in the Aspect of Evaluating the Completion Process

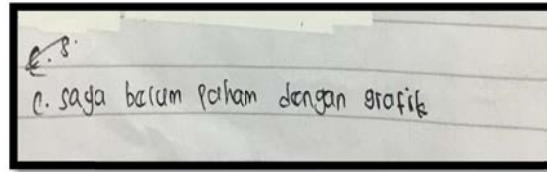


Figure 6. Work results of undergraduate students

The picture above shows that, in the aspect of evaluating the completion process, students find it difficult to prove the correctness of the answers obtained. S1 students in the dimension of procedural knowledge can be seen from the results of student work in the picture above. Students are convinced that the answers obtained are correct, but it is difficult to prove the correctness of the answers obtained. Undergraduate students find it difficult to remember previous material regarding systems of dissimilarities with graphical functions which makes it difficult for these students to give the truth of the answers they get.

III) Students' Mathematical Reflective Thinking Difficulties in Solving Linear Program Problems Based on Mathematical Ability in the Low Category.

a. Difficulty in Aspect Linking new knowledge to previous understanding.

Figure 7. Student work results R1

The results of student R1's work in students' mathematical reflective thinking showed that these students had difficulty in the aspect of connecting new knowledge with previous understanding, student R1 found it difficult to connect previous knowledge about a system of two-variable linear inequalities to solve a newly given problem. Student R1 experienced factual difficulties, namely students found it difficult to translate contextual problems, it was difficult to give symbol descriptions to variables labeled with x and y symbols, they did not predetermine examples with variables to explain the variables that appeared. Based on the results of the interviews that the students found it difficult to change the word problems into mathematical models, students were mistaken in solving contextual problems where it was seen from the results of students' work in making mathematical models that student R1 was mistaken in translating story problems into mathematical models.

b. Difficulties in Aspects of Finding Relationships and Formulating Solutions

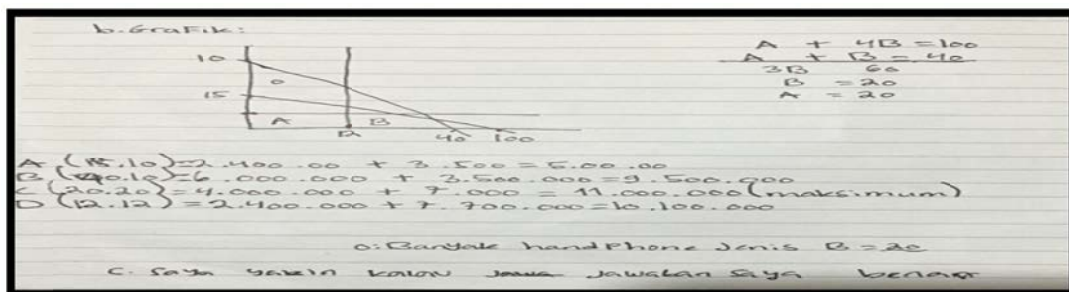


Figure 8. Student work results R1

Based on the picture of Student R1 it appears that the students' work has difficulties in the aspects of finding relationships and formulating solutions. Students experience conceptual difficulties, namely student R1 finds it difficult to determine coordinate points so that it makes students even difficult when drawing graphs to connect any dots that can be connected to the graph, it can be said that these students find it difficult to recall previous

material which makes students unable to solve linear programming problems where students are required to draw graphs and find the maximum value. The reasons given in the results of the interviews were that students tended to understand that learning was offline, because for one full semester students studied online, which made it difficult for students because online learning was considered less effective.

c. Difficulties in the Aspect of Evaluating the Completion Process

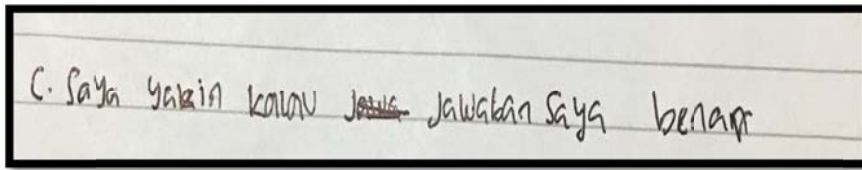


Figure 9. Student work results R1

In the picture above, it can be seen that student R1 has difficulty in the dimensions of procedural knowledge. It is difficult for students to prove the correctness of the answers obtained. the correctness of the answers obtained it can be said that student R1 has difficulty evaluating aspects of the completion process

4. Conclusion

- 1) The results of the analysis can be concluded that: Mathematical reflective thinking difficulties based on mathematical ability in the high category, namely the data obtained shows that fact, conceptual and procedural difficulties based on the results of interviews the difficulties felt by students when translating story problems into mathematical models, accuracy is needed to translate word problems. Accuracy in question is paying attention to the sign (symbol) of inequality less than equal to (\leq) more than equal to (\geq), and making an example of an auxiliary table by giving an explanation of the sign of each variable, for example x and y in "types of handphone A and B" while in conceptual difficulties, students are mistaken in the sign of linear inequality of two variables, in procedural difficulties, students find it difficult to prove the correctness of answers using the graphical method
- 2) The difficulty of mathematical reflective thinking based on mathematical ability for the Moderate category, the data obtained shows that students experience facts, concepts and procedural difficulties, namely students find it difficult to connect new knowledge with previous understanding, students find it difficult to find relationships and formulate solutions and find it difficult to evaluate the completion process. Based on interviews that students need accuracy to translate contextual problems into mathematical models, students do not understand equations, inequalities and graphs of functions so that students find it difficult to evaluate the completion process by testing the graphical method.
- 3) The difficulty of mathematical reflective thinking based on mathematical ability for the low category based on data obtained on students who are in the medium category, namely students experiencing facts, concepts and procedural difficulties. formulating solutions and difficult to evaluate the settlement process. The difficulties experienced by students made students unable to complete linear programming questions.

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Data sharing statement

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