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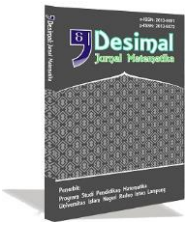

Mathematical problem-solving ability: The impact of self-regulated learning on the system of linear inequalities in two variables

Hilda Amalia, Hella Jusra*

Universitas Muhammadiyah Prof. DR Hamka, Indonesia

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*Correspondence: E-mail: hella.jusra@uhamka.ac.id

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ABSTRACT

This research aims to analyze the mathematical problem-solving ability of students in terms of self-regulated learning. The method used in this research is the qualitative descriptive method. There are 4 indicators of problem-solving ability in this research, namely understanding the problem, formulating the problem, solving the problem, and re-examining the answers. The four indicators of problem-solving ability can be met by subjects who have a high self-regulated learning category. Subjects with medium self-regulated learning category were only able to fulfill 3 indicators of problem-solving ability. Meanwhile, subjects with low self-regulated learning were only able to fulfill 2 indicators of problem-solving ability. The results showed that the ability to solve problems with high categories was owned by subjects with high self-regulated learning.

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INTRODUCTION

Mathematics is a structured science because it requires a series of stages to find the right and appropriate solution in the process of solving a mathematical problem so that mathematics becomes a lesson that can improve one's abilities (Fatmawati et al., 2014). The basic abilities that can help the learning process run well are problem-solving skills that can combine the information obtained in order to be able to find solutions to the problems given by using the right method so that they can achieve the targets to be achieved (Ince, 2018; Maisyaroh Agsya et al., 2019; Nisa et al., 2020; Purnama et al., 2020; Suryani et al., 2020). Based on this, problem-solving skills are the basis of other abilities, namely mathematical reasoning abilities, because when students solve problems, they must also be able to present, and model problems until they can finally find a solution (Cerda et al., 2017). If students' problem-solving ability is maximized, then they will be able to solve a problem well, but some students in Indonesia have low problem-solving abilities, especially in applying them to problem solving (Akbar et al., 2017; Suraji et al., 2017). The main goal of problem-

solving is to find out how the process of solving the problem that is given (Hendriana et al., 2017). For this reason, this research uses indicators according to Polya, namely understanding the problem, formulating problems, solving problems, and re-examining which can facilitate students to be able to understand the whole process of solving.

The results of student problem solving are influenced by the level of problem-solving abilities, not being good at solving a problem results in difficulties when solving mathematical problems (Andayani & Lathifah, 2019). Besides being able to determine success in problem solving abilities, self-regulated learning can also determine success in the learning process, and can help develop one's problem solving abilities in the problem solving process, so it is very important to have (Kurnia & Warmi, 2019; Musliha & Revita, 2021; Nurmawati et al., 2021).

Self-regulated learning is one of the most common educational theories to observe the success of student achievement because it includes a large number of variables related to learning, such as goal orientation, task-specific strategies, metacognitive strategies, attribution theory, and others. Self-regulated learning is a way of learning independently, when a person can have the initiative in compiling a series of learning, such as designing learning targets, learning resources, examining learning needs, and determining learning methods (Sundayana, 2018). At the time of learning, students will be guided to become independent students in order to achieve self-regulated learning in learning (Kurnia & Warmi, 2019). For this reason, self-regulated learning is quite important to have because it can provide knowledge about self-regulation abilities (Badjeber, 2020). To measure self-regulation in this research, several indicators are needed, including 1) Initiative and ambition in learning, 2) Analyzing learning needs, 3) setting learning goals, 4) Adjusting learning strategies, 5) Reviewing, regulating, and controlling learning, 6) Seeing difficulties as challenges, 7) Utilizing and finding relevant sources, 8) Evaluating learning processes and outcomes, 9) Self-efficacy adopted from Saepulloh, E (2017).

Several relevant studies on problem-solving abilities and self-regulated learning, including those conducted by Umrana et al., (2019) stated that learning styles can cause different levels of problem-solving abilities. Then research by Yuliati, (2016) stated that learning motivation can cause differences in students' problem-solving abilities. Likewise research on self-regulated learning in mathematics academic ability by Herlina et al., (2022), stated that mathematics academic achievement can be influenced by self-regulated learning. Then about the ability of interrelated problems with self-regulated learning (Zamnah, 2017). The weakness of this relevant research is that no one has discussed the relationship between students' mathematical problem-solving abilities with affective aspects, namely the ability to self-regulate learning or the term self-regulated learning.

Referring to previous studies that have been carried out, problem-solving abilities and self-regulated learning play an important role in the mathematics learning process. Students are expected to have the ability to solve the problems faced by using the knowledge they have and be able to organize themselves in learning to support their success in learning. This is because no one has categorized the mathematical problem-solving abilities of students who have self-regulated learning in various categories. In line with previous research, this research aims to determine the ability to solve mathematical problems in terms of self-regulated learning.

METHOD

The method used in this research is the qualitative descriptive method. The aim is to describe the data obtained in written or oral form. In this research, subjects were selected using a purposive sampling technique based on a category level. In this research, the subjects involved were 104 students of class X in different areas in Jakarta, Indonesia.

The research procedure was carried out by distributing self-regulated learning questionnaires and a test of problem-solving skills on the system of linear inequalities in two variables (SPtLDV) material. The questionnaire consists of 28 statement items and five ability test questions. Furthermore, interviews were conducted with predetermined subjects based on the level of self-regulated learning. The questionnaire data were obtained from 104 participating students. Then 6 subjects were selected based on the high, medium, and low self-regulated learning categories consisting of two subjects each using the Rasch model with Win step. Next, an analysis of the answers to these questions was carried out. Before being given to the subject, the test instrument was validated and declared valid and feasible to use. Interviews were conducted to find out whether there were differences in information in the written and oral tests.

The stages in this research are described in Figure 1.

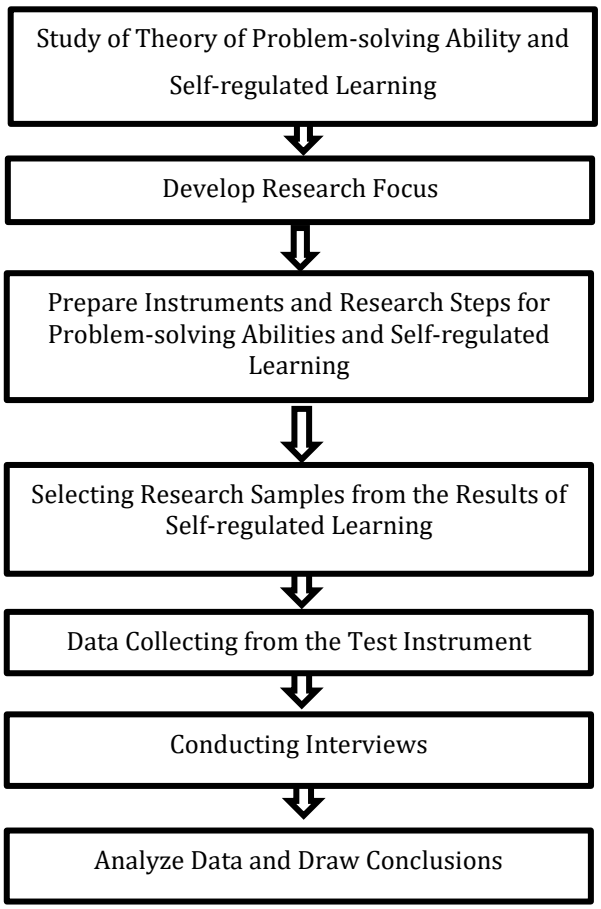

Figure 1. Research Flowchart

RESULTS AND DISCUSSION

The subjects in this research were 2 for students with high self-regulated learning, 2 for medium self-regulated learning, and 2 for low self-regulated learning. There are 25 students who have high self-regulated learning, 72 students are medium, and 7 are low. Data

information from the six students is presented in Table 1.

Table 1. Data Information

Student Code	Category
H1	High
H2	High
M1	Medium
M2	Medium
L1	Low
L2	Low

Students who have been selected according to the level of self-regulated learning are then given a test that measures mathematical problem-solving abilities. Furthermore, an in-depth analysis of the results of the settlement is carried out.

Then interviews were conducted with 6 subjects who had been selected based on their level of self-regulated learning. Figure 2 and 3 are the results of the written test for subjects H1 and H2.

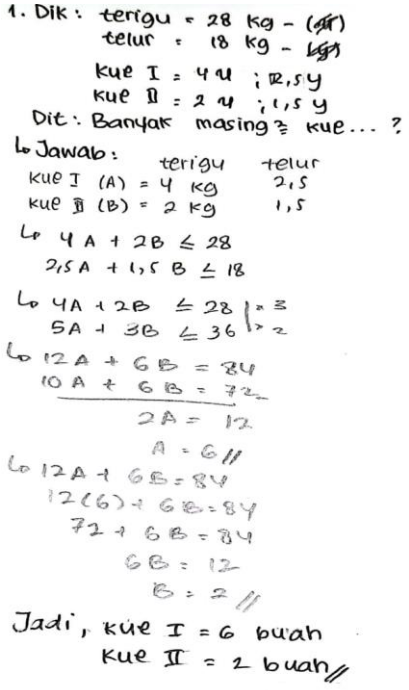

Figure 2. Solution Result of Subject H1

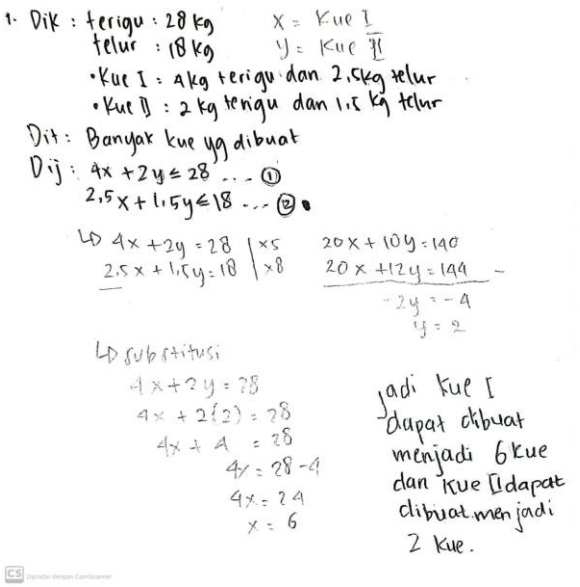

Figure 3. Solution Result of Subject H2

Based on the answers to the ability test questions, H1 and H2 can understand the problem well, make plans properly, the subject can also solve problems correctly, and re-examine the answers by writing conclusions correctly.

Based on the results of the interview analysis, H1 and H2 were able to re-express the information and question obtained from the problems correctly, were able to correctly state the mathematical model, and both subjects were able to explain what method was used in the completion process to the final step and draw conclusions correctly.

Based on the written and oral test data, the four problem-solving indicators can be met by subjects H1 and H2. Subjects H1 and H2 have a good understanding of the problem, seen from the subject who is able to know the data from the given problem, then knows what is being asked. Subjects H1 and H2 also use the right method to solve problems and can make mathematical models correctly, it can be said that subjects H1 and H2 can make plans for solving problems correctly. Then subjects H1 and H2 can also complete the plans they have made by finding the right results. Subjects H1 and H2 were also re-examined, it can be seen from the written

test that subjects H1 and H2 can draw conclusions correctly.

Figure 4 and 5 are the results of the written tests for subjects M1 and M2.

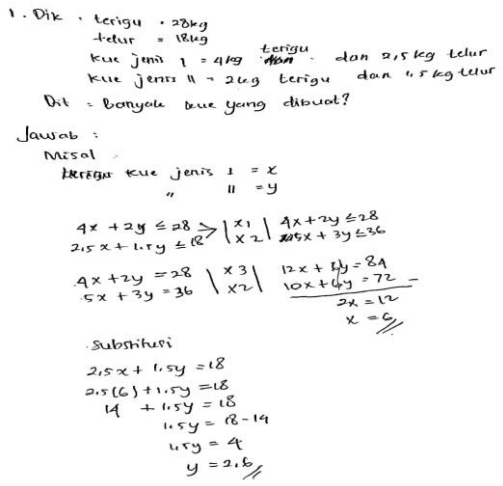

Figure 4. Solution Result of Subject M1

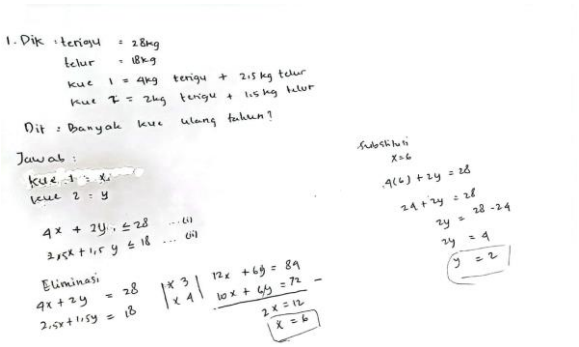

Figure 5. Solution Result of Subject M2

Based on the results of the completion of the test questions from the subject, M1 and M2 have a good understanding of the problem and are able to make plans correctly. The subject M1 seems to be solving it using the right way, but the results obtained are still not precise, while M2 can do the right solution, but the re-examination stage was not carried out by M1 and M2. Because both subjects did not make a conclusion.

Based on the results of the analysis from interviews conducted with subjects, M1 and M2 revealed information and question that were known from the problems. Then both subjects were able to mention the mathematical model of the given problem and know the right method to solve the problem. Both subjects can explain the completion process carried out. Subject M1 did not make conclusions because one was not too sure of the results obtained. Meanwhile, the subject of M2 did not make any conclusions because according to M2, the completion was sufficient until the stage of finding the results.

Based on the written and oral test data, it can be seen that both subjects have a good understanding of the problem, seen from the way the subject can find out information and questions. For the planning stage of problem-solving, both subjects can also plan properly. At the stage of implementing the plan, subject M1 could not get the correct result, while subject M2 could finish it well. Then, subject M1 could not reach the re-examination indicator, because the subject was unsure of the answer. While the subject of M2 does not make conclusions because according to him the completion is sufficient until the stage of finding results.

Figure 6 and 7 are the results of the written tests for subjects L1 and L2.

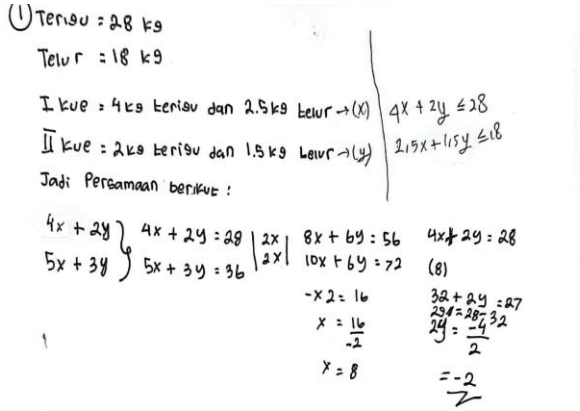

Figure 6. Solution Result of Subject L1

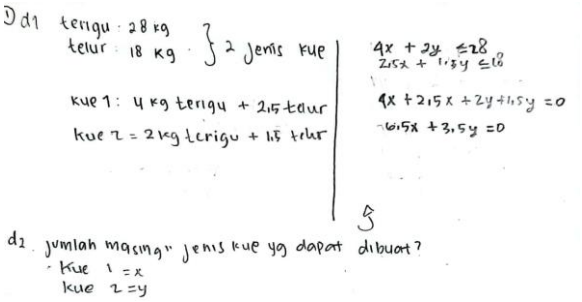

Figure 7. Solution Result of Subject L2

The results of the completion of the test questions from subjects L1 and L2 showed that the two subjects did not seem to understand the problem very well. For the planning stage of completion, subject L1 seems to be planning but not quite right, while subject L2 does not make a plan for completion at all. For the stage of solving the problem, both subjects did the completion but the results did not appropriate. Both subjects did not re-examine, because they were unable to write down the conclusions.

Based on the results of the interview analysis, subject L1 did not understand the problem given but was still able to reveal known information. While L2 can mention known information. Both subjects can also mention the mathematical model of the problem. Subject L1 did not know the right method to solve the problem. At the problem-solving stage, subject L1 can tell the process of solving the problem, but the process that is re-explained using interviews is different from the written test answer. For the solution, subject L2 says if the subject is still confused, what one should do.

Based on the data on the written and oral test questions, it can be seen that both subjects did not really understand the problems given. It can be seen from the answers of subjects L1 and L2 who only wrote down known information without writing down the question. For the problem planning stage, subject L1 wrote an inaccurate plan, while subject L2 did not plan. At the problem-solving stage, both subjects did the completion, but the method used when solving the problem was still not right so the results obtained were also wrong. L1 and L2 did not perform the re-examine stage.

Subjects with a high self-regulated learning category were able to work on problems systematically and could fulfill the four indicators of solving ability. Subjects H1 and H2 were able to find information and questions from the problems given. In the stage of formulating the problem, subjects H1 and H2 make mathematical forms from existing information, in the stage of carrying out the plan, subjects H1 and H2 are able to solve using the right method so that they get the correct result. At the stage of re-examination, both subjects were able to draw conclusions correctly.

Subjects in the medium self-regulated learning category were only able to master 3 indicators of problem-solving ability. For the problem understanding stage, subjects M1 and M2 were able to find information and questions from the problems given. Then for the stage of formulating the problem, subjects M1 and M2 are able to make mathematical models and know the methods to solve them. At the problem-solving stage, subjects M1 and M2 solve the problem according to the strategy in the previous stage. For the re-examination stage, both subjects did not make any conclusions.

Subjects with a low self-regulated learning category were able to achieve 2 indicators of problem-solving ability. At the stage of understanding the problem, subjects L1 and L2 were able to find information but did not know the question of the given problem. In the formulation of the problem, subjects L1 and L2 were able to change the problem into mathematical form, but the subject did not know the method used for solving it. At the stage of solving the problem, subjects L1 and L2 have not been able to solve the problem properly, due to the subject's error in

making a settlement plan. Then at the re-examination stage, L1 and L2 have not been able to reach this stage, because L1 and L2 did not make conclusions.

In each category of self-regulated learning, it is illustrated that both subjects in the high self-regulated learning category are able to meet the four indicators of problem-solving ability, while in the medium category, there are subjects who make mistakes in answering but both do not provide conclusions on the problems given. Subjects with low categories cannot understand the problem even though they are able to solve it but the results are not right. From the results of this research, subjects with high self-regulated learning categories can solve problems that measure problem-solving abilities well.

CONCLUSIONS AND SUGGESTIONS

Based on the explanation above, it was found that students with a high self-regulated learning category were able to solve problems well and could achieve 4 indicators of solving ability. Subjects with a medium self-regulated learning category were able to work but could only meet 3 indicators of problem-solving ability. Subjects with low self-regulated learning categories have not been able to do the problems correctly, and only achieved 2 indicators of problem-solving ability. It can be said that the ability to solve problems very well or is categorized as high is owned by someone with high self-regulation.

This research is still limited to the SPtLDV material and to class X students. And the variables used are still limited. This research can be developed based on students' gender for further research.

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