Mathematics Modeling Ability of Students in System of Linear Equation of Two Variables Materials with PBL Model at SMPN 1 Pangkalan Baru

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Mathematics Modeling Ability of Students in System of Linear Equation of Two Variables Materials with PBL Model at SMPN 1 Pangkalan Baru

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ABSTRACT
This research is motivated by the low ability of students' mathematical modeling, especially on SPLDV material. The Problem-Based Learning (PBL) model is used to overcome this problem. This study aims to describe students' mathematical modeling abilities on system of linear equations of two variables material after the Problem-Based Learning (PBL) model is applied. This research took place at Junior High School number 1 in Pangkalan Baru involving 16 students as research subjects. The research method used is descriptive with data analysis techniques which are quantitative and qualitative based on mathematical modeling indicators. The data were collected using a written test. The written test consists of 2 non-routine essay questions aimed at obtaining data on students' mathematical modeling abilities. Based on the overall results, students' mathematical modeling abilities are in the sufficient category with an average score of 54.80, with details of 31.25% of students in good category, 56.25% of students in sufficient category and 12.5% of students in poor category. The indicator of mathematical modeling ability with the highest percentage of occurrences are identifying problems of 89.06%, while for the lowest percentage of occurrences the indicator of analyzing and assessing solutions is 28.13%.

Keywords: *Mathematical Modeling Ability, SPLDV, Problem Based Learning*

1. INTRODUCTION

One of the mathematical abilities in the 2013 curriculum that must be possessed by students is the ability to model mathematics. The importance of mathematical modeling is stated in Permendikbud RI No. 22 of 2016 where when solving a problem there is a process that includes the ability to understand the problem, design a mathematical model, complete the model, and interpret the solution obtained [1]. To solve problems, mathematical modeling skills are required.

Mathematical modeling arranges the context of real problems in a mathematical model with the process of understanding, solving problems, and solving problems so that it is easy to find solutions [2,3]. A contextual problem can be solved and manipulated using mathematics if it has been interpreted into a mathematical model [4]. A mathematical model is a description of a condition of a contextual problem that uses mathematical language or symbols in the form of mathematical equations, tables, graphs, or diagrams by selecting important information and can be used to solve problems [5].

The material for a system of linear equations with two variables or abbreviated in Indonesian as SPLDV is one of the materials that require mathematical modeling skills to master. This is because in studying system of linear equations of two variables material, students must make linear equation of two variables forms from the problems presented, create mathematical models from linear equation of two variables, create mathematical models from system of linear equation of two variables, and determine problem-solving from system of linear equation of two variables related to everyday problems [6].

This research started from the results of several previous studies which showed the low ability of students' mathematical modeling on system of linear equation of two variables material. The research of Muntaha, et al, states that when students work on problems in the form of word problem, many students still have difficulty in making mathematical models [7]. The difficulty is caused by the lack of students' understanding of the steps of mathematical modeling and the inability of students to assume verbal sentences. In addition, in learning, there are still many students who have difficulties or errors in changing the form of word problems into mathematical models, especially in system of linear equation of two variables material [8,9].

One of the causes of low student learning outcomes is the learning tools used by teachers do not describe the learning objectives to be achieved [10]. The teacher should first review the basic competencies according to the curriculum to determine the appropriate approach and learning model and to find out the abilities that students must master after studying the material [11]. Efforts to overcome this problem are by applying KIkuduko-based learning tools to system of linear equation of two variables material developed by Indaryanti, et al (2021).

KIkuduko-based learning tools have been prepared following the right guidelines and procedures. The preparation starts from analyzing Graduate Competency Standards (SKL), then analyzing Core Competencies (KI) which is a description of SKL, followed by Basic Competency (KD) analysis which is then poured into Competency Achievement Indicators (GPA). The next step will proceed to the planning, implementation, learning evaluation, and follow-up stages [12]. So that this learning device already contains the planning of the learning implementation process by the objectives to be achieved.

In addition to improving learning tools, to improve mathematical modeling skills, an appropriate mathematical learning model is needed, namely the Problem-Based Learning (PBL) learning model. The PBL learning model is a problem-based learning model that can develop students' problem-solving abilities to problems in real life [13]. According to Eric, when students are trained in solving a problem in learning, their mathematical modeling abilities can develop well [14]. The results of Silmina's research stated that students' mathematical modeling abilities were categorized as high and there was an increase after being taught using the PBL model [15].

There are 5 syntaxes in the PBL model that have been developed by Arends namely: 1) Providing problem orientation to students, 2) Organizing students to study and research, 3) Guiding independent and group investigations, 4) Developing and presenting students' work, 5) Analyzing and evaluating the process of problem-solving [16]. The five syntaxes of the PBL model lead students to solve a problem so that students are accustomed to translating a real problem into the form of a mathematical model. Therefore, SPLDV material can be presented using the PBL model.

Based on the explanation of the background above, it can be concluded that the importance of mathematical modeling skills in mastering the SPLDV material so that a PBL learning model is needed in learning. The purpose of this study is to describe students' mathematical modeling abilities on the SPLDV material with the PBL model at SMP N 1 Pangkalan Baru.

2. METHOD

The method used in this research is descriptive quantitative and qualitative methods. The subjects of this study were students of class VIII SMP N 1 Pangkalan Baru. The research was conducted in the 2021/2022 academic year. This study used one class VIII, namely class VIIIA, which consisted of 16 people. The categories in this study consisted of 5 levels, namely very good, good, sufficient, less, and very poor. The data in this study were obtained through written tests and interviews. The test questions are arranged in the form of non-routine description questions to determine the students' mathematical modeling abilities, totaling 2 questions.

In descriptive research, data analysis begins by examining students' answers and assigning scores to the criteria for assessing students' mathematical modeling abilities based on the following scoring guidelines. The following table of test scoring guidelines:

Table 1. Guidelines for scoring test questions

Indicator	Descriptor	Score
Identify the problem	Identify what information is in the question	3
	Formulate the problem asked in the question	3
Making Assumptions and Defining Variables	Using symbols or symbols to make mathematical models fit	3
	Making the Right Assumptions	2
Doing math	Formulate a mathematical model based on the given information and previously defined variables.	3
	Solve the model mathematically to get the correct solution	3

Analyze and assess solutions	Interpreting the solution of the obtained mathematical model	2
	Write down whether the solution obtained is reasonable	2
Check again	Checking the results obtained through the mathematical model that has been made	2
	Checking the results obtained through the mathematical model that has been made	2
Applying the Model	Interpreting solutions to the real world	2
	State the conclusion based on the solution obtained as a solution to the problem	2

Then, it is continued by calculating the test score using the following formula:

$$\text{Test Score}=\frac{\text{Total score obtained}}{\text{Maximum score}}\times 100$$

After that, the scores obtained are categorized according to the category table. The following is a table of categories of mathematical modeling abilities:

Table 2. Category of mathematical modeling ability

Test score range	Category Mathematical Modeling Ability
81-100	Very good
61-80	Good
41-60	Enough
21-40	Less
0-20	Very less

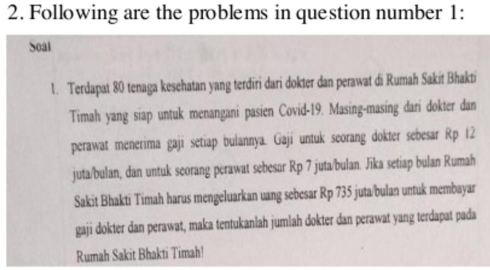
Furthermore, the results of the test are calculated as a percentage of each indicator and analyzed what mathematical modeling indicators appear. After that, the data analysis was continued by describing the test results qualitatively based on the indicators of the mathematical modeling ability of each research subject in each category that had been selected for questions number 1 and number 2. Then from the data that has been obtained conclusions are drawn.

3. RESULTS AND DISCUSSION

Before conducting the research, the researcher made the necessary preparations for the research. These things include research proposals, making observations to schools to ask for research permission and asking for class recommendations to teachers of mathematics subjects who will be research subjects, compiling learning tools and research instruments, as well as administering research permits. The learning tools made consist of Kikuduko-based competency achievement indicators (GPA), learning implementation plans (RPP), and student worksheets (LKPD). The research instrument made was a test of mathematical modeling ability, which consisted of two questions and an interview guide.

The research was carried out in three meetings consisting of two meetings for the learning process using the PBL model, and one meeting for conducting tests. The allocation of time for one meeting for the learning process is three hours of learning in which one learning hour consists of 25 minutes. The learning process uses LKPD which contains one problem in the form of non-routine questions. Students are led and trained to be able to solve these problems using mathematical modeling steps.

At the third meeting, a written test consisted of two questions. The written test will be held on Thursday, October 7, 2021, in class VIIIA of SMP N 1 Pangkalan Baru. The number of students who took the test was 16 students. The time allotted to do the test questions is 60 minutes. After the test is complete, the test results are checked and scored according to the assessment guidelines listed in table 1. Then, proceed to calculate the test scores according to the assessment table quantitatively and determine the category of students' mathematical modeling abilities listed in table 2. Steps The next step is to calculate percentage of each indicator to see whether the indicator appears or not. After that, the test results were described qualitatively based on the indicators of the mathematical modeling ability of each research subject in each of the selected categories. The researcher discussed the written test answer sheets from 2 students for question number 1 and question number 2. Following are the problems in question number 1:


Soal

1. Terdapat 80 tenaga kesehatan yang terdiri dari dokter dan perawat di Rumah Sakit Bhakti Timah yang siap untuk menangani pasien Covid-19. Masing-masing dari dokter dan perawat menerima gaji setiap bulannya. Gaji untuk seorang dokter sebesar Rp 12 juta/bulan, dan untuk seorang perawat sebesar Rp 7 juta/bulan. Jika setiap bulan Rumah Sakit Bhakti Timah harus mengeluarkan uang sebesar Rp 735 juta/bulan untuk membayar gaji dokter dan perawat, maka tentukanlah jumlah dokter dan perawat yang terdapat pada Rumah Sakit Bhakti Timah!

Figure 1 The problems in question number 1

Based on the test results, DK subjects have good mathematical modeling abilities. This can be seen from DK's answer to question number 1, it can be seen that DK has been able to carry out the mathematical modeling process well. That's because the subject of the DK has been able to bring up the six indicators correctly and completely. Here's DK's answer to question number 1:

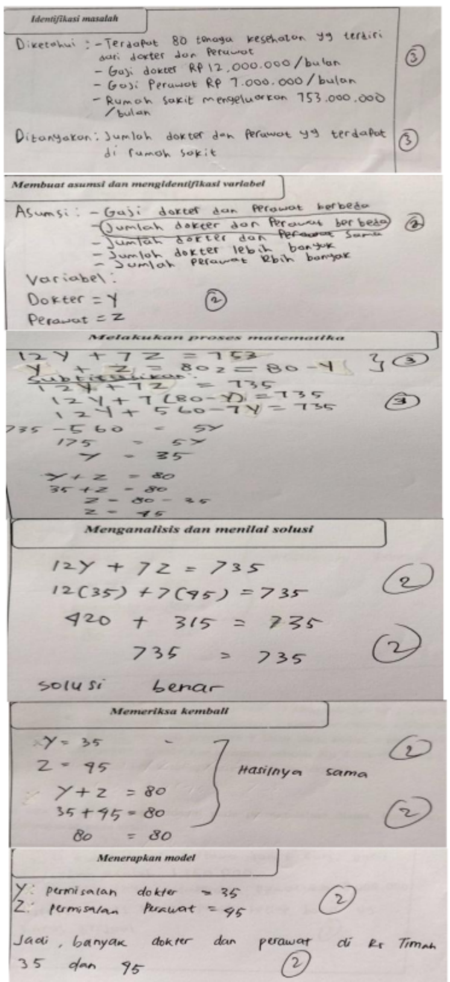


Figure 2 DK's answer to question number 1

From the answers to the DK test, it is known that the DK subject has been able to carry out the process of identifying problems because the subject can identify any information contained in the questions correctly and completely and can formulate the problem from the question so that the score obtained for each descriptor is a maximum of 3. The subject has also been able to make assumptions from the problem and define variables so that the score obtained for each descriptor is a maximum of 2. In the indicators of carrying out the mathematical process, the DK subject can make mathematical models and complete the model mathematically correctly so that the score for each indicator maximum is 3. In addition, the subject of DK can interpret whether the solution obtained is correct and reasonable by obtaining a maximum score of each descriptor which is 2 . For the re-examination indicator, the DK subject can re-examine the answers he obtained through the mathematical model that has been made and obtain a maximum score of 2 for each descriptor. DK subjects have also been able to apply the model by interpreting solutions to the real world and stating conclusions based on the solutions obtained by obtaining a maximum score for each descriptor, which is 2.

Here's the problem for question number 2:

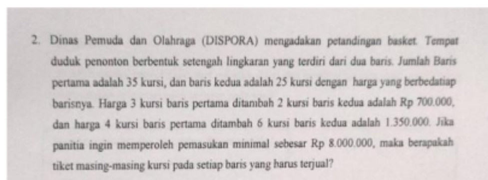

2. Dinas Pemuda dan Olahraga (DISPORA) mengadakan petandingan basket. Tempat duduk penonton berbentuk setengah lingkaran yang terdiri dari dua baris. Jumlah Baris pertama adalah 35 kursi, dan baris kedua adalah 25 kursi dengan harga yang berbedatiap barisnya. Harga 3 kursi baris pertama ditambah 2 kursi baris kedua adalah Rp 700.000, dan harga 4 kursi baris pertama ditambah 6 kursi baris kedua adalah 1.350.000. Jika panitia ingin memperoleh pemasukan minimal sebesar Rp 8.000.000, maka berapakah tiket masing-masing kursi pada setiap baris yang harus terjual?

Figure 3 The problems in question number 2

Based on the answers to the CF test, it is known that the CF subjects have sufficient mathematical modeling abilities. This is because the CF subject has not been able to bring up all the indicators of mathematical modeling. Here's CF's answer to question number 2:

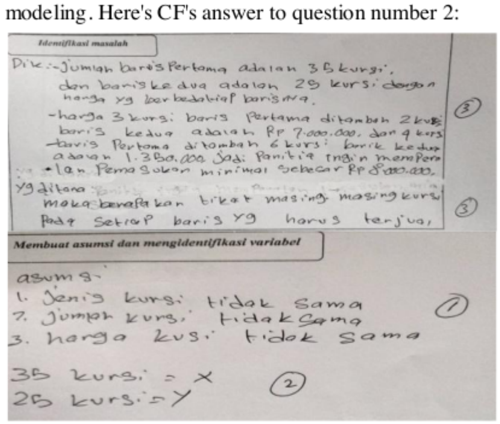


Figure 4 CF's answer to question number 2

From the answers to the CF test, it is known that CF has been able to identify the information contained in the questions and formulate problems so that CFs get a score of 3 each. The CF subject was also able to make assumptions but it was not correct so that the score obtained was only 1, and he was also able to define the variables so that the score obtained was 2. go back and apply the model. According to Puspitasari, et al (2015) , students who have difficulty converting known information into mathematical sentences will have difficulty making mathematical models [17]. This is because students do not understand the meaning of the question. Because the CF subject had difficulty in making mathematical models, he could not continue his work to the next stage.

After scoring, the test data that has been obtained is converted into scores. These values are categorized as in table 3:

Table 3. Quantitative data of students' mathematical modeling ability

Test value range	Category Mathematical Modeling Ability	Students' Mathematical Modeling Ability	
		Frequency	Percentage
81-100	Very Good	0	0
61-80	Good	5	31,25%
41-60	Enough	19	56,25%
21-40	Less	2	12,5%
0-20	Very Less	0	0
Amount		16	100%
Average Value		54,80 (cukup)	

In table 3 it can be seen the students' mathematical modeling abilities. The ability of students in the moderate category consists of at most 9 students. Furthermore, there are 5 students with good category and also 2 students with less category. Based on table 3, it can be concluded that the average grade VIIIA student of SMP N 1 Pangkalan Baru has a fairly good mathematical modeling ability with an average score of 54.80. The following table shows the occurrence for each indicator:

Table 4. Percentage of appearing indicators of mathematical modeling ability

Indicator	Occurrence Percentage (%)
Identify the problem	89,06%
Making assumptions and defining variables	60,16%
Doing math	58,33%
Analyze and assess solutions	28,13%
Check again	42,97%
Applying the model	31,25%

Furthermore, the test result data will be analyzed for each indicator. For indicators of identifying problems, there are 89.06% of students who master it. Indicators make assumptions and identify variables controlled by 60.16% of students. While the indicator of performing the mathematical process consists of 58.33% of students who master it, followed by indicators of analyzing and assessing the solution mastered by 28.13% of students. For indicators to check again, there are 42.97% of students who master it, and indicators of applying the model are mastered by 31.25% of students. From the data obtained, the highest percentage of occurrences of indicators is the indicator of identifying problems, and the lowest occurrence of indicators is the indicator of analyzing and solving.

In the indicator of identifying problems, there are 89.06% of students have mastered it. This means that many students can identify the information contained in the questions correctly and completely and formulate the problem correctly. Some students have identified the information completely and correctly, but the formulation of the problem made is still wrong. Some students also only identified information on the questions but did not formulate problems. Some identify the problem but are not yet complete. Based on the results of the interviews, students still experience errors and difficulties in identifying problems because these students are not careful in reading the questions. This is in line with the research of Hidayat & Pujiastuti which stated that some students did not write important information on the questions because students were not careful in reading the questions [18].

For indicators to make assumptions and define variables, only 60.16% of students mastered it. Some students have made assumptions correctly and defined variables. Several other students have also started making assumptions, but the assumptions made are not correct. Some students have not been able to make assumptions at all. From the results of interviews, students' difficulties in making assumptions were caused by students not understanding how to make assumptions about a problem. This is in line with the research of Muntaha, et al which states that the cause of students' difficulties in making assumptions is because students still do not understand how to assume verbal sentences into mathematical sentence [7]. In addition, some students also have not used symbols to symbolize the information contained in the questions. This difficulty is in line with research from Bahir & Mampouw which says that students do not identify the variables in the questions so that students do not make a description of the variables to become mathematical models [19].

The indicator of doing the math process is only mastered by 58.33% of students. The test data obtained shows that some students can make mathematical models and complete mathematical models correctly and completely. Some students are also able to make mathematical models, but when completing the model there are still errors. In addition, some students cannot make mathematical models. When interviewed, students said that students did not know which information could be converted into mathematical models. Thus, students cannot continue to solve problems because they do not create mathematical models to solve. Putro & Setiawan's research said that the reason why students find it difficult to make mathematical models is that students cannot understand the problem in the problem, as a result, students cannot change the question sentence into a mathematical sentence [20].

In the indicator of analyzing and assessing solutions, there are only 28.13% of students who master it. In this indicator, many students do not do it. Based on the results of interviews, the cause of the low number of students who master this indicator is students who cannot provide reasons, evidence, or support for the answers they have obtained. In addition, students feel that the solution they get is right, so they don't need to be analyzed and assessed again. This is in line with the research of Prasetyani, et al which says that many students cannot evaluate and assess solutions because students cannot assess, support, and state whether the solutions they get are correct or not [21]. So that students immediately conclude the solutions they get without being analyzed first. The low appearance of this indicator is also since in the previous step students did not find a solution so that no solution could be interpreted.

As for the indicator to re-examine, 42.97% of students have mastered it. In the re-examination step, only a few students checked and proved the correctness of the results they obtained. From the results of interview data, students said students did not recheck the answers they received because they felt that the answers given were correct. This is in line with research by Akbar, et al which states that many students do not re-examine the solutions obtained because students feel they no longer need to do this. After all, they feel that the answers they have given are correct. Another cause is that students are not used to doing the mathematical re-examination step on the answer sheet [22].

Indicators of applying the model are only mastered by 31,25% of students. Some students have interpreted the solutions they got into the real world and concluded the solutions they got correctly. However, many students do not interpret the solutions that have been obtained into real solutions. The student said that the student immediately concluded from the results he had obtained from the stages of carrying out the mathematical process without interpreting the solution first. In addition, some students are wrong in stating the conclusions they get. The low appearance of this indicator is also since at the stage of carrying out the mathematical process, students do not find a solution so that no solution can be interpreted and concluded. In research, Agustini & Pujiastuti said that there was a link between concepts so that if the initial process was wrong, the final results and conclusions made were also wrong [23].

4. CONCLUSION

Based on research that has been carried out in class VIII.A of SMP N 1 Pangkalan Baru, it can be concluded that the students' mathematical modeling ability after applying based learning (PBL) models using mathematical modeling stages when solving a problem in class VIII of SMP N 1 Pangkalan Baru is in the sufficient category with an average value of 54.80. There are 9 students who have modeling skills in the fairly good category, 5 students in the good category, and 2 students in the poor category.

There are 6 indicators of mathematical modeling used in this study. In the indicator of identifying problems, there are still students who experience errors because they are not careful and thorough in reading the questions. In indicators of making assumptions and defining variables, many students still do not understand how to make assumptions from a problem and do not use symbols to identify information. Students also have difficulty in the process of doing mathematics because of confusion about which information can be converted into a mathematical model, so they cannot perform the calculation process. In the indicators of analyzing and assessing solutions, many students cannot provide reasons or support for the answers obtained. In addition, many students also passed the re-examination stage because they felt the answer was correct. For indicators of applying the model, many students do not interpret the solutions that have been obtained into real solutions. Students immediately conclude from the results they have obtained from the stages of doing the mathematical process.

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