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Mathematics Modelling Ability in the Materials of Relations and Functions in Class VIII Junior High School with Problem-Based Learning Model

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ABSTRACT
Mathematical modelling ability is an important skill to be mastered by students in learning mathematics because mathematical modelling has a function to simplify and solve real-life problems with mathematics. However, the ability of mathematical modelling is still relatively low. To overcome these problems, it is possible to apply a problem-based learning (PBL) model. This study aims to see and describe students' mathematical modelling abilities in relation and function material. The research method used is descriptive with qualitative and quantitative data analysis based on mathematical modelling indicators. This research was conducted at SMPN 1 Simpang Katis in class VIII B involving 12 students as subjects. The data collection used is 2 test items. The results in this study indicate that the students' mathematical modelling abilities are classified as moderate. This is indicated by the test results obtained by students with an overall average of 52.5.

Keywords: *Mathematical modelling ability, Problem Based Learning, relations, and functions*

1. INTRODUCTION

Mathematics is a science that is closely related to everyday life and has a vital role in solving problems in various aspects of life related to mathematics [1]. Therefore, learning mathematics has changed from rote learning to learning related to applications (Kemendikbud, 2016). This is in line with the framework of the international student assessment program (PISA) and the minimum competency assessment (AKM), namely mathematical literacy [2,3].

Mathematical literacy is the ability of students to relate things related to real problems into mathematical forms, including concepts, assumptions, formulating models, and solving problems related to the real world [2, 4]. The ability to relate mathematics in real life is one of the essential skills that students must master to get used to solving real-life contexts with mathematics and changing mindsets about the relationship between real life and mathematics. The ability to convert real-world problems into mathematical form to solve the problems presented is called mathematical modelling ability [5]. Mathematical modelling ability has a function to understand, simplify problems to eliminate things that are considered unrelated to find solutions to make them easier to understand, and solve real problems with mathematics [6, 7]. In addition, the importance of mathematical modelling abilities is shown by the application of mathematical modelling as a significant component in curriculum content used by several developed countries [8, 9]. Germany and Singapore make modelling a mandatory competency in mathematics learning standards [10].

However, the facts on the ground show that based on the results of the 2018 PISA assessment issued in December 2019, the Indonesian students' mathematics PISA score of 379 was ranked 74th out of 79 countries [11]. The result is a decrease compared to PISA 2015, with a score of 386, and is ranked 64th out of 72 countries [3]. This shows that students in Indonesia have difficulty solving PISA questions where the questions are questions with real-world contexts. According to Suharyono and Rosnawati [12], the difficulties experienced by students are difficulties in connecting mathematical concepts that have been learned with everyday experience, so it is challenging to interpret real problems into mathematical models. Students are accustomed to remembering and memorizing formulas instead of feeling the meaning of mathematics and applying it in real life.

One of the mathematics materials that require students to solve problems in real situations is relations and functions. Referring to the 2013 curriculum, the competencies achieved are solving problems related to relations and functions with various representations [2, 13]. In addition, the material for relations and functions is the primary material for mastering other materials such as limit functions, quadratic functions, derivatives, and others [14]. However, students still have difficulty understanding concepts, identifying questions, and converting questions into mathematical models [25]. In addition, the learning carried out is still teacher-centred and still individualistic, thus making students feel bored and giving the impression of scary mathematics [15]. The low ability of student modelling about and function material is caused by several factors such as learning activities that have not been carried out in a conducive, strategic, or learning model that does not facilitate the achievement of learning objectives.

One of the efforts to overcome this is applying a problem-based learning model in the learning process. According to Arends [16], the PBL model is a learning model that uses real-world problems as situations for students to practice problem-solving skills. In addition, PBL also demands student activity during the learning process. Moreover, the teacher's task as a facilitator is to support and reinforce the learning process. Based on the results of research by [5], it shows that the PBL learning model can improve students' mathematical modelling abilities

In addition, to support the learning process in the classroom to make it more meaningful, teachers also need learning tools to assist in implementing learning. According to [17], learning tools are guidelines used by teachers in carrying out learning so that the learning process is more directed to achieve goals. Learning tools can also be useful in increasing the role of teachers and students, conditioning activities, and creating a more focused learning atmosphere. In this study, the learning device used was the KIkuduko guide-based learning device developed by Indaryanti et. al. [18]. This KIkuduko-based learning tool is prepared based on the analysis of SKL, KI, and KD, which will then produce a GPA that has been prepared by taking into account operational verb, which are continued to the planning, implementation, evaluation, and follow-up stages of learning [18]. Based on this description, researchers are interested in knowing and describing students' mathematical modelling abilities and function material for class VIII SMP by applying the PBL model.

2. METHOD

This study is descriptive with quantitative and qualitative methods in order to know and describe students' mathematical modelling abilities concerning and function materials for class VIII SMP with the PBL model. This research was conducted in the odd semester 2021/2022 academic year at SMPN 1 Simpang Katis in class VIIIB with 12 students as research subjects.

The instrument used in this study was two items of mathematical modelling ability test, which were arranged in the form of description questions validated by experts and declared valid. The data collection technique in this study used a written test. Written tests are used to determine students' mathematical modeling abilities in solving problems with real problems in relation and function material Based on the test results obtained, it will be analyzed according to the scoring guidelines that have been made.

Table 1. Written test scoring guidelines.

Indicator	Description	Score
Identify the problem	Identifying the information in the question	3
	Formulation of the problem asked in the question	3
Making assumptions and defining variables	Using symbols or symbols to create mathematical models according to the available information	2
	Make assumptions correctly based on the questions	3
Do mathematics	Formulate mathematical models and known variables	3
	Solving the model mathematically to get the right solution	3
Analyze and assess solutions	Interpreting the results obtained through the mathematical model that has been made	2
	Write down whether the solution obtained makes sense	2
Recheck the solution	Carry out a re-examination regarding the completion steps that have been carried out	2
	Proving the truth of the results obtained	2

Applying the model	Interpreting solutions into the real world	2
	Stating conclusions based on the solutions that have been obtained	3

Furthermore, the written test will be scored according to the existing scoring guidelines. Then the test results that have been scored will be analyzed to determine the students' mathematical modelling abilities. Furthermore, the results of students' mathematical modelling abilities will be grouped based on predetermined categories, namely high, medium, and low categories—the following table of students' mathematical modelling abilities.

Table 2. Category of student's mathematical modelling ability

Value Interval	Category of Student's Mathematical Modelling Ability
$75 < x \leq 100$	high
$45 < x \leq 75$	average
$0 \leq x \leq 45$	low

Then, the students' written test results are calculated and presented based on mathematical modelling indicators to see whether students master the indicators. After doing the percentage according to the indicators of mathematical modelling ability, it is then analyzed to describe the results of written tests qualitatively based on indicators of students' mathematical modelling abilities.

3. RESULT AND DISCUSSION

This research was carried out from October 11, 2021, to October 15, 2021, in class VIII B SMP Negeri 1 Simpang Katis. The learning activities were carried out in three meetings with details, namely two meetings for learning mathematics with relation and function materials with the PBL model using learning media. In the form of LKPD and one meeting to implement a written test of students' mathematical modelling abilities.

At the first and second meetings, learning activities were carried out following the stages of PBL learning, namely orientation of students to problems, organizing students to learn, guiding individual and group investigations, developing and presenting work, and analyzing and evaluating problem-solving processes. The time allocation for one meeting is 2 hours of learning with 1 hour of learning equal to 60 minutes. In the learning process, using learning media in LKPD is arranged based on a mathematical modelling approach. In the LKPD, there is a real-world problem that students will be directed or guided to solve following the stages of mathematical modelling.

Furthermore, students were given a written test question consisting of two description questions at the third meeting. Students work on individual problems to determine students' mathematical modelling abilities on the relation and function material with the PBL model.

This research was carried out to know and describe the mathematical modelling abilities of junior high school students in relation and function material for class VIII junior high school with the PBL model. Researchers will discuss the results of student work on the questions listed in numbers 1 and 2. below are the details.

Based on the written test results that the subject has done, AA has a high mathematical modelling ability. This can be seen from the AA worksheet. In question number 1, the subject of AA seems to have been able to carry out the mathematical modelling process well. This can be seen from the subject of AA that has brought up almost all mathematical modelling indicators well. The following is the AA worksheet for question number 1.

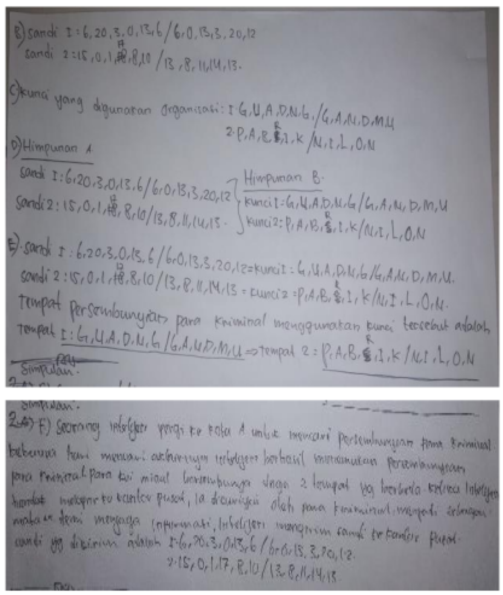

Figure 1 Answer subject AA question number 1

Based on the answers to the AA written test in number 1, it is known that AA has brought up indicators to identify problems as shown by identifying the information contained in the questions correctly and has been able to formulate the problems that exist in question number 1. AA has also brought up indicators for making assumptions and defining variables even though the answer from AA is still not quite right at the point of defining the variables in the question. In the indicator of doing mathematics, AA has been able to create a model that will be used to solve problems, and AA can also complete the model that has been made. AA has also created indicators to analyze and assess solutions. This is shown by AA's ability to interpret the solutions obtained as reasonable and correct. Furthermore, the indicators for applying the AA model have also emerged. This can be seen from the AA's answer, which has been able to interpret the solutions obtained in the real world and draw conclusions based on the results obtained.

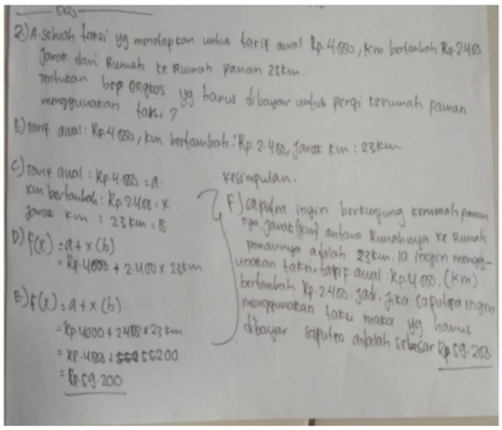

Figure 2 Answer subject AA question number 2

In answer to question number 2, the completion steps taken by AA are correct. The appearance can see this of all indicators of mathematical modelling ability.

In addition, there are six students with moderate mathematical modelling abilities. During the learning process, the researchers observed that students who were included in the moderate category in mathematical modelling abilities were unsure of the answers. We were still afraid to express our opinions during the group discussion process. So that students who are afraid to express their opinions during the discussion process and are not sure of the answers that have been obtained tend to have difficulty making assumptions and completing the model used [19]. The following is the written test result of one of the students in the medium category.

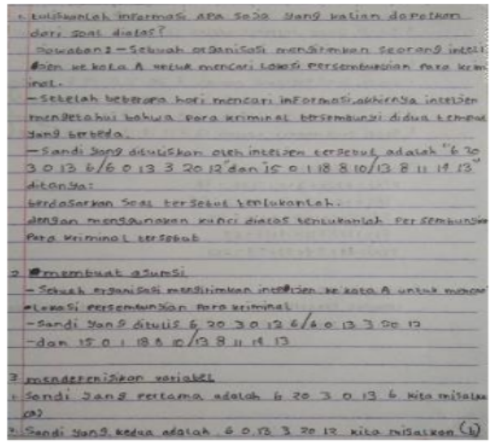

Figure 3 Answer subject AZ question number 1

Based on the answer to question number 1, which was done by the subject AZ. Almost all of the indicators of mathematical modelling ability appear, but the indicators make assumptions and define variables that AZ works on are still wrong. In the indicator of doing mathematics, AZ is also still wrong; this can be seen from the results of the work that AZ is still wrong in making the model and completing it so that the indicator applying the AZ model draws the wrong conclusion.

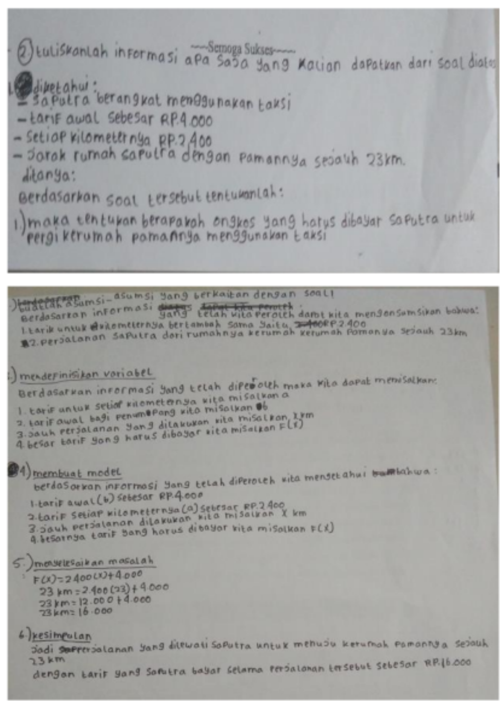

Figure 4 Answer subject AZ question number 2

In answer to question number 2, AZ did not complete the answer correctly. Some of the steps taken by subject AZ are still not quite right on some indicators, and this is shown in the indicators of doing mathematics; subject AZ has been able to make mathematical models steadily but has not been able to complete the model correctly. So that on the indicators of applying the model, AZ cannot conclude correctly.

After the written test is carried out, the student's answers will be analyzed based on the scoring guidelines that have been made. The data from the written test results will show students' mathematical modelling abilities with the PBL model. The results of the written test can be seen in the following table.

Table 3. Category of student's mathematical modelling ability

Value Interval	Category	Frequency	Percentage
$75 \leq x \leq 100$	high	2	16, 67%
$45 < x \leq 75$	average	6	50%
$0 < x \leq 45$	low	4	33, 33%
Total		12	100%
Average Value		52, 5	

Based on the results presented in table 3, students' mathematical modelling abilities are still classified as moderate. As many as six students have moderate mathematical modelling abilities, and the overall average score is 52. 5.

Furthermore, the test result data will be re-analyzed based on indicators to see the percentage of occurrences of each indicator of students' mathematical modelling abilities, as shown in Table 4 below.

Table 4 Percentage of appearance indicators of students' mathematical modelling ability on written test questions

Indicator	Percentage
Identify the problem	71, 53%
Making assumptions and identifying problems	64, 16%
Do mathematics	59, 72%
Analyze and assess solutions	38, 54%
recheck the situation	33, 33%
Applying the model	35, 83%

Based on these data, the indicator for identifying problems has an occurrence percentage of 71. 53%. In this case, some students have collected and identified the information contained in the questions. However, many students still have difficulty in determining the problem or have not been able to find the problems that exist in the questions that will be the goal to solve the problem. So that students have difficulty in formulating problems. This is usually caused by students who are not careful and in a hurry to read and understand the questions, so that students often miss important information contained in the questions [20].

In the indicator making assumptions and identifying variables, the percentage of occurrences is 64. 16%. Students have difficulty making assumptions to use or relate to in making mathematical models. Although some students have made assumptions correctly and correctly, some have made assumptions and defined variables but are still not correct. This is due to several factors: students still have difficulty assuming verbal sentences into mathematical sentences [21]. In addition, students are also not used to and rarely work on problems with real-world contexts [24].

In the indicator doing mathematics has an occurrence percentage of 59. 72%. In the indicators of doing mathematics, students have difficulty making mathematical models and completing the models that have been made. According to Putro and Setiawan [22], the difficulty of students on this indicator is because students are not able to understand the problems and essential information in the questions, thus making it students difficult to convert verbal sentences into mathematics, and students also have difficulty choosing which information to use—converted into a mathematical model. This causes students to be unable to complete the mathematical model that has been made and cannot draw conclusions.

The indicator of analyzing and assessing solutions has an occurrence percentage of 38. 54%. In this indicator, students are still relatively low, and this is because many students still feel unfamiliar with this stage. In addition, students also assume that the written test results they get are correct so that their answers no longer need to analyze whether the answers they get are reasonable and correct, so most students ignore this stage.

The indicator to re-examine the situation has an occurrence percentage of 33. 33%. In this indicator, many students assume that the answers they get at the mathematics stage are correct, so they feel no need to recheck whether the answers are correct or there are errors. In addition, most students are not used to doing the re-examination stage [23].

While the indicators of applying the model have an occurrence percentage of 35. 83%, in this indicator, most students only conclude without interpreting the solutions that have been obtained previously into real-world solutions.

4. CONCLUSION

Based on the results of the research that has been carried out in class VIII B SMP Negeri 1 Simpang Katis, it is obtained an overview of students' mathematical modelling abilities by learning the PBL model on relation and function material can be categorized as moderate, with an average value of 52. 5 with intricate details. Obtained as follows: the percentage of students with high mathematical modelling abilities is 16. 67%, students with moderate mathematical modelling abilities are 50%, and the percentage of students with low mathematical modelling abilities is 33. 33%.

Moreover, the percentage of students' mathematical modelling abilities for each indicator is as follows: the percentage of indicators identifying problems is 71. 53%, the percentage of indicators making assumptions and defining variables is 64. 17%, the percentage of indicators doing math is 59. 72%, the percentage the indicator of analyzing and assessing the solution is 38. 54%, the percentage of the indicator rechecking is 33. 33%, the percentage of the indicator applying the model is 35. 83%. The highest percentage of students' mathematical modelling ability indicators appear to identify problems, 71. 53%, while the lowest occurrence of indicators is the re-examination indicator, which is 33. 33%.

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