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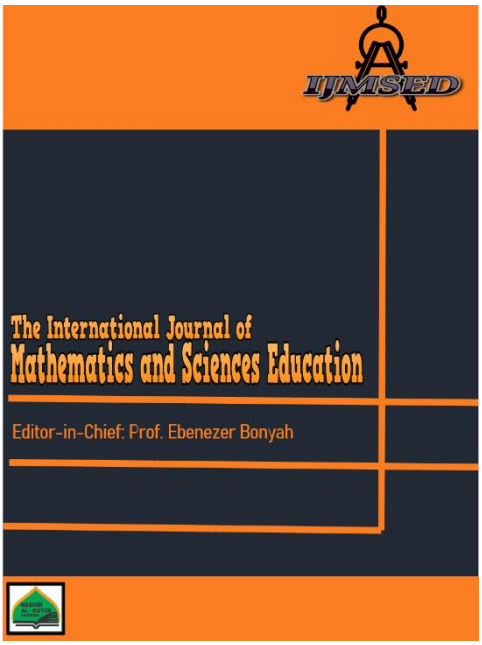

Students' problem-solving ability in hybrid learning using problem-based learning model: a case study

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Orginal Article

Students' problem-solving ability in hybrid learning using problem-based learning model: a case study

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Abstract
This study aimed to describe the process of learning mathematics in hybrid learning using a problem-based learning model. Furthermore, investigate the performance of students' problem-solving abilities in hybrid learning using problem-based learning. This case study research was conducted in one of the secondary schools in Bogor, Indonesia with a total of 20 students (13-15 years old) and a sample of six students who were selected based on convenience sampling. Data were collected through participant observation and written test. Researchers carry out problem-based learning on the material of a two-variable system of linear equations. The results showed that the hybrid learning process went smoothly. Students were enthusiastic about new media of learning. However, researchers found differences in the strategies used by students at home and school. Students' problem-solving ability to understand the problem is in a good category; devising a plan has a good enough category; carrying out a plan is not good enough; looking back is still in the very poor category.
Keywords: problem-solving ability, hybrid learning, problem-based learning model, case study

1. Introduction

Problems will always be present in life. There are many kinds of problems, one of which is problems in mathematics. Problems in mathematics are problems that cover a variety of situations, including non-routine, open, and real-world situations (Berinderjeet, 2009). Therefore, problem-solving skills are indispensable for every aspect of life. Problem-solving is a process in which a person uses their previous experience, skills, understanding, and intuition to find solutions to new situations (Charles & Lester, 1984). Thus, NCTM (2000) believes that problem-solving should be an integral part of all mathematics learning rather than a separate component of a mathematics program. In addition, problem-solving activities and mathematics learning are closely related because mathematics involves problem-solving (Nurkaeti, 2018). Therefore, the development of students' problem-solving abilities has been the primary goal of mathematics education for more than a century.

However, the COVID-19 pandemic has had an impact on education. Several research findings found that students' problem-solving abilities in solving math problems were low during the pandemic and even decreased (Harianda & Diana, 2021; Pratiwi, 2023). It is supported by the researchers' findings in class VIII G at SMPN 17 Bogor. In each aspect of problem-solving based on Polya (1973), students are in the not enough and even significantly less category. This school implement hybrid learning in the process of teaching and learning. That is due to

the government that declared a new policy according to circular letter number 4 of 2021 that allows limited face-to-face learning with a hybrid pattern. Hybrid learning is a teaching method in which the teacher simultaneously teaches students directly and remotely. In other words, some of the students learn directly in the classroom, and the rest learn online at home.

Based on the initial observations, the factor causing students' low problem-solving ability is the lack of implementation of appropriate learning approaches or models. Therefore, it is necessary to improve the learning process or method that helps students develop mathematical problem-solving skills and increase their motivation to learn mathematics. Boud & Felleti (1998) and Husnidar et al. (2014) stated that problem-based learning is an approach that can improve thinking skills and problem-solving skills and train students' independence. It means the problem-based learning model is one of the learning models that can meet student learning needs. Furthermore, it is also effective in helping teachers guide students to solve problems during teaching mathematics in COVID 19 pandemic era (Jacinto, 2023).

Based on the problems found in the field, following with an explanation of problem-based learning. Therefore, this study aimed to describe the process of learning mathematics in hybrid learning using a problem-based learning model in class VIII G SMPN 17 Bogor. Furthermore, investigate the performance of students' problem-solving abilities of VIII G students at SMPN 17 Bogor in hybrid learning using problem-based learning. The research question addressed in this study are: (1) How is the process of learning mathematics in hybrid learning using a problem-based learning model in class VIII G SMPN 17 Bogor? (2) What is the performance of students' problem-solving abilities in the problem-based learning process?

2. Method

A descriptive case study method was used to answer the research objectives. A case study provides a unique picture of real people in real situations. It makes it possible to understand ideas more clearly than simply presenting them with an abstract theory or principle (Cohen et al., 2018). The researcher uses this model to describe this phenomenon studied based on the actual context. It describes the performance of students' abilities in solving the given problems in the hybrid learning process during a pandemic using problem-based learning methods in Polya's problem-solving strategy.

Data were collected through classroom observation in of the secondary schools in Bogor, Indonesia. This class was chosen because students in this class have never done a problem-based learning system. Additionally, students' problem-solving ability in solving mathematical problems is still lacking. Observations were carried out with participant observation in which the researcher participated in activities that occurred during the learning process. In addition, the researchers also conducted a final test to find out in more detail about students' problem-solving abilities in a mathematics problem. The final test consists of two non-routine problems regarding a system of linear equations with two variables. This written test is made in the form of an essay to know how students solve problems so that students need strategies and mindsets to solve them. Previously, the test was validated by involving experts who were three mathematics lecturers at Sampoerna University.

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Table 1
Written-test questions

No	Problem
1	There are two types of tables for sale at Pak Akbar's Wood Shop: a 1-legged table and a 3-legged table. Mr. Sendy is responsible for checking the availability of these tables in the warehouse. Mr. Sendy found that the total number of tables is 24. Overall, the number of table legs is 44. How many tables are there in each? 
2	 Today, The Jungle gives a promo event. The Jungle sells two types of tickets: tickets for adults and children aged 6 to 10 years. Toddlers aged five years and under do not need to pay a ticket fee. Andien's family and Bagas' family agreed to go together. The total cost of the ticket paid by Andien's family is Rp. 300,000, which is for three adults, two children, and one toddler. The total ticket fee paid by the Bagas family is Rp. 230,000, which is for two adults and two children. How much is the total ticket fee that must be paid for one adult, one child, and one toddler?

The analysis technique was carried out using the following guidelines (Table 2). Researchers were classified into criteria, as shown in Table 3. Then to determine the problem-solving ability based on these indicators, the researcher used the following formula:

$$P_k = \frac{ASI_k}{TSI_k} \times 100\%$$

Where:
P_k : Percentage of the total score on the indicator to -*k*
ASI_k : Acquisition of the score on the indicator to -*k*
TSI_k : Total score on the indicator to -*k*
k : 1, 2, 3, 4

Table 2
Scoring description of problem-solving

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Aspect	Score	Description
Understanding the problem	2	Write the information and the unknown with logical reasoning
	1	Incomplete give information
	0	Not write any information
Devising a plan	2	Writing problem-solving strategy and lead to the correct answer
	1	Inaccurate in strategy/method writing
	0	Not write a problem-solving strategy
Carrying out the plan	4	Demonstrate all working until they obtain the right solution and there is no miscalculation.
	3	Demonstrate incomplete steps in the solution with the correct answer
	2	Demonstrate all processes or steps involved in obtaining the solution, but the solution is wrong.
	1	Demonstrate certain components or steps in the solution-finding process but fail to complete the task before the solution is obtained.
	0	Not write a problem-solving strategy
Looking back	2	Complete written check and correct
	1	Incomplete written check
	0	Not writing check

Table 3
Qualification of total score percentage

Percentage	Qualification
$85 \leq P_k \leq 100$	Very Good
$70 \leq P_k \leq 84.99$	Good
$55 \leq P_k \leq 69.99$	Good Enough
$40 \leq P_k \leq 54.99$	Not Enough
$0 \leq P_k \leq 39.99$	Very Less

3. Result

Implementing the problem-based learning model in hybrid learning for two meetings runs quite well following the problem-based learning steps. Learning lasts for 60 minutes using google meet and Pear Deck as interactive media for students. The material explained at this meeting is a system of linear equations with a subtopic of a system of linear equations of two variables. Based on observation sheets and field notes during the process of implementing problem-based learning in the first meeting, the following data were obtained:

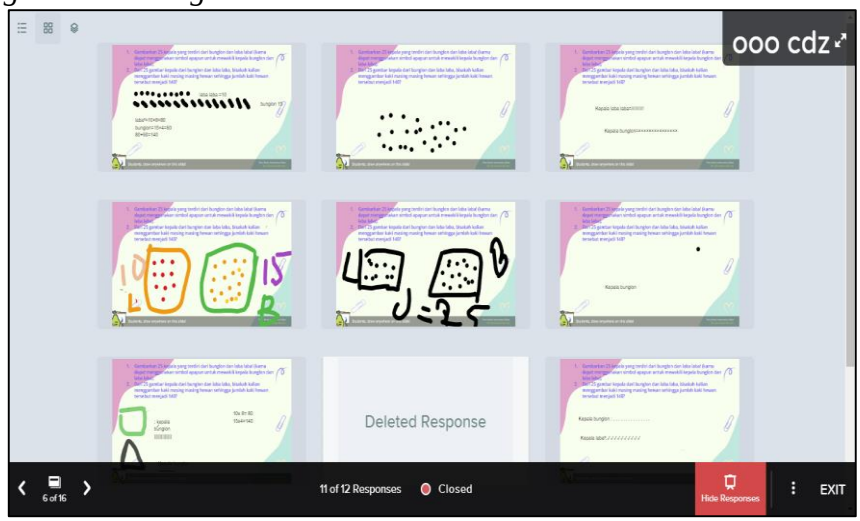
Some aspects have not been met. Students are still confused in preparing action plans and evaluating ideas and information. However, once teachers provide some direction and critical questions, it helps them find and design strategies to solve problems. Most students are enthusiastic about using Pear Deck in learning. However, some students have difficulty operating it. Some students at home have

bad internet connections and have difficulty getting into the Pear Deck room. So, learning is hampered because the teacher helps students enter the Pear Deck page. When given a problem, the teacher can see the discussion taking place in class. However, the discussion process did not occur for students at home, so the teacher tried to ask questions.

It is their first time investigating a math problem and doing problem-based learning, so it takes much more time than expected.

Figure 1

Learning Process using Pear Deck



While in the second meeting, based on observation sheets and field notes, the data found were:

- The learning process has fulfilled all aspects. Students have begun to adapt to learning so that learning is more effective and runs according to the expected time.
- Unlike the first meeting, students can develop their action plans at the second meeting.
- Students at school use more varied strategies than students studying at home.
- Students at school actively discuss role-playing so that problems become more authentic, leading to logical reasoning strategies.
- Most of the students at home use the strategy of writing equations to solve the problems given.
- Most of the students used a guessing and checking strategy to solve this problem by relating the information they got about the average selling price of coffee, which was the issue raised in this meeting.
- There are 2-3 students in the class trying to use their knowledge in the previous lesson, using a drawing model strategy, but feel it is inappropriate.

Figure 2

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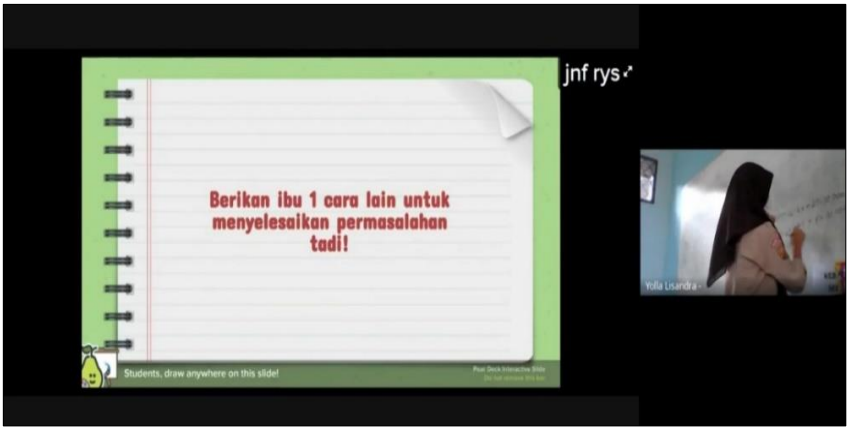
The process of hybrid learning



The things that are felt by researchers in implementing hybrid learning by applying a problem-based learning model are as follows:

- Teachers must ensure that students at school and at home have the same understanding.
- Difficulty in controlling live and online classes simultaneously, especially when using new learning media with students. Some students have difficulty, and the teacher has to help them.
- Difficulty in helping students at home who have difficulty operating Pear Deck due to the limited distance and time of ongoing learning.
- After implementing problem-based learning in class VIII G, the researchers then conducted a written test to determine students' problem-solving abilities after knowing the learning. Based on the data analysis, the following is the student's performance in taking the written test, which consists of two non-routine problems regarding the linear equation of two variables system.

Table 4
Data of Problem-Solving Ability Test Results

Students	Question							
	1				2			
	Indicators of Problem-Solving							
	Understanding the problem	Devising a plan	Carrying out the plan	Looking back	Understanding the problem	Devising a plan	Carrying out the plan	Looking back
S.1	2	1	1	0	1	2	3	2
S.2	1	2	2	0	1	0	0	0
S.3	2	2	2	0	2	1	1	0
S.4	2	1	1	1	2	2	4	2
S.5	1	1	1	0	1	1	1	0
S.6	2	1	1	0	2	2	4	2
S.7	0	1	1	0	0	1	1	0
S.8	2	2	4	1	2	2	4	0
S.9	2	2	4	1	2	2	4	2
S.10	1	0	0	0	2	2	4	1
S.11	2	1	1	0	2	1	1	0

S.12	1	2	2	0	1	2	2	2
S.13	0	1	1	0	0	1	1	0
S.14	2	1	1	0	2	1	1	0
S.15	0	1	1	0	0	1	1	0
S.16	2	2	4	1	2	1	1	0
S.17	2	1	1	0	1	0	0	0
S.18	1	2	2	1	1	2	3	0
S.19	2	2	4	2	2	2	4	2
S.20	2	0	0	0	2	0	0	0
Acquisition Score	29	26	34	7	28	26	40	13
Total Score	40	40	80	40	40	40	80	40

This data was processed based on the calculation to get the percentage. Then, categorize it according to Table 4 to get the results below.

Table 5

Problem-solving skill ability percentage of grade VIII G based on the indicator of problem-solving in written test

Number Question	Indicators of Problem-Solving	Score of Students	Total Score	Percentage	Category
1	Understanding the problem	29	40	72.5%	Good
	Devising a plan	26	40	65%	Good enough
	Carrying out the plan	34	80	42.5%	Not enough
	Looking back	7	40	17.5%	Very less
2	Understanding the problem	28	40	70%	Good
	Devising a plan	26	40	65%	Good enough
	Carrying out the plan	40	80	50%	Not enough
	Looking back	13	40	32.5%	Very less

Discussion

The implementation of problem-based learning in the mathematics class in a hybrid learning took place smoothly according to the stages of problem-based learning. It was proven at the second meeting that students were able to determine how to solve the problems given. Students seem enthusiastic about participating in learning with a different system than usual because they are invited to be active in learning and making decisions. The learning process using the Pear Deck media is a new experience for them.

During the implementation of hybrid problem-based learning, which was carried out for two meetings, the researchers found differences in students' strategies at home and school. Because students at school interact with friends and can discuss, they produce more varied strategies than students at home. That is because students at home do not have discussion partners and can only do questions and answers with the teacher.

However, teachers find it challenging to control live and online classes simultaneously, especially when using new learning media for students. Some students have difficulty and must be assisted by the teacher. In addition, it is challenging to help students at home who have difficulty operating the Pear Deck due to the limited distance and time of ongoing learning. Another found thing was that sometimes students at home experienced connection problems in learning, so some students did not experience learning perfectly. To overcome this, the teacher saves recorded videos and shares them after class so that students who experience connection problems and are not present can access them and try learning in their spare time.

At the end of the problem-based learning meeting, the written test results in solving mathematics problems based on each indicator of the problem-solving stage based on Polya: understanding the problem, devising a plan, carrying out the plan, looking back. The results of student performance based on these indicators during initial observation in problem 1 were 60%; 35%; 28.75%; 0% for problem 2 is 67.5%; 42.5%; 40%; 7.5%. It can be seen that students are already in a good category for understanding problems and are good enough to devise a plan. However, students still cannot show sufficient performance to carry out the plan. Most students only demonstrated certain components or steps in finding a solution but failed to complete the task before a solution was obtained. Students often make mistakes in calculations so that the results are wrong.

The looking back aspect is in category very less. Some of the students did not do the stage because they felt confused about how to prove it and did it because they were not too used to it. So that for problem 1, 14 students out of 20 students did not check their findings, four did not check entirely, and only one student did the check entirely and correctly. For problem 2, the percentage of students looking back is also very less, at 32.5%, because 13 out of 20 students did not check.

Giving non-routine problems in class and letting students find possible ways and solutions to solve problems needs to be done by a teacher (Boesen, Lithner & Palm, 2010; Saygili, 2017). In this learning, the researcher provides and involves non-routine problems. The researcher stimulates students to implement the problem-solving strategy stage to solve the given problem and guides them to get a strategy that suits their choice. That can allow students to use their experience, intuition, and knowledge to solve a given problem and use various strategies to find a solution to a problem.

4. Conclusion

Unlike previous research, which only implemented problem-based learning through offline or online learning, this research implemented hybrid learning. The implementation of problem-based learning completes two meetings for learning mathematics with the material of a two-variable linear equation system in class VIII

G public schools in Bogor. Overall, students are enthusiastic about the learning activities. They actively follow every process and stage that the researchers designed to run smoothly and fulfill every aspect of the problem-based learning process.

There were differences in understanding material and choosing the strategies used by students because of some of the challenges felt by the teacher in directing students at home. In addition, students at home just have little discussion and interaction between students. Therefore, further researchers can choose more interactive learning media so that students at home can interact and discuss easily so that they are more active in learning

In addition, students' problem-solving ability in solving non-routine problems shows that aspects of understanding the problem and devising a plan are already good and good enough. Nevertheless, some aspects need to be improved, namely carrying out a plan and looking back. Thus, teachers need to involve problem-solving activities in the classroom and pay attention to students' problem-solving abilities during this pandemic.

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