AKSIOMA: Jurnal Program Studi Pendidikan Matematika ISSN 2089-8703 (Print)
Volume 13, No. 2, 2024, 699-707 ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v13i2.8217

IMPLEMENTATION OF PROBLEM-BASED LEARNING (PBL) MODELS TO IMPROVE STUDENTS' MATHEMATICAL COMMUNICATION ABILITY

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Received 29 June 2023; Received in revised form 02 September 2023; Accepted 19 June 2024

Abstract

Math problem-solving skills among students are still lacking. This is demonstrated by kids' inability to comprehend inquiries, offer proper responses, or convey ideas. Low communication ability can also result from instruction that downplays the importance of students' ability to solve problems. This study aimed to determine whether the increase in the mathematical communication skills of students who received problem-based learning models was better than that of conventional learning. Moreover, to find out how students' attitudes toward problem-based learning models. This research method is quasi-experimental, and the research design is a Nonequivalent control group design. The experimental class gets learning with the problem-based learning model, and the control class with conventional learning. The population of this study was all students of class VII SMPN 2 Kota Mojokerto. The samples used were two classes of five selected by purposive sampling technique. To obtain research data, pretest, posttest, mathematical communication skills were used using the independent sample t-Test. Based on the results of data analysis, 1) improving students' mathematical communication ability using problem-based learning models is better than students using conventional learning; 2) students' attitude towards learning mathematics using the problem-based learning model is positive.

***Keywords**: Mathematical Communication; Problem-Based Learning Model*

Abstrak

Kemampuan siswa untuk memecahkan masalah matematika masih rendah. Hal ini ditandai dengan kurangnya siswa dalam memahami pertanyaan dan memberikan jawaban serta mengutarakan pikiran atau ide secara tepat. Rendahnya kemampuan komunikasi juga disebabkan oleh model pembelajaran yang belum menekankan siswa pada aspek pemecahan masalah.Tujuan penelitian ini adalah untuk mengetahui apakah peningkatan kemampuan komunikasi matematis siswa yang memperoleh model pembelajaran problem based learning lebih baik dari pada siswa yang menggunakan pembelajaran konvensional, dan untuk mengetahui bagaimana sikap siswa terhadap model pembelajaran problem based learning. Metode penelitian ini adalah quasi eksperimen dan desain penelitian adalah Nonequivalent control group design. Kelas eksperimen memperoleh pembelajaran dengan model problem based learning dan kelas kontrol dengan pembelajaran konvesional. Populasi dari penelitian ini adalah seluruh siswa kelas VII SMPN 2 Kota Mojokerto, Adapun sampel yang digunakan sebanyak dua kelas dari lima kelas dipilih dengan Teknik purposive sampling. Untuk mendapatkan data hasil penelitian digunakan pretest, posttest, kemampuan komunikasi matematis menggunakan independent Sample t-Test. Berdasarkan hasil analisis data, 1) peningkatan kemampuan komunikasi matematis siswa yang menggunakan model pembelajaran problem based learning lebih baik dari pada siswa yang menggunakan pembelajaran konvensional; 2) sikap siswa terhadap pembelajaran matematika yang menggunakan model pembelajaran problem based learning adalah positif

***Kata kunci**: Komunikasi matematis; model pembelajaran problem based learning.*

DOI: https://doi.org/10.24127/ajpm.v13i2.8217

INTRODUCTION

Communication is the basis for growing mathematical knowledge orally and in writing. So mathematical communication is important in learning (Paridjo, 2018). However, based on the research that has been done by Sinaga & Manik (2019) that students' ability to solve math problems still needs to improve. This is marked by students' need to understand questions, provide answers, and express thoughts or ideas appropriately. Low communication abilities are also caused by learning models that have not emphasized students' problem-solving aspects (Madhavia et al., 2020). Teachers, as educators, have an important role in selecting learning models to help improve students' mathematical communication ability (Mardaleni et al., 2018; Triana et al., 2019). Based on other research(Herdin et al., 2018), the learning model of Problem-Based Learning shows that Praoblem-Based Learning is learning that supports positive achievement for problem-solving ability and mathematical communication ability.

Communication is one of the students' ability to convey something they know through dialogue events or mutual relations that occur in the classroom environment, where messages are transferred (Purnamasari & Afriansyah, 2021). The transferred message contains the transfer of mathematics material students study, for example, as a formula concept or strategy for solving a problem. Parties involved in communication in the classroom are teachers and students. Students' mathematical communication abilities need to be improved because, through mathematical communication, students can organize their mathematical thinking both orally and in writing (Sunardi et al., 2021), students can respond appropriately (Riyanti & Mardiani, 2021), both among students themselves and between students and teachers during the learning process takes place.

More mathematical communication ability will be needed to improve students' ability to use mathematical language to express mathematical ideas appropriately experiencing difficulties. They will impact the need for more ability to analyze and evaluate people's mathematical forecasts and strategies (Lutfianannisak & Sholihah, 2018). One of the causes of the low ability of students to communicate in mathematics is that the teacher is still the center of the learning process and dominates activities in class, thereby reducing student activity (Nurhanurawati et al., 2021). When learning occurs, most mathematics teachers only focus on students being skilled in answering questions, so the lack of mastery of students' mathematical communication ability needs to be handled (Pambudi et al., 2021).

Based on this, it is necessary to develop in the process of learning mathematics to help students improve mathematical communication skills (Sholihat et al., 2021); acquiring mathematical communication should emphasize real problem learning (Wardhana & Lutfianto, 2018). In problem-oriented mathematics learning, students are encouraged to explore existing knowledge and ideas about finding various strategies and solutions to problems. To help students understand mathematical concepts, one of the learning models related to real problems that can improve mathematical communication is problem-based learning (Surya et al., 2018). The Problem-Based Learning model

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v13i2.8217

requires students to communicate mathematically because this model presents real problems that must be converted into the mathematical language (Supriatna, 2020)

One of the objectives of learning mathematics above is so that students can communicate symbols, tables, diagrams, or other media to clarify situations or problems. The ability that is measured is communication ability because it is needed so that students can apply it in solving problems. In addition to problem-solving and understanding mathematics, mathematical communication needs to be the focus of attention in learning mathematics because, through communication, students can organize their mathematical thinking and explore mathematical ideas. This is consistent with studies (Ningrum, 2016; Sartika, 2017) that claims problem-based learning can be employed as a learning model that can help students enhance their ability to communicate mathematically and have an impact on students' ability to communicate mathematically.

This study looks at problem-based learning, which can be used to help students communicate their mathematical ideas more effectively. It also looks at how problem-based learning has affected students at SMP Negeri 2 Kota Mojokerto. Based on the statement described above, the objective of the research is to apply *Problem-Based Learning* models to improve mathematical communication abilities.

RESEARCH METHODS

The research method used was quantitative research with a quasi-experimental design using a non-equivalent control group design. (Septian et al., 2022).

Experimental group:	*O*	X	*O*
	--------	--------	--------
Control Group:	*O*		*O*

Information :
O: Pretest and posttest
X: Treatment using the Problem-Based Learning learning model

This research was conducted at SMPN 2 Mojokerto City, 22 until 24 May 2023. The population in this study were class VII students at SMPN 2 Kota Mojokero. As for the samples in this study, as many as two classes. Sampling in this study uses purposive sampling. Producing VII A for the experimental class using the *problem-based learning* model and VII B for the control class using conventional learning. The subjects studied were the number of students who took part in the pretest and posttest administration, namely, 20 students in the experimental class and 20 students in the control class.

The three steps in doing this study are as follows: 1) planning the research by observing for one day, then identifying the issues and compiling this research; and 2) conducting the research. 2) conducting research, which entails administering pretest and posttest exams to students over the course of two meetings; 3) organizing and analyzing data, which entails gathering, processing, and drawing conclusions from research data.

Data collection techniques used in this study were tests and questionnaires. The test instrument used is two items declared valid.

Table 1. Validity Categories

Persentase	Kategori
$\bar{x} > 3{,}40$	Sangat Valid
$2{,}80 < \bar{x} \leq 3{,}40$	Valid
$1{,}60 < \bar{x} \leq 2{,}80$	Kurang Valid
$1{,}00 < \bar{x} \leq 1{,}60$	Tidak Valid

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The following are two questions used in this study:

1. Two days ago, Dima's birthday. Dimas celebrates it in his class. Dimas prepared 40 boxes of cakes for his birthday. The cakes were brought to class to be distributed among their classmates; each received a box of cakes. Because three of her friends did not enter, three cake boxes were left.
   a. Make an equation/mathematical model that states the situation above.
   b. If Dimas pays the total price of the cake, Rp. 160,000.00. Using this mathematical equation, determine the cost of 1 box of cookies.
   c. If Dimas wants to give cakes to his two teachers, he will add two more boxes with a total price of Rp. 200,000.00. Determine the price of a box of cakes added.
2. Bagus has a rectangular fish pond in front of her house. The width of the fish pond is 10 cm shorter than its length. If the perimeter of the fish pond is 3,8m.
   a. Make an equation/mathematical model that states the situation above.
   b. Determine the area of the fish pond

The description questions given represent the indicators to be achieved. This study employs a Likert scale that includes four items: student’s ability to produce many answers, their ability to apply mathematical symbols, and their ability to draw conclusions. Four response options are provided on this questionnaire: Strongly Agree (SS), Agree (S), Disagree (TS), and Strongly Disagree (STS). The attitude scale that will be used as a criterion for answers.

Table 2. Criteria for answering the attitude scale

Percentage	Interpretation
0%	There are not any
1%-25%	Fraction
26%-49%	Almost Half
50%	half
51%-75%	Most of the
76%-99%	Almost Entirely
100%	Whole

The data analysis method makes use of SPSS 26. The normality test, the homogeneity of variance test, and the test for the equality of two means are steps in the data analysis process. Analyzing student responses to the learning outcomes exam (THB) can provide data analytic approaches for students' mathematics communication abilities. Decidable intervals In the table 3, mathematical communications are displayed.

Table 3. mathematical communication determinant interval

Interval	Kategori
$87,5\% \leq NP \leq 100\%$	Sangat tinggi
$69,64\% \leq NP < 87,5\%$	Tinggi
$51,79\% \leq NP < 69,64\%$	Cukup Tinggi
$NP < 51,79\%$	Rendah

RESULTS AND DISCUSSION

Pretest Data Analysis of Students' Mathematical Communication Ability

The data used to analyze the students' initial mathematical communi-cation abilities used the pretest results obtained from the experimental and control classes. The pretest was given before learning to determine whether the experimental and control classes had the same students' initial mathematical communication abilities. The results of the pretest data normality test are presented in Table 4.

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v13i2.8217

Table 4. Pretest data normality test results

Class	Shapiro Wilk			
	Statistics	**Df**	**Sig**	**Ket**
Experiment	0.962	20	0.593	Normal Distribution
Control	0.963	20	0.602	Normal Distribution

From the results of the Shapiro-Wilk normality test in the table, the significance value for the experimental class was 0.593, while the control class was 0.602. The pretest data for both classes is more than 0.05, so the data on student pretest scores in the experimental and control classes come from normally distributed populations. The normality of post test data can be seen in Table 5.

Table 5. Postest data normality test results

Class	Shapiro Wilk			
	Statistics	**Df**	**Sig**	**Ket**
Experiment	0.140	20	0.598	Normal Distribution
Control	0.158	20	0.649	Normal Distribution

The significance value for the experimental class is 0.598, whereas the significance value for the control class is 0.649, according to the Shapiro-Wilk normality test results in the table. The posttest data are normal because they are greater than 0.05 for both classes. Following that, you can perform the independent sample t-Test.

Tabel 6. Independent sample t-test results for pretest and postest values

		F	**Sig**	**t**	**df**	**Sig (2-tailed**	**Mean Differences**	**std. Error Difference**
Pretest results	Equal Variances Assumed	0.374	0.544	-2.108	38	0.042	-4.300	2.039
	Equal Variances are not Assumed.			-2.108	36,149	0.042	-4.300	2.039
Postest results	Equal Variances Assumed	4.987	0.033	4.196	38	0.000	5.550	1.323
	Equal Variances are not Assumed.			4.196	31.468	0.000	5.550	1.323

Based on Table 6, there is a significant difference between the pretest results in the experimental class which uses the Problem Based Learning model and the control class which uses conventional learning. This is in line with research (Hakiki et al., 2022) which states that there is a significant

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v13i2.8217

difference between the pretest results of the experimental class and the control class. Meanwhile, for the posttest results, there was a significant difference between the posttest results in the experimental class which used the Problem Based Learning model and the control class which used conventional learning.

Gain Index Analysis of Students' Mathematical Communication Ability

Gain index data analysis was used to determine whether there were differences in the increase in students' mathematical communication ability after being given different treatments. The data were obtained from the pretest and posttest scores of the experimental and control classes. The gain index data from the two classes based on the high, medium, and low categories obtained are presented in Table 7.

Table 7. Gain index grouping data

Class	Many Students		
	Low	Currently	Tall
Eexperiment	1	18	1
Control	7	13	0

Based on Table 7, with a significant difference in the high category, the experimental class's improvement in conceptual under-standing of mathematics outperformed the control class. In addition, there was one student in the low category in the experimental class. This demonstrates that the experimental class has improved more than the control class. However, a statistical analysis test was conducted to determine whether the rise was more significant.

Analysis of Students' Attitudes Towards Learning Mathematics Using a Problem-Based Learning Model

Data the attitude scale obtained is calculated and tabulated with the help of SPSS 26 software. In full, the student attitude scale scores are presented in Table 8.

Table 8. Data on students' attitudes toward learning mathematics using the problem-based learning model

NO/property	Student Attitude Data				Answer Presentation		Mode	Ket
	SS	S	TS	STS	Positive	Negative		
1(+)	4	16	0	0	100%	0	S+SS	Positive
2(+)	2	16	2	0	90%	10%	S+SS	Positive
3(+)	6	13	1	0	95%	5%	S+SS	Positive
4(+)	3	14	3	0	85%	15%	S+SS	Positive
5(+)	9	6	5	0	75%	25%	S+SS	Positive
6(-)	1	2	15	2	85%	15%	TS+STS	Positive
7(-)	4	1	10	5	75%	25%	TS+STS	Positive
8(-)	1	3	14	2	80%	20%	TS+STS	Positive
9(-)	1	0	16	3	95%	5%	TS+STS	Positive
10(-)	1	1	14	4	90%	10%	TS+STS	Positive
Average					**87%**	**13%**		

ISSN 2089-8703 (Print)
ISSN 2442-5419 (Online)

DOI: https://doi.org/10.24127/ajpm.v13i2.8217

Based on the ten statements given, all students responded positively. An average percentage of 87% of students responded positively, and 13% responded negatively. This means that almost all students learn mathematics well with the problem-based learning model. However, on average, it does not affect the results of students' attitudes toward learning mathematics using the problem-based learning model, which still shows a positive attitude because the average score still far exceeds the neutral score.

Some statements are positively supported dominantly by students, in statement no. 1 with a percentage of 100% where all students are excited to start learning because they have studied previous material through classroom learning. Next is number 3, with a percentage of 95%, where almost all students expressed enthusiasm for working on lots of questions when learning in class. Moreover, number 2 with a percentage of 90%, where almost all students said they were happy when learning mathematics with group discussions. During the learning process, students are actively involved and able to discuss oral and written communication among group members. So that students can more easily master the material and solve problems with real contexts in the one-variable linear equation (PLSV) material. Feelings of boredom during the learning process can change to fun; students can also explore written mathematical communication with the help of worksheets. The results of the study are also in line with several researchers who state that the problem-based learning model can improve students' mathematical communication ability (Hakiki et al., 2022)

The drawbacks of this research are that there is only 1 SMP and a short time, so it needs to be done in many schools, and the time to prepare lessons is long. On the other hand, the advantage of the learning process with the problem-based learning model is that students will easily master the material because they are directly faced with everyday problems; worksheets also provide opportunities for students to communicate orally and in writing and develop their thoughts on the concepts encountered. Besides that, the goals to be achieved in the mathematics learning process can be optimal.

The study's findings indicate that there is an improvement in mathematics communication abilities in the experimental class using the problem-based learning paradigm compared to the control class using traditional instruction. Research (Madhavia et al., 2020; Rianti Rahmalia et al., 2020) supports this. A student's ability to communicate with others and with the teacher allows them to exchange and convey their ideas, which can help them enhance their mathematical communication abilities. Ideas can be turned into communication material through discussion, reflection, and evaluation of student knowledge. Students will understand what is presented more clearly if they attempt to explain the conclusions of their thinking to other students in accordance with their capacities.

CONCLUSION AND SUGGESTION

Based on the findings and subsequent discussion, it is clear from this research that students' mathematical communication skills improve more quickly when using the Problem Based Learning model than when using conventional teaching methods. The

DOI: https://doi.org/10.24127/ajpm.v13i2.8217

problem-based learning approach in teaching mathematics is considered good.

The problem-based learning model can be applied as an alternative to learning mathematics to help improve students' mathematical communication skills. The subject of mathematics developed in this study was at the seventh-grade junior high school level, material for One Variable Linear Equation (PLSV). Therefore, further research must be conducted at different levels, classes, or materials.

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