

The Effect of Problem-Based Learning Model with Realistic Mathematics Education Approach on Mathematical Communication Skills

Suharti^{1*}, Nur Fakhriyah Syahid², Baharuddin³,
Lisnasari Andi Mattoliang⁴, Nurmala R⁵

^{1,2,3,4}Universitas Islam Negeri Alauddin Makassar, Indonesia

⁵Universitas Borneo Tarakan, Indonesia

*Corresponding Author: suharti.harti@uin-alauddin.ac.id

Abstract. *This research aims to determine the effect of the Problem-Based Learning (PBL) model with the Realistic Mathematics Education (RME) approach on students' mathematical communication skills. This research approach uses a quantitative approach with an experimental research type, a quasi-experimental type with a pretest-posttest control design. The population in this study was 107 MTs Guppi Buntu Barana students. The research sample consisted of 36 students. The sampling technique uses Cluster Random Sampling. Tests and observations were carried out for data collection. The research instruments used in this research were mathematical communication ability test questions and observation sheets. Data analysis techniques use descriptive statistical analysis and inferential statistical analysis. The results of this research show that the average mathematical communication ability of students in classes that do not use the PBL model with the RME approach from pretest to post-test increased from 34.50 to 81.56, with an increase of 47.06. The mathematical communication skills of students in classes that use the PBL model with the RME approach obtained an average score from pretest to posttest that increased from 40.39 to 89.72, with an increase of 49.33. So, the PBL model with the RME approach has a significant influence on students' mathematical communication skills.*

Keywords: *Problem-Based Learning (PBL), Realistic Mathematics Education (RME), mathematical communication skills*

1. Introduction

Mathematics is the science of numbers, shapes, conceptual relationships, and logic using language symbols to complete daily life problems (Hafsyah, 2019; Muqdamien et al., 2021; Suhendri, 2011). The goal of learning mathematics is so that students can communicate ideas using symbols, tables, diagrams or other media to make things clear a state or problem to achieve. For this purpose, one of the abilities that students must master is mathematical communication skills (Harianja & Susiana, 2022; Hidayat, 2019; Samnufida et al., 2021). Along with developing the educational curriculum, there is strong encouragement for improving communication skills in students' mathematics, so an effective learning approach becomes necessary.

In an era of technology and connectivity, mathematical communication skills are becoming important. This is not only about students' ability to understand and calculate but also their ability to explain and communicate mathematical concepts clearly and effectively. Mathematical communication skills are students' ability to express ideas to describe and discuss mathematical concepts coherently and clearly (Lomibao et al., 2016). It can also be interpreted as students' ability to express mathematical ideas verbally and in images (Deswita & Kusumah, 2018).

The current reality shows that students' mathematical communication skills still

need to improve. Firmansyah et al. (2018) also said the same thing that one of the causes of students' low communication skills in mathematics lessons is the lack of teacher creativity in creating more interesting learning, the use of inappropriate learning models, the level of students' abilities in communicating mathematics into different problems. In line with research conducted by Nurhasanah et al. (2019) based on percentage data regarding students' non-achievement in solving problems using story problems and using indicators of mathematical communication skills also show high results of non-achievement, it can be concluded that students' mathematical communication abilities are relatively low.

Based on interviews with mathematics teachers at MTs Guppi Buntu Barana, students' communication skills in mathematics learning still need to improve. It can be seen from the learning process that teachers still use conventional learning, which causes most students to find it difficult to channel mathematical ideas in working on problems. Also, most students still need help to create mathematical forms. Realizing this reality, one innovation that can be done is by changing the learning model in the classroom. The learning model used is a learning model that makes students actively communicate their mathematical ideas and express a problem in mathematical form well (Corebima et al., 2020), one of which is the method of using the Problem-Based Learning (PBL) model with a Realistic Mathematics Education (RME) Approach.

Problem-based learning (PBL) is a learning method that involves connecting learning material with real-life problems. In this context, students face real problems that require mathematical understanding to be solved. Students must collaborate and think critically, while the teacher is a facilitator, providing necessary guidance and feedback. PBL has been implemented widely and has shown positive results in various subjects and levels of education, including mathematics education.

The RME approach, on the other hand, emphasizes the use of real-life situations and contexts to teach mathematical concepts and procedures that help students understand the relevance of mathematics in real life (Pramartha et al., 2022; Widyastuti & Eliyen, 2022). RME has been proven effective in improving students' learning outcomes and mathematical representation abilities (Ningsih, 2021). Combining the PBL model and the RME approach promises great potential in improving students' mathematical communication skills. PBL encourages mathematical problem-solving and collaboration in real-world situations, while RME connects mathematics to everyday contexts. The combination of these two models stimulates the development of students' mathematical communication skills, which is the focus of this research. By digging deeper into the impact of these two learning models, this research will provide valuable insight into their ability to stimulate students' mathematical communication skills.

2. Method

This research was conducted at MTs Guppi Buntu in Barana, Buntu Barana Village, Curio District, Enrekang Regency, South Sulawesi Province. Implementation time is in the odd semester of the 2022/2023 academic year. The method used is a quantitative approach with a quasi-experimental type of research (Quasi Experiment).

The population in this study was 107 people, consisting of 34 students in class VII, 36 in class VIII, and 37 in class IX. The sample in this study included all classes VIII, namely class VIII A with 18 students as the experimental class and VIII B with 18 students as the control class. The sampling technique in this research is Cluster Random Sampling. Tests and observations were carried out for data collection. The instrument

used is a test instrument regarding communication skills, which consists of pretest and posttest questions in the form of a description of 5 questions.

The data analysis technique used in this research begins with descriptive analysis and then inferential analysis. The inferential analysis uses an independent sample t-test. The research design uses a Pretest-Posttest Control Group Design. The design can be seen in Table 1.

Table 1. Research Design (Pretest-posttest Control Group Design)

Group	Pretest	Treatment	Posttest
Experiment	O_1	X_1	O_2
Control	O_1	-	O_2

Information:

O_1 : Pretest given to the experimental class and control class.

O_2 : Posttest given to the experimental group and control group after implementing the treatment.

X_1 : Treatment through the Problem-Based Learning (PBL) model with the Realistic Mathematics Education (RME) approach.

3. Results and Discussions

Descriptive Analysis

Research data was obtained from students' mathematical communication ability tests. The research data on the control class is presented in Table 2.

Table 2. Descriptive Statistics for Pretest and Posttest Control Class

Statistics	Pretest	Posttest
Sample Size	18	18
Lowest Score	13.00	60.00
Highest Score	53.00	100.00
Average	34.50	81.56
Standard Deviation	10.517	8.226

Source: Primary data processed, 2022.

Control class students' mathematical communication abilities are grouped into several categories category. Acquisition frequency and percentage categories are as follows:

Table 3. Distribution Frequency of Mathematical Communication Ability Results for Control Class Students

Intervals	Category	Pretest		Posttest	
		Frequency	Percentage (%)	Frequency	Percentage (%)
0 – 54	Very low	18	100	0	0
55 – 64	Low	0	0	1	5.6
65 – 79	Moderate	0	0	5	27.8
80 – 89	High	0	0	11	61.1
90 – 100	Very High	0	0	1	5.6
Total		18	100	18	100

Source: Primary data processed, 2022.

Data on the experimental class is presented in Table 4.

Table 4. Pretest and Posttest Descriptive Statistics for Experimental Class

Statistics	Pretest	Posttest
Sample Size	18	18
Lowest Value	21.00	76.00
The highest score	60.00	100.00
Average	40.39	89.72
Standard Deviation	9.312	6.497

Source: *Primary data processed, 2022.*

The mathematical communication skills of students in the experimental class are also grouped into several categories as follows:

Table 5. Frequency Distribution of Experimental Class Students' Mathematical Communication Ability Results

Intervals	Category	Pretest		Posttest	
		Frequency	Percentage (%)	Frequency	Percentage (%)
0 – 54	Very low	17	94.4	0	0
55 – 64	Low	1	5.6	0	0
65 – 79	Moderate	0	0	1	5.6
80 – 89	High	0	0	8	44.4
90 – 100	Very High	0	0	9	50
Total		18	100	18	100

Source: *Primary data processed, 2022.*

Based on Table 5, in the pretest, the mathematical communication skills of students in the experimental class were mostly in the very low category. Meanwhile, on the posttest, the mathematical communication skills of students in the experimental class were mostly in the very high category.

Inferential Analysis

a. Normality test

Table 6. Normality Test Analysis Results

		Kolmogorov-Smirnov ^a			Shapiro-Wilk		
group		Statistics	df	Sig.	Statistics	df	Sig.
results	postcon	.137	18	.200*	.966	18	.722
	posex	.188	18	.092	.918	18	.121

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 6 shows that the posttest results of students' mathematical communication skills in the experimental class show that the sig value is > 0.05 , so it can be concluded that the data is normally distributed.

b. Homogeneity test

Testing Homogeneity was conducted on the posttest results in the control and experimental classes. The results of the analysis can be seen in Table 7.

Table 7. Results of Homogeneity Test Analysis

		Levene Statistics	df1	df2	Sig.
results	Based on Mean	.003	1	34	.956
	Based on Median	.001	1	34	.974
	Based on Median and with adjusted df	.001	1	27.422	.974
	Based on trimmed mean	.000	1	34	.983

Based on table 7, it shows that the sig value = 0.956 > 0.05, so it can be concluded that the data has the same variance.

c. Hypothesis testing

Table 8. Independent Sample t Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						95% Confidence Interval of the Difference
		F	Sig.	t	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	Lower	Upper
results	Equal variances assumed	.003	.956	3,305	34	.002	8,167	2,471	3,145	13,188
	Equal variances not assumed			3,305	32,268	.002	8,167	2,471	3,135	13,198

Based on Table 8, because the significance value is $\alpha = 0.002 < 0.05$, H_0 is rejected, indicating that there are differences in students' mathematical communication abilities between classes that apply the Realistic Mathematics Education (RME) approach with the Problem-Based Learning (PBL) model and class that do not apply the Realistic Mathematics Education (RME) approach with the Problem-Based Learning (PBL) model.

Based on research conducted in 6 meetings with each group, the author obtained data through a test instrument for students' mathematical communication skills at MTs Guppi Buntu Barana. The research was carried out by treating two classes, namely the control and experimental classes. Class VIII A, as an experimental class, uses the PBL model with the RME Approach, and class VIII B uses a conventional approach.

The research results showed that the experimental group that applied the PBL Model with the RME approach experienced a significant increase in their mathematical communication skills compared to the control group that did not use PBL with the RME approach. It can be seen from the consistent increase in the average score on the mathematical communication test, which was carried out before and after the intervention, presented in Table 4. This finding is to the research results of Alzianina et al. (2016); Jasija et al. (2018); and Yanti (2017).

This increase in mathematical communication skills is explained by students' involvement in the learning process during the research. The PBL approach with the RME approach allows students to be actively involved in formulating questions, explaining mathematical concepts, and presenting solutions. This involvement stimulates cooperation and collaboration between students (Ambarwati & Widodo, 2023), where they learn to listen to the opinions of their classmates, convey mathematical arguments more clearly, and provide concrete evidence that supports their arguments. The

description of the role of students using the PBL model is also in line with what was stated by Kodariyati & Astuti (2016).

Furthermore, the RME approach, which emphasizes contextualization, helps students connect mathematical concepts with real-world situations (Larasati, 2017; Mutia, 2015). In this study, students were exposed to several mathematical problems relevant to everyday life, which facilitated deeper understanding. Students can detail solutions more clearly and effectively in their mathematical communication because they can relate theory to practice. It differs from conventional learning; students only hear the teacher's explanation and take notes.

In the context of mathematics education, these findings have important implications. The PBL approach with the RME approach is an effective solution for improving students' mathematical communication skills. Therefore, mathematics educators should consider integrating elements of PBL and RME in mathematics learning. PBL can provide a more student-centred learning environment (Santayasa, 2015). It can create a learning environment that focuses more on deep mathematical understanding and effective communication, which students can then use in real-world situations.

4. Conclusions

Based on the research results and discussion in this research, the conclusion is that there is a difference in the average students' mathematical communication skills between classes that use the conventional approach and classes that use the Problem-Based Learning (PBL) model with the Realistic Mathematics Education (RME) approach. That means there is an influence of the PBL model with the RME approach on students' mathematical communication skills. As a next step, further research can evaluate the impact period from the PBL Model with the RME approach to mathematics communication skills in students and the factors that influence its successful implementation.

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