Problem-Based Learning with Portfolio Assessment and Its Effect on Mathematics Communication Skills of Junior High School Students

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Abstract. This study was conducted to analyze the effect of the Problem-Based Learning (PBL) Model with Portfolio Assessment on the Mathematics Communication Skills of Junior High School Students. This goal was obtained by an experimental study at a junior high school in Lembor Distrik, Indonesia. The hypothesis was tested using a t-test after previously fulfilling the analysis prerequisites. The Hedges equation was applied to describe the treatment's effect size (ES). The analysis results show that the mathematical communication skills (MCS) of students in the class that follow the learning model of PBL with Portfolio Assessment are higher than the MCS of students who follow the conventional learning model. From the calculation of the Hedges formula, it is obtained that ES = 0.69, which means that the application of the Problem-Based Learning model with Portfolio Assessment has a moderate effect on the Mathematics Communication Ability of Junior High School Students.

Keywords: problem-based learning, mathematics communication skills, portfolio assessment

1 Introduction

Learning mathematics is a very very important and useful learning for other sciences. The process of learning and learning mathematics is expected to be able to foster students' mathematical communication skills (MCS) [1], [2]. This is important considering that MCS are not only a thinking tool that helps students to develop patterns, solve problems and draw conclusions but also as a tool to communicate thoughts, ideas and ideas clearly, precisely and briefly [3], [4]. Mathematical communication is a communication skill that includes activities using writing, listening, analyzing, interpreting and evaluating ideas, symbols and mathematical information terms obtained through the process of listening, presenting and discussing [5], [6]. Students' MCS include writing mathematically (written text) to be able to explain explanations and answers to problems mathematically, clearly and logically, mathematically describing (drawing) to be able to paint pictures, diagrams and tables completely and correctly, and expressing, namely students modeling problems math correctly or express concepts by stating everyday events [7]–[9]. Mathematical problems presented in classroom learning tend to be routine problems so that students' understanding is very minimal to understand problems related to communication.

ICEHHA 2022, October 21-22, Ruteng, Indonesia

DOI 10.4108/eai.21-10-2022.2329593

The results of the researchers' interview with one of the mathematics teachers stated that the learning model often used is the conventional learning model. This situation gives the impression that mathematics brings boredom or laziness, a learning atmosphere that is not exciting and fun for students, resulting in a lot of less productive teaching and learning activities. Therefore, it is necessary to learn mathematics that can motivate or encourage students to study independently or in groups so that they can effect on students' MCS. Indeed, the importance of students' MCS in solving problems is necessary to make various efforts to increase students' MCS. To improve and optimize students' MCS, it is necessary to use a different learning model, namely by using a problem-based learning model containing a portfolio assessment. The problem-based learning model has components including realistic, inquiry, retention, and growing problem-solving skills [10], [11]. Problem-based learning provides encouragement to students not only to think according to concrete things but more than that to think about abstract and complex ideas [12]–[14].

In the placement of Problem-Based Learning as a solution to improve students' MCS, it will be combined with a portfolio assessment. Portfolio assessment can be used to see the development of students from time to time based on a collection of works [15], [16]. Portfolios can be used by students to collect all documents from the knowledge learned both in the school yard, in the classroom, and outside the school environment.

One of the previous studies conducted by Aditya Hidayat on the effect of problem-based learning models with problem solving approaches on students' MCS. The results showed that the MCS of students who were taught through a problem-based learning model with a problem-solving approach were better than students who were taught using a conventional learning model. Therefore, the researchers conducted a research entitled "The Effect of Problem-Based Learning Model Containing Portfolio Assessment on Mathematics Communication Ability of Class VIII Students of SMP Negeri 2 Lembor.

2 Method

This research is a quasi-experimental research (quasi-experimental). Experimental research is a research approach that shows two things, firstly experimental research examines the effect of a variable on another variable directly, secondly tests the hypothesis of a causal relationship [17]. The design in this study was a posttest-only control group design. In this study, pretest data were not included in the analysis because they did not explore differences in the improvement of the two classes. The population in this study was the eighth grade students of SMP Negeri 2 Lembor in the 2021/2022 academic year which consisted of three classes. Prior to randomization, a class equivalence test was conducted using the t-test. Then an examination was conducted to determine the research sample. The sample selected was class VIII A as the experimental class and class VIII C as the control class. The number of research samples is 56 students.

3 Results and Discussion

Based on the data description shown to describe the mean, variance, standard deviation, maximum value and minimum value. The data described are posttest data on students' MCS Posttest is a test of students' MCS given to the experimental class and control class after both groups received treatment. In the analysis of the posttest value calculation for the experimental class and the control class, the researchers used the help of the Microsoft Office Excel program.

The following is a summary of the results of the posttest value calculation analysis with statistics for the experimental class and the control class.

Table 1. Summary of Posttest Values for Experimental Class and Control Class

Statistics	Experiment Class	Control Class
Rata-rata	77,357	67,464
Varians	122,98	199,888
Standar Deviasi	11,090	14,138
Modus	81	69
Median	78	69
Nilai Maksimum	94	87
Nilai Minimum	57	37
Range	38	50
Total students	28	28

Based on Table 1, it is known that the posttest results in the experimental class obtained the highest score of 94 and the lowest value of 57, the average value of 77,357, the standard deviation of 11,090 and the variance of 122,98. Meanwhile, students in the control class had the highest score of 87, the lowest score of 37, the average value of 67,464, standard deviation of 14,138 and variance of 199,888.

Meanwhile, the data analysis technique with inferential statistics requires that the analyzed data come from a normally distributed population and homogeneous variance. For this reason, normality and homogeneity tests were carried out. The normality test used the Kolmogorov-Smirnov test and the homogeneity test used the Bartlett test.

Normality test was conducted to determine whether the sample under study came from a normally distributed population or not. The normality test in this study was carried out with the help of SPSS Version 16.0. Testing the normality of the data of MCS carried out is Kolmogorov-Smirnov. The summary of the normality test of the data can be seen in Tables 2.

Table 2. Normality Test Results

Class	Kolmogorov-Smirnov[a]		
	sig	df	Sig.
Experiment	,129	28	,200*
Control	.115	28	.200*

From the three tables 2 it is found that the average in the experimental class is 77,357 with a standard deviation of 11,090 and the standard value of significance using the Kolmogorov-Smirnov formula with the help of SPSS 16.0 is 0.200 and this value is greater than the significance value of 0.05 or in the words another 0.200 > 0.05 which means the data in the experimental class is normally distributed.

In the control class, an average of 67.464 with a standard deviation of 14.138 was obtained, the significance value using the Kolmogorov-Smirnov formula with the help of the SPSS 16.0 program was 0.200 and this value is greater than the significance value of 0.05 or in other words that 0.200 > 0, 05 which means the data in the control class is also normally distributed.

After testing the normality of the data, the next step is to test the homogeneity. Homogeneity test was conducted to find out that the sample under study came from homogeneous variance or not. In this study, the homogeneity test was carried out using the Bartlett test. Summary of homogeneity test can be seen in Table 3.

Table 3. Results of Homogeneity Test Calculation

Levene Statistic	Sig
2,79	0,37

Based on Table 3 above, it can be observed that the value of sig. = 0.37 > 0.05, then the variance of the two samples is homogeneous. This means that the data from the experimental class did not differ, either in mean or variance values, from the data from the control class. By referring to the results of the calculation of the normality test and the homogeneity test of the data from the experimental class and the control class, it is known that the data comes from a normally distributed population and the variances of the two samples are homogeneous. With the fulfillment of all assumptions as a prerequisite for data analysis to use parametric statistics, namely independent t-test, then hypothesis testing can then be carried out. Hypothesis testing in this study uses a t-test with a separated variance formula because [18]. The results of the t-test calculations for students' MCS are presented in Table 4 below.

Table 4. Hypothesis Test Results

Class	N	t_{count}	t_{table}	Conclusion
Experiment	28	2,91332	1,6735	Accept Research Hypothesis
Control	28			

Based on Table 4 shows that the calculation results = 2.91332 and = 1.6735 at the significance level = 0.05 and the degrees of freedom = = 28 + 28 - 2 = 54. Next is the Effect Size of using the Problem-Based Learning model containing Portfolio Assessment. Effect Size is used to determine how much influence the use of a given model has. The results of the calculation of Effect Size can be seen in Table 5.

Table 5. Result of Calculation of Effect Size Test

Effect Size	Interpretation
0.6997	medium

Table 4 shows that the effect of using a problem-based learning model containing portfolio assessment on the MCS of eighth grade students of SMP Negeri 2 Lembor is in the medium category.

Based on the research results obtained from statistical data processing above, it can be seen that the average mathematical communication ability in the class that follows the problem-based learning model with portfolio assessment is higher than the average mathematical communication ability of students who take part in learning with the learning model. conventional. In other words, the problem-based learning model containing portfolio assessment has a positive effect on students' MCS.

This is influenced by the learning model used in learning. In the control class, students are taught using conventional learning models. In this learning model, the teacher plays an active role in the learning process and communication occurs only in one direction. Students are not given the opportunity to actively participate in class. This will result in students being passive. In learning using conventional learning models, besides students being passive, students are also rigid in conveying ideas because they are not used to working more in teams.

While in the experimental class the learning model used is a problem-based learning model containing a portfolio assessment. PBMBAP model is a learning model that places students as active learning subjects and involves maximally all students' abilities to seek information and investigate problems so that they can formulate their own knowledge of the problems they face. The problem-based learning model containing portfolio assessment has the advantage that students are very active during the mathematics learning process, because in the learning process students are given the opportunity to follow the steps in the problem-based learning process containing portfolio assessment, including students faced with authentic (real) problems.

4 Conclusion

This research was conducted to analyze the effect of problem-based learning model containing portfolio assessment on students' MCS. Based on the results of the analysis, it can be concluded that the problem-based learning model containing portfolio assessment has a moderate effect on students' MCS. By clarifying the effect of the problem-based learning model containing portfolio assessment, this study recommends the need to use related media to improve students' overall understanding so as to support their MCS.

Acknowledgments. Thank you to the research and community service institutions of the Indonesian Catholic University of Santu Paulus Ruteng who contributed to this research.

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