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Improving mathematical communication ability through problems based learning model

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Abstract. This study aims to examine the improvement of mathematical communication ability of students who learn with Problem Based Learning and students who learn by Direct learning. This study is a quasi experiment with a non-equivalent control group design. The population is all students of class XI one of Senior High School in Indragiri Hilir regency, Riau by taking sample of class XI IPA 3 students as experimental group that get Problem Based Learning (PBL) and XI IPA 1 as control group that get Direct learning. The problem studied is the improvement of students' mathematical communication ability. The instrument used is the test of mathematical communication ability. Quantitative analysis uses the Mann-Whitney test. While qualitative analysis done descriptively. Based on the data analysis obtained in this study, it is found that the mathematical communication ability of students who get Problem Based Learning is significantly better than the students who learn by direct learning.

1. Introduction

The purpose of mathematics learning formulated in Education Unit Level Curriculum [1] one of them is that learners have the ability to describe and symbols, tables, diagrams, or other media to clarify the conditions or problems. This is in accordance with the purpose of learning mathematics according to the National Council of Teachers Mathematics [2] one of which is learning to communicate mathematically (mathematical communication). One of the mathematical skills that must be developed is the ability of mathematical communication [3].

There are no two reasons why communication is needed. First, mathematics is a language, which means that mathematics is not only used for aids, tools for finding patterns, or problems; however, mathematics is also an appropriate tool for communicating ideas clearly, precisely and accurately. Second, learning mathematics as a social activity, learning mathematics as a social activity or interaction between students, and communication between teachers and students [4]. In addition, through mathematical communication students can organize mathematical thinking, both orally and in writing. In addition, students can also provide appropriate responses among students in the learning process [5].

The importance of communication skills in mathematics learning is not supported by the conditions in the field. Students still do not have the appropriate communication skills as expected. research in one high school on trigonometric material that students' mathematical communication ability is still lacking. Almost all students experience problems in the form of images. This is included in the learning process which only explains the steps to make it possible without guiding students to express ideas in oral and written

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form [6]. Meanwhile, the research which discussed with students' mathematical communication ability in one of high school materials in Bandung stated that by learning Creative Problem Solving through geogebra media, showed less good result. Students have difficulty describing the function of more than two [7]. Based on the experience of being a teacher in one of the State Senior High Schools in Indragiri Hilir Regency of Riau Province, the student compilation is faced with the application of a derivative function to calculate the volume that best matches the 216 cm2 room area, the things that are still needed in terms of problem-day problems into mathematical models, translation models of extreme function problems. It is caused by problems in context, the problems, and how to bring the problems of everyday life into the concept of derivatives, but then to develop them. These facts show that the level of students' mathematical communication ability is still low. This should be addressed immediately by finding the right solution.

The low ability of students' mathematical communication caused by several factors is the less than optimal learning. Based on the experience of the authors in the interviews and teachers in Mathematics Teacher Subject in Indragiri Hilir Regency Riau Province, that in learning mathematics students only modeled and how the solution of problems that have been done by the teacher. If students are given different problems with the exemplified problem, then they are confused because they do not know where to start from where they work. This means learning is still teacher-centered. Mathematical communication would occur well if the teacher prepared the lesson well [8]. Recognized by the ability of mathematical communication, for it needs an effort to improve students' mathematical communication skills through the learning process that can make the spirit more meaningful. One concrete way is by learning that highlights on active student learning. One of the learning models that can be done is Problem Based Learning (PBL).

PBM is a learning model that is oriented to the principle of the problem can be used as the beginning or end of a new science (knowledge). Starting from the definition of the problem, then the students do a discussion to equate perceptions about the problem and set goals and targets to be achieved, then students search for materials from the source library, the internet through personal or observation. So it can be understood that problem-based learning is a learning model that emphasizes more to the student as a learner as well as to the problems that are authentic and relevant to be solved by using all the knowledge it has or from other sources [9].

Problem-Based Learning is learning that begins with a contextual problem with the following characteristics: (1) learning begins with a problem, (2) ensures that problems are related to the real world of students (3) organizes lessons around problems, not around discipline (4) giving learners greater responsibility in shaping and running their own learning processes directly, (5) using small groups, and (6) demanding learners to demonstrate what they have learned in the form of a product or performance [10]

Based on the description it is clear that learning with the PBM model begins with a problem (can be raised by students or teachers), then students deepen their knowledge of what they already know and what they need to know to solve the problem. Students can choose issues that are considered interesting to solve so that they are encouraged to play an active and more communicative role in learning. In PBM students are required to work together in groups to achieve mutual results. When students work in groups, there will be interaction between students, sharing ideas, interpreting mathematical ideas and information, and discussing mathematical concepts and presenting them to solve problems. It is expected that PBL model can improve students' mathematical communication ability.

Based on the above exposure then it is necessary to conduct research on the effectiveness of the application of learning PBM in improving the mathematical communication skills of high school students. The purpose of this research is to find out whether the improvement of mathematical communication of students who learn with Problem Based Learning (PBL) is significantly better than students who learn by Direct learning.

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2. Experimental Method

This research was conducted at SMA Negeri Dharma Pendidikan Kempas, Regency of Indragiri Hilir, Riau. The population in this study is all students of class XI SMA Negeri Dharma Pendidikan. Samples in this study were students of class XI IPA 3 as experimental group and XI IPA 1 as a control group taken with Purposive Sampling technique.

The type of research used is quasi experimental research. While the research design used in this study is non-equivalent control group design [11]. The design is described as follows.

Experiment Class : O X O
Control Class : O O

Information:
O = pretes and postes mathematical communication skills as well as student self-efficacy
X = Problem Based Learning model
------- = Subjects are not randomly selected

Variables in this study involves two types of variables consisting of independent and bound variables. As for which is the independent variable is Problem Based Learning (PBL), the dependent variable is the ability of mathematical communication. The instrument used in this research is the test instrument. The test instrument is a set of questions that measure students' mathematical communication skills. It was also given teaching materials in the form of work sheet used by the experimental class.

Before the research was done, the researcher first conducted an instrument test about the mathematical communication ability given to the students of grade XII IPA 1 SMAN Dharma Pendidikan. This trial aims to determine the validity and reliability of each item that will be used as a measure of the ability of mathematical communication. In addition, the instrument is also validated by the supervisor and teacher concerned in order for the instrument to be eligible for use.

Mathematical communication capability data is collected through pretest and postes. The pretest is given to the experimental class and control class before being treated. Postes are given after both classes get treatment. Quantitative analysis using Mann-Whitney. While qualitative analysis done descriptively.

3. Result and Discussion

3.1. Research result

This research was conducted in one of State Senior High School in Indragiri Hilir Regency, Riau Province involving 66 students where 32 students in experimental class studying with Problem Based Learning and 34 students in control class who learn by Direct learning. Data analysis performed for the test results of mathematical communication ability is descriptive statistical analysis and inferential statistical analysis. Descriptive statistical analysis provides an overview of mean, standard deviation, N-gain, and the percentage of pretest, postes, scores obtained by students. Inferential statistical analysis is used for conclusion through the mean difference test.

3.1.1. Descriptive Statistics Analysis of Mathematical Communication Skills

Data of mathematical communication ability include pretest score used to know mathematical ability of student before given action, and postes score used to know student communication ability after given action. The improvement of students 'mathematical communication ability is obtained from the difference between postes score and pretest score and ideal score of students' mathematical communication ability expressed in N-Gain. The following table scores pretes, postes, and N-gain students' mathematical communication skills.

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Table 1. Descriptive statistics of student mathematical communication ability

NILAI	Kelas PBM						Kelas Langsung					
	N	X_{min}	X_{maks}	$\bar{x}$	**SB**	**%**	**N**	X_{min}	X_{maks}	$\bar{x}$	**SB**	**%**
Pretes	32	0	10	5,50	2,49	27,5	34	0	10	5,88	2,73	29,4
Postes		4	16	13,88	2,72	69,4		9	19	10,82	3,04	54,1
N-gain		5	12	0,58	0,16			3	7	0,37	0,11	
Skor Maksimal Ideal = 20												

Table 1 shows that N-Gain Increase in PBM class is higher than Direct class by 0.21 difference. Graphically, the difference in the average increase (N-Gain) Mathematical communication skills of PBL and Direct class students can be seen in Figure 1 below.

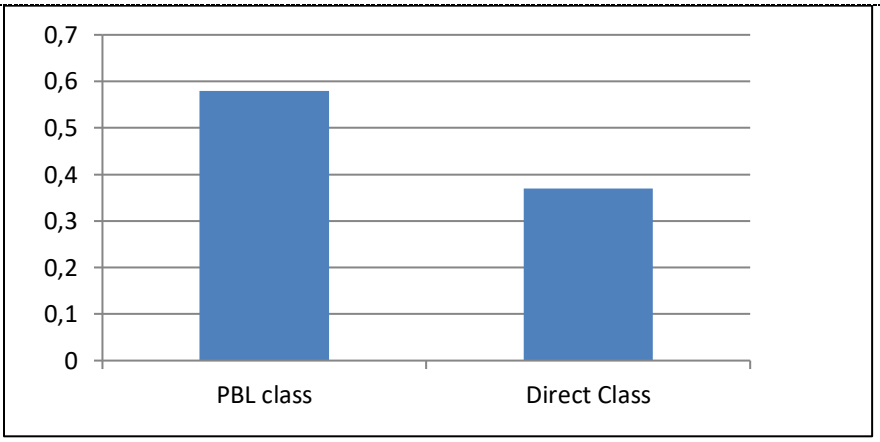

Figure 1. Average n-gain score comparison of student mathematical communication skills

Figure 1 above shows a difference in the improvement of students' mathematical communication skills between the two classes. The increase that occurs in the PBL class is higher than the Direct class. However, to know the difference of the average increase in the ability of mathematical communication significantly between the two classes need to do inferential statistical analysis through the test of average difference.

3.1.2. Inferential Analysis of Mathematical Communication Skills

Inferential statistical analysis is done to answer the hypothesis in this research that is "Improving mathematical communication ability of students who get Problem Based Learning is better significantly than students who get Direct learning as a whole". The statistical hypothesis formula is as follows:

H0: μe ≤ μk The average N-gain mathematical communication ability of students who acquired Problem Based Learning was not significantly better than in the students who received Direct learning overall.

H1: μe> μk The average N-gain of mathematical communication ability of the students who acquired Problem Based Learning is significantly better than the students who acquired the overall Jump learning.

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With the following test criteria:
If the value is Sig. (p-value) $<\alpha$ ($\alpha = 0,05$), then H_0 is rejected
If the value is Sig. (p-value) $\geq \alpha$ ($\alpha = 0,05$), then H_0 is accepted

The summary of the average difference test of the improvement of mathematical communication ability can be seen in table 3 below.

Table 2. Average difference test results improved mathematical communication skills

	SKOR
Mann-Whitney U	115,500
Z	-5,504
Asymp Sig (2-tailed)	0,000
Asymp Sig (1-tailed)	0,000

Based on Table 2 above obtained value of Sig value. (1-tailed) is 0.000 $<\alpha = 0,05$ so hypothesis H_0 is rejected, it means that improvement of mathematical communication ability of students who get Problem Based Learning is significantly better than students who learn by Direct learning.

3.2. Discussion

The initial condition of the students described with pretest results indicates that the average of students' mathematical communication ability is still low in both classes. In addition, this indicates that the initial ability of both classes is relatively similar.

The results showed that there was an increase in the value of students using Problem Based Learning (PBL) of 0.58, while for the control class increased by 0.37. Based on the classification of increase (gain) according to Hake, the improvement of communication skills of both classes are in the medium category. But based on the hypothesis test obtained the results of improving the mathematical communication skills of students who acquired Problem Based Learning is significantly better than the students who acquired Direct learning. This indicates that the increase for the experimental class is higher than the control class.

The results have shown that learning by PBL can improve students' mathematical communication skills. This increase is due to the Characteristics of Problem Based Learning itself which is more emphasized to the students as a learner as well as to the authentic and relevant problems to be solved by using all the knowledge it possesses or from other sources. Students learn math through work sheet given and construct their own knowledge according to the indicators in the Problem Based Learning. Problems given can train students in performing mathematical habits that will affect the ability of high-level students, especially the ability of mathematical communication. The results above show that Problem Based Learning provides a significant role in improving the ability of mathematical communication.

4. Conclusion

Based on the results of research and discussion has been raised can be concluded that the improvement of mathematical communication skills of students who acquired Problem Based Learning is significantly better than the students who get Direct learning.

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