THE EFFECT OF *PROBLEM BASED LEARNING* (PBL) MODEL TO MATHEMATICAL COMMUNICATION SKILLS AND PROBLEM SOLVING 7TH GRADE STUDENTS OF JUNIOR HIGH SCHOOL IN MERGANGSAN DISTRICTS OF YOGYAKARTA

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Tiar Ayu Kuntari

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By : Tiar Ayu Kuntari, Dr. R. Rosnawati, M.Si.
Jurusan Pendidikan Matematika, FMIPA, Universitas Negeri Yogyakarta
Email: ara.akimoto94@gmail.com, rosnawati_uny@yahoo.com

Abstract

This study aims to determine the effect of problem based learning models for mathematical communication and problem solving skills in grade VII students of Junior High School in district Mergangsan. The method in this study is a quasi experimental research with pre-test post-test group design. The samples in this study are the students of Junior High School Taman Dewasa Ibu Pawiyatan of grade VIIA and VIIB, each of which is treated with problem-based learning and expository model respctively. The instrument used in this study were the test and observation sheets. Data analysis technique used were T^2-Hotteling test to determine the significance differences and further tests using independent sample t-test test. The results of statistics descriptive test analysis showed that the problem based learning models give posttest average value higher than the expository, namely for the class with problem-based learning models have the posttest averaged value of 84.25 for mathematical communication skills and problem solving skills of 85.05,. While in the classroom with expository have posttest average value of 71.64 and problem solving skills of 69.34. Based on the average results the model of problem-based learning is more influential and significant than the expository teaching of the mathematical communication skills and problem solving.

Keywords: Problem Based Learning, mathematical communication, problem solving.

INTRODUCTION

Mathematics is one of the subjects that have an important role in the development of students mathematical abilities. This is in line with the learning objectives formulated Education Unit Level Curriculum (Depdiknas: 2006) states that the mathematics courses aim to enable students to have the following capabilities:

1. Understand the concepts of mathematics, describes the relationship between concepts and apply concepts or algorithms, are flexible, accurate, efficient, and right in problem solving.
2. Using the reasoning on the pattern and nature, perform mathematical manipulation in making generalizations, compile evidence, or explain mathematical ideas and statements.
3. Solve problems that include the ability to understand a problem, design a mathematical model, solve the model and interpret the obtained solution.
4. Communicate ideas with symbols, tables, diagrams, or other media to clarify the situation or problem.
5. Have respect for the usefulness of mathematics in life, which has the curiosity, attention and interest in studying mathematics and a tenacious attitude and confidence in solving problems.

In line with the educational unit level curriculum, National Council of Teachers of Mathematics (NCTM, 2000) formulate mathematical learning objectives: 1) learn to communicate (mathematical communication),

learn to reason (mathematical reasoning), learn to solve problems (problem solving), learn to associate ideas (mathematical representation).

Based on mathematical learning objectives can be concluded that the learning of mathematics can help students understand the concepts, solve problems systematically, linking mathematics with everyday life, and can express with mathematical ideas both orally and in writing. Mathematical communication skills should be explored and developed in mathematical learning so that students have the ability to provide information that is dense, concise, and accurate values. Brodie (2010: 7) that communication is part of the process of understanding. Therefore, communication plays an important role as a mathematical representation of the students understanding of mathematical concepts themselves.

In addition to mathematical communication skills, problem solving ability is very important to be developed in the process of learning mathematics. Problem solving skills need to be improved in mathematics, to improve the mindset of students. Muhibbin syah (2010: 127) states that learning problem solving is basically learning to use scientific methods or to think in a systematic, logical, organized and accurate. The goal is to acquire the skills and cognitive skills to solve mathematical problems by using analysis and measures of completion as well as using several procedures to achieve the expected results.

Based on this it can be seen that the communication skills and problem solving mathematics students in learning math is very important to be studied. The issue is how teachers can instill the concept of best to the students. These issues are always relevant for all education actors in finding an appropriate learning models used.

One model of learning that can improve communication skills and problem solving mathematics is *problem based learning* (PBL). *Problem Based Learning* (PBL) is one of *problem based learning* model that allows the development of students thinking skills. Sungur and Tekkaya (2006: 308) states that Problem Based Learning allows students to interact with their environment, classmates, who will lead the students to improve their knowledge.

Based on research conducted by Endang Hariyati (2013), states that the learning achievement of students who have communication skills and problem solving mathematical model PBL is better than learning achievement of students who have the communication skills of mathematics and problem solving with direct instructional model.

Khoirunnisa research results (2013) stated mastery learning students with learning model of *problem based learning* to train communication skills mathematical reached 92% in the classical style. Student activity treated with learning model of *problem based learning* also reached a percentage of 74.9%.

Based on the above theory, the authors feel the need to do a study that is able to reveal how communication skills and problem solving mathematics through *problem based learning* to class VII students of Junior High School in Mergangsan District.

RESEARCH METHOD

Type and Design Research

This research is a *quasi experimental* quantitative approach. Design used in this research is *Nonequivalent-Groups pretest-posttest* design. The draft can be described as follows.

Table 1. Research Design *Nonequivalent Group Pretest-Posttest Design*

Group	*Pretest*	Treatment	*Posttest*

Place and Time Research

This study was conducted in SMP Taman Dewasa Ibu Pawiyatan Yogyakarta in the second semester of 2014/2015 academic year in June 2015.

Subject Research

Population is used by researchers around the seventh grade junior high school students in the Mergangsan District as many as 215 students. By using the formula slovin then the sample size can be calculated as many as 68 students with an error rate of 10%.

Data Collection Techniques and Instruments Research

The research instrument used in this study is a test instrument that measures the shape descriptions communication skills and problem solving mathematics students. The test instrument consisting of the initial test questions (*pretest*) and final test (*posttest*).

Non test instruments in the form of structured observation sheet to make sure the main steps in the learning activities models *Problem Based Learning* can be done well.

Data Analysis Technique

The data analysis technique used in this study is a statistical analysis of multivariate analysis. Multivariate analysis in this study using *Hotelling's Trace* with SPSS *16.0 for windows*. The analyzed data is the data obtained from the *pretest* and *posttest* mathematical communication skills and problem solving.

MANOVA test statistic calculated according to Stevens (2009: 148), formulated as follows.

$$F = \frac{n_1 + n_2 - p - 1}{(n_1 + n_2 - 2)p} T^2$$

With

$$T^2 = \frac{n_1 \times n_2}{n_1 + n_2} (\overline{y_1} - \overline{y_2}) S^{-1} (\overline{y_1} - \overline{y_2})$$

$$S = \frac{W_1 + W_2}{n_1 + n_2 - 2}$$

$$W = \begin{bmatrix} ss_1 & ss_{12} \\ ss_{21} & ss_2 \end{bmatrix}$$

and the degrees of freedom p and $(N - p - 1)$, $N = n_1 + n_2$, and $\alpha = 0{,}05$.

Description :

T^2 = *Hotelling Trace's*
n_1 = The sample size of the experimental group
n_2 = The sample size of the control group
$(\overline{y_1} - \overline{y_2})$ = average matrix
S^{-1} = inverse covariance matrix
p = the amount of the dependent variable
S = sample dispersion matrix
W_1 = matrix sum of squares in the experimental group
W_2 = matrix sum of squares in the control group
ss_1 = sample variance experimental group
ss_2 = sample variance control group
$ss_{12} = ss_{21}$ = sample covariance between the experimental group and the control group

Decision criteria for the analysis manually is H_0 is rejected if $F_{hit} > F_{0,05;(p,(N-p-1))}$ (Steven, 2009: 148).

Further analysis followed by univariate test with *independent sample t-test*. Univariate test formula used by Stevens (2009: 148) is:

$$t = \frac{\overline{y_1} - \overline{y_2}}{\sqrt{\frac{(n_1-1)S_1^2 + (n_2-1)S_2^2}{n_1+n_2-2}\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$$

Description :
$\overline{y_1}$ = The average value of samples of the experimental group
$\overline{y_2}$ = The average value of samples of the control group
S_1^2 = Varian sample experimental group
S_2^2 = Varian sample control group
n_1 = Number of members of the experimental group samples
n_2 = Number of members of the control group samples

RESULTS AND DISCUSSION

Description Data Communication Skills Mathematics Test Results and problem solving.

Test data communication skills and problem solving mathematics described consists of a data *pretest* and *posttes*t of data. In summary, the test results in both groups are presented in the following.

Table 2. Mathematical Statistics Data Communications skills

Deskription	Experiments Class (E_1)		Control Class (E_2)	
	Pretest	***posttest***	***Pretest***	***Posttest***
Mean	49,83	84,17	44,92	70,00
Standard Deviation	14,443	9,241	14,321	11,58
The maximum value	80,00	100	72,50	90,00
The minimum value	27,00	67,50	17,50	45,00

Table 2 shows that communication skills mathematically in the average value of *posttest* students in experimental class is higher than the control class. Moreover, judging from the average scores of each aspect of the communication skills of mathematics at *pretest* and *posttest* results of experimental classes and control classes are listed in Table 3.

Table 3. Average Value Every Aspect Mathematics Communications Skills

Aspect Mathematics Communications Skills	Average Value Every Aspect			
	Experiment Class		Control Class	
	Pretest	*Posttest*	*Pretest*	*Posttest*
The ability to write information	41,04	86,54	30,44	39,99
The ability to present problems in the form of drawings, diagrams, and tables are complete and correct	33,04	76,00	32,56	65,42
provide conclusions	36,49	90,95	22,18	68,42
Scores Average	36,87	84,57	28,47	57,94

Based on Table 3 shows that the average value of each aspect *posttest* experimental class of mathematical communication skills have good category, while in the control class value in every aspect still classified in the category of very less.

Table 4. Statistical Data Problem Solving

Deskription	**Experiments Class (E_1)**		**Control Class (E_2)**	
	Pre-test	***post-test***	***pretest***	***Post-test***
Mean	35,16	85,43	33,45	69,62
Standard Deviation	12,560	9,552	8,703	16,306
The maximum value	79,69	100	57,81	95,31
The minimum value	15,63	70,31	15,63	34,38

Table 4 shows that the average value of *posttest* students in experimental class is higher than the control class. Moreover, judging from the average scores of each aspect of the problem solving skills *pretest* and *posttest* results of experimental classes and control classes are listed in Table 5.

Table 5. Average Value Every aspect of Problem Solving Ability

Aspects of Problem Solving Ability	Average Value Every Aspect			
	Experiment Class		Control Class l	
	pretest	*posttest*	*pretest*	*posttest*
Understanding the problem	34,19	83,09	27,02	66,73
Problem solving plan	31,62	87,68	36,76	70,22
Solve the problem according to plan	39,34	85,80	28,68	64,15
provide conclusions	41,36	85,11	41,36	77,38
Scores Average	36,63	85,42	33,45	69,62

Based on Table 5 shows that the average value of posttest every aspect of class problem-solving capabilities experiments have good category, while in the control class is classified in the category less.

Data Analysis Technique

Analysis of the data used is inferential statistical analysis, a statistical analysis is used to make decisions based on data that has been obtained. Data were analyzed in inferential statistical analysis is the data obtained before and after treatment.

Data Analysis Before Treatment

Data obtained before treatment include test data communication skills and problem solving mathematics well for the experimental group and the control group.

Normality Test

Normality test is done to determine whether the population distribution is normal or not. Results using SPSS 17 software can be seen in Table 6 as follows:

Table 6. Normality Test Results Analysis Data Before Treatment

Variable	Value Significance		Conclusion
	Experiment Class	Control Class	
Mathematics Communication Skills	0,376	0,924	Normal distribution of data
Problem Solving Ability	0,867	0,757	Normal distribution of data

Homogeneity Test

Homogeneity test is intended to test the similarity of the variance-covariance matrix of the dependent variables simultaneously (multivariate). Homogeneity test results simultaneously obtained was 0.274 and is worth more than. This shows that the variance-covariance matrix homogeneous experimental and control groups.

Multivariate Test

Multivariate statistical test can be used if previously been met assumptions of multivariate normality and homogeneity.

Based on the calculations, the significance of 0.206 (greater than 0.05). This shows that Ho is accepted. Thus there is no difference in the average initial capability between experimental and control groups.

Data Analysis After Treatment.

Data obtained after treated include *posttest* measurement result data communication skills and problem solving mathematics.

Normality Test

The test results indicate normality after treatment number greater than 0.05 as shown in the following table.

Table 7. Normality Test Data Analysis Results After Treatment

Variable	Value Significance		Conclusion
	Experiment Class	ControlClass	
Mathematics Communication Skills	0,732	0,708	Normal distribution of data
Problem Solving Ability	0,726	0,848	Normal distribution of data

Homogeneity Test

Results of multivariate homogeneity test after treatment obtained was 0,010 and is worth more than 0.05. This shows that the variance-covariance matrix of the experimental group and the control group is homogeneous.

To test the similarity of variance for each dependent variable used *Levene's test*. Results of univariate homogeneity test after treatment is significant value communication 0.403 and problem solving mathematical 0.011. This demonstrates the significant value of each variable is more than 0.05. It means variance of the experimental group and the control group is homogeneous in the variable

mathematical communication skills and problem solving.

Multivariate Test

Based on the calculations, the significance of 0.000 (less than 0.05). This shows that Ho is rejected. Thus there are differences in the average ability of the final between experimental and control groups together in class VII students of Junior High School in Mergangsan District.

Univariate Test

In the previous test multivariate analysis we concluded that there is a difference between the control group and the experimental group. Therefore, it should be investigated further to compare which group is more influential in terms of any mathematical communication skills and problem solving.

Based on the calculations, the significance of 0.000 (less than 0.05). showed that the experimental group with a model of *problem based learning* is more influential than the control group in aspects of mathematics communication skills and problem solving partial in class VII students of Junior High School in Mergangsan District.

PBL model the influence of the Communication Ability and Mathematical Problem Solving

Multivariate testing is done using MANOVA to see the effect on the ability of PBL model of mathematical communication and problem solving simultaneously by analyzing the results of calculations with *Hotteling's Trace*.

Calculations show that in F_{hit}= 1,620 the value of less than F_{table}= 3,14 and a significance value of 0,206 which is greater than 0,05. This means that the *pretest* between the experimental and control groups there is no difference.

While calculating the value *posttest* shows F_{hit}= 25,979 smaller than F_{table}= 3,14 and a significance value of 0,000. This means that on average there are differences between the experimental class and control class for mathematical communication skills and problem solving together in class VII students of Junior High School in Mergangsan District. This is consistent with that expressed by Rusman (2014: 230) that may facilitate successful PBL problem solving, communication, teamwork and interpersonal skills better.

PBL model the influence of the Mathematical Communication Skills

Based on descriptive analysis well known to an increase of the percentage of students who passed the KKM and the average value of mathematical communication skills significantly in the experimental class. Such improvements can be seen in the diagram below.

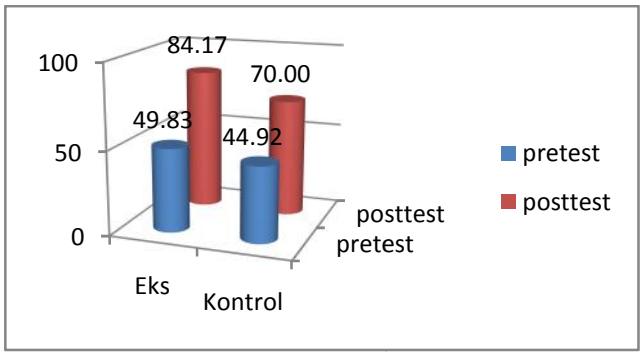

Figure 1. Graphic Communication skills Mathematical Results

The graph above shows an increase in the experimental class with an average increase of 34,34. Meanwhile, the control group showed an increase of 22.08. These calculations show that an increase in the average score of students mathematical communication skills experimental group was higher than the control class.

This was confirmed by statistical calculation by *independent sample t-test*. at *posttest*. It is known that the entire value$t_{hitung} > t_{table}$, the entire value of any significance < 0,025. From these calculations indicate that on average there is a difference between the model PBL in the experimental class with expository model of the control class for mathematical communication skills. That is, the model PBL more positive effect on students mathematical communication skills.

It is appropriate that expressed by the NCTM (2000: 60) that the communication is an important part of mathematics and mathematical education, this is a way to share ideas and classifying understanding. Through communication, the idea becomes the object of reflection, repair, discussion, and change.

The communication process also helps students build an understanding. When students are challenged to think and make excuses about mathematics and communicate the results to others thoughts either orally or in writing, they learn to explain and convince.

PBL model the influence of the problem solving ability

Based on the descriptive analysis of the experimental class is known that an increase in the average value of solving significant problems. Such improvements can be seen in the diagram below.

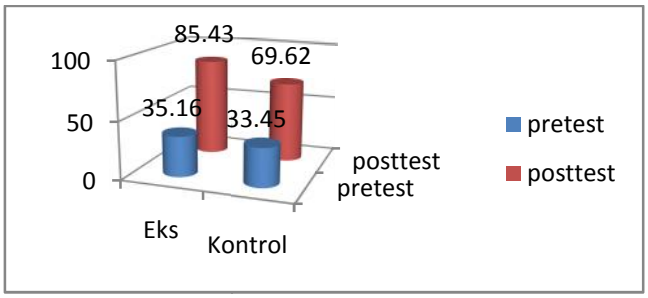

Figure 12. Graph Results Mathematics Problem Solving

The graph above shows an increase in the experimental class with an average increase of 50,27. Meanwhile, the control group only showed increase 36,17. This calculation shows that an increase in the average score of mathematical problem solving capabilities experiments grade students was higher than the control class.

This was confirmed through statistical calculations with *independent sample t-test* to *posttest* comparing the experimental class and control class. Test results in the experimental group showed a value of t_{hitung}= 4,878 with 0,000 significant value. Value also shows the

significance of the figure 0,000 where < 0.025. This proves that the model PBL indeed have a positive influence on problem solving in class VII students of Junior High School in Mergangsan District.

As stated by Ali et al. (2010: 68) that "*in the problem based learning approach the students turn from passive listeners of information receivers to active, free self-learner and problem solver*". It means that PBL is a model of student centered learning from passive to active listener information, develop problems and problem solving skills. In addition, through group discussions, students were asked to find their own math concepts. This is consistent with research Ferreira & Trudel (2012: 23), which showed that PBL can provide a positive influence on problem-solving ability in science.

CONCLUSIONS AND SUGGESTIONS

Conclusion

Based on the results of the study it can be concluded that: 1) study of mathematics by using a model of *problem based learning* in the material algebra give a positive and significant impact in terms of mathematical communication skills and problem solving junior high school students of class VII SMP Budi Luhur Yogyakarta, SMP Piri 2 Yogyakarta, as well as SMP Taman Dewasa Ibu Pawiyatan; 2) model of *problem based learning* is a positive and significant impact on the ability of mathematical communications; 3) model of *problem based learning* is a positive and significant impact on the ability of solving the problem.

Suggestions

Based on the research conclusions above, there are some suggestions that can be submitted are: 1) to teachers, when applying the model PBL in the learning process, should the teachers need to understand each of the steps that exist in the model PBL, so that teachers can give clear instructions to students to follow the steps implementing PBL models; 2) To the next researchers conducted another study on the application of the model PBL on students learning materials and different conditions, both in terms of class and individual conditions of students.

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