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The Effect of the PBL Model on Learning Outcomes Viewed from Mathematical Communication Ability of Students

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ABSTRACT

Teachers as educators need to apply various learning models in order to optimize student learning outcomes. In addition, teachers need to concern to the mathematical communication skills possessed by students. The purpose of this research was to analyze the effect of Problem Based Learning (PBL) model on Mathematics Learning Outcomes in terms of students' mathematical communication skills. This research is a quantitative research using experimental methods and using a factorial experiment design. The sampling technique used is purposive sampling technique. The instruments used in this research were questions on the test of mathematical communication ability and test questions on learning outcomes in the form of descriptions. Statistical analysis used the Friedman two way ANOVA test. The results showed that there was an effect between learning models and mathematical communication skills on student learning outcomes. Students who receive PBL learning have an average learning outcome higher than students who receive conventional learning. In addition, students had high mathematical communication skills get the highest average learning outcomes compared

***Keywords**: Friedman Test, Learning Outcomes, Mathematical Communication Skills, PBL*

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INTRODUCTION

Mathematics is a comprehensive science and forms the modern basis technological developments, plays an important role in various sciences and can advance human thinking abilities. According to (Puspitasari, Afriansyah, Nuraeni, Madio, & Margana, 2019), Mathematics is a structured science and implies that the concepts contained in it are interdependent on one another. The objectives of learning mathematics include: 1) students can master, explain, and apply mathematical principles accurately to solve problems in mathematics; 2) students can think logically and carry out mathematical operations, as well as show and explain ideas from a mathematical expression; 3) students can solve mathematical problems coherently; and 4) students can communicate ideas by using formulas/symbols/charts/graphs/diagra ms to explain the problems encountered (Rezi Ariawan, 2017; Amalia et al., 2017).

Mathematics learning is interaction process between a teacher and students who can relate logic and mindset in learning environment on purpose created by the teacher using various models, mathematics learning schemes are formed and optimally developed, and students could implement mathematic learning effectively appropriate. Students who study at school have many different behaviors and temperaments (Djali dalam Tasya & Abadi, 2019).

The purpose of mathematics learning is to optimize students skills when applying them in everyday life. The important thing in mathematics learning is to understand the concept well. Explore a new concept, students must first try to understand the concepts contained the previous object. This is used as a prerequisite for students to be able accept easily and understand new concepts. Students' lack of knowledge of the material provided causes not maximal learning outcomes and learning completeness has not been achieved.(Kamarianto, K., Noviana, E., & Alpusari, 2018).

In general, the difficulties experienced by students when solving mathematical problems are that the methods used by teachers are still ordinary and not effective, students have not been able to understand the problems given, they have not understood the steps for solving them, and they do not understand questions based on concepts (Jatmiko, 2018). Besides that, the learning carried out by teachers, especially in mathematics, is still not optimal. This is corroborated by Fauzia's explanation that the teacher's way of teaching is still usual with the lecture method, explanations in class, and only discussing with students who are able or active during the learning process (Fauzia, 2018). The result of the learning process is only controlled by the teacher and a of students small number. Conversely, less active students do not play a major role in the learning process. Seeing these problems, it is necessary made improvements so the learning process is improved, then the quality of learning, especially in mathematics, increases.

One of the efforts to keep active students during the learning process is to apply various learning models (Riswati, R., Alpusari, M., & Marhadi, 2018). To explain a concept to students, teachers as educators must choose an effective model. To achieve maximum learning outcomes, the effort that can be made by a teacher is to apply strategies and models that are suitable for explaining material to students, namely learning models that can support students connecting material with daily

activities. One appropriate learning model is Problem Based Learning (PBL) or problem-based learning.

The problem-based learning process is a learning model, in which students are first presented had a problem then followed by a student-centered or student-centered material search process. In terms of philosophy, PBL is centered on students by confronting them with a problem. Meanwhile, on the subject of based learning, the teacher describes what he knows to students before using problems to illustrate the knowledge that has been conveyed. PBL aims to assist students in acquiring and forming their knowledge effectively (Paradina, Connie, & Medriati, 2019). PBL has 5 steps, namely: (1) Orienting students on problems, (2) Grouping students on study, (3) Conducting guidance to in individual students or group investigations, (4) Developing and presenting work, (5) Conducting analysis then evaluation of students' processes in solving problems (Ariyana, Pudjiastuti, Bestary, & Zamroni, 2018).

According to (Rezi Ariawan, 2017), PBL has a characteristic, namely as a learning model that always starts and focuses on problems. PBL requires students to work together in small groups and explore what they already know and what they don't know. In addition, students must also learn about how to solve a problem. The main role of the teacher is to facilitate students by groups learning process, not by giving answers directly. The application of the PBL model with real media can be used as an effort to optimize mathematics learning outcomes. This has the reason that the model describes the problem as the first step in acquiring and gathering new knowledge.

From preliminary observations made by researchers in class VIII SMPIT Taqiyya Rosyida, the results of students' mathematics learning were still relatively low. This data can be seen from the results of giving assignments or tests, many students' scores are still less than the Minimum Completeness Criteria (KKM).

One of the factors causing low learning outcomes is students' mathematical communication skills that are still weak. Mathematical communication ability is students ability from mathematical communication ideas both orally and written. Based on the conclusions from the research conducted by Zahara, that in the learning process of mathematics, students are required to elaborate on the language of mathematics and its symbols so they communicate them either orally or writing prosess. This process will have an impact on students' mathematics learning outcomes, because learning outcomes are very closely related to students' skills in representing what they know and what they have learned the language form and mathematical symbols. (Zahara, 2021).

Mathematical Indicators of communication ability according to NCTM in (Purwati & Wuri, 2019) namely: (1) Disclousure abylity to express the mathematical ideas orally and written, as well as demonstrate and describe mathematic visually; (2) students could understand, interpret, and evaluate Mathematical concepts both orally and visually; (3) students could use mathematical terms, notations and mathematical structures to express ideas, describe relationship and be able to situate model.

As one of main factors in achieving maximum learning outcomes, teachers need to pay attention to students' mathematical communication skills. In the process of understanding

and communicating these ideas, mathematical communication skills are needed. This weak communication skill result thy weaknesses in other to mathematical abilities (Swastika, 2016). Mathematical communication provides opportunities, encouragement and support for students to speak, write, read and listen to mathematical expressions. In addition, they can also communicate mathematically because mathematics is often given in the form of symbolic, written and verbal communication (Serupa Laia & Nias, 2022).

Based on this description, the formulation of the problem of this research is Is there any influence between model of learning and mathematical communication ability on students' mathematics learning outcomes?

METHOD

This research used a quantitative approach by the method the experimental method. Quantitative research could also be understood as a research method based on the positivism philosophy used to examine a particular population or sample. Data was collected used instruments. (Sugiyono, 2017). The research design of this esearch is factorial experimental design. The factorial experimental design can be seen in Table 1.

Tabel 1. Reseach Design

B / **A**	**B_1**	**B_2**	**B_3**
A_1	$A_1 B_1$	$A_1 B_2$	$A_1 B_3$
A_2	$A_2 B_1$	$A_2 B_2$	$A_2 B_3$

Eksplanation:
A : Learning model
A_1 : PBL Model (Experimental Class)
A_2 : Conventional Model (Control Class)
B : Level of Mathematical Communication Ability
B_1 : High mathematical communication ability
B_2 : Moderate mathematical communication skills
B_3 : Low mathematical communication ability

This research was conducted at SMPIT Taqiyya Rosyida which is located at Prayan, RT.02/RW.01, Hamlet I, Gumpang, Kec. Kartasura, Sukoharjo Regency, Central Java 57169. The time for conducting this research was at the beginning of the even semester of the 2022/2023 academic year, starting from January 2023. The population in this research were all students of class VIII. This research used two classes were taken, the experimental class and the control class. The experimental class, the researcher had given PBL treatment while the control class had given conventional treatment with lectures.

The collection data technique of this research was through tests. The instruments used are mathematical communication ability test questions (KKM) and learning outcomes tests in the form of descriptions. KKM questions are given to group students according to high, medium, and low levels of mathematical communication ability. While the learning achievement test questions are given to collect data on students' mathematics learning outcomes on the Pythagorean theorem material.

The collection data technique of this research used a purposive sampling technique. Researchers will take 30 students consisting of 15 students in

class A and 15 students in class B, with the provision that each class will be taken by students taking into account the category of mathematical communication abilities of 5 students each. Corrected student work results are then assessed according to the assessment guidelines in the instrument. The following presents the category of grouping mathematical communication abilities according to Arikunto in (Arikunto, 2014).

Tabel 2. Grouping Category Matematical Comunication skills

Value criteria	Category
$X > (\bar{x} + SD)$	High
$(\bar{x} - SD) \leq X \leq (\bar{x} + SD)$	Medium
$X < (\bar{x} - SD)$	Low

Eksplanation:
X : Student scores
$\bar{x}$: Student's average score (Mean)
SD : Standard Deviation

The analysis data technique of this research is the Friedman Test. The Friedman test is used because the assumptions in parametric statistics are not fulfilled, the data is not distributed normally. The test was carried out used the SPSS 23.0 software windows program with a significance level of α = 0.05.

RESULTS AND DISCUSSION

Data on mathematical communication skills and learning outcomes in this research were collected from the results of giving tests to students which were taken after the research was conducted. Table 3 below shows the percentage of categories for grouping students' mathematical communication skills in the control (conventional) class.

Tabel 3. Presentage of KKM category Grouping Control Class

Category	Value Criteria	Number of Students	Percentage
High	X > 76,57	5	21%
Medium	60,29 ≤ X ≤ 76,57	12	50%
Low	X < 60,29	7	29%

Based on table 3, 5 students with a high KKM category accounted for a percentage of 21%, 12 students with a moderate KKM category accounted for a percentage of 50%, and 7 students with a low category accounted for a percentage of 29%. The following is the percentage of categories for grouping students' mathematical communication skills in the experimental class (PBL).

Tabel 4. Presentage of KKM category Grouping Experimental Class

Category	Value Criteria	Number of Students	Percentage
High	X > 86,85	6	25%
Medium	58,34 ≤ X ≤ 86,85	13	54%
Low	X < 58,34	5	21%

Based on table 4, 6 students classified the high KKM category accounted for a percentage of 25%, 13 students classified medium KKM category accounted for a percentage of 4%, and 5 students classified low category accounted for a percentage of 21%. Then the learning outcomes data in the control and experimental classes for each level of KKM are presented in table 5 below.

Tabel 5. Study Result Data whole sample

Treatment Class	KKM level		
	High	Medium	Low
Control Class	48	38	48
	43	33	38
	48	48	43
	29	48	48
	48	24	33
Experiment Class	67	10	52
	81	52	48
	48	52	48
	81	48	48
	52	52	10

Friedman's test is used as an alternative when two-way ANOVA in parametric statistics cannot be used because the assumptions needed in two-way ANOVA are not fulfilled, one of which is that the data is not normally distributed. The normality test was carried out to find out whether the sample came from a normally distributed population or not. Data can be said to be normal if the probability value or significance value is greater than 0.05 (Sig > 0.05). Conversely, if the number less than 0.05 (Sig < 0.05) then the data is not normally distributed. The results of normality test for student learning outcomes data are presented in table 6.

Tabel 6. Normality Test Result

	Treatment Class	Shapiro-Wilk Sig.
Learning outcomes	Conventional	.007
	PBL	.006

Based on the data on table 6 above can be seen from the results of the normality test used the Shapiro-Wilk test, that the learning outcomes in conventional and PBL classes have a Sig value of <0.05. This shows that there are some data that are not normally distributed, so there is no need to do a homogeneity test. Hypothesis testing can be continued with a non-parametric test using the two-way ANOVA Friedman test.

The data obtained was formed of the learning outcomes and analyzed the Friedman ANOVA test with the same two way cell contents. The results of the Friedman test are shown in table 7 as follows.

Tabel 7. Friedman Test Result

N	30
Chi-Square	50.909
df	2
Asymp. Sig.	.000

The research hypothesis on the Friedman test is:

H_0 : There is an influencing of the learning model in terms of mathematical communication skills on learning outcomes

Ha : There is no effect of the learning model in terms of mathematical communication skills on learning outcomes

H0 is accepted if the value is sig.<0.05 while Ha is accepted if the value is sig.>0.05. Referring to the results of the analysis in table 7, the probability (asymp sig) is 0.000 <0.05 so that H0 is accepted. That is, learning models and mathematical communication skills have a significant influence on learning outcomes

Next, we will compare the learning outcomes in the PBL class with the conventional class. The average learning outcomes in the class treated with the conventional model and in the class treated with the PBL model are presented in table 8.

Table 8. The Average learning outcome of conventional and PBL Clasess

Treatment Clas	Mean
Conventional Class	41.133
PBL Class	49.933

Based on the results test presented in table 8, the conventional class obtained an average of 41.133 and the PBL class 49.933 so that the learning outcomes in PBL learning were higher compared to students who received conventional treatment. This is because, in classes with the PBL model, students were more active in thinking and acting ability. This is what is really expected by the world of modern education, students are more interactive in independent learning guided by teachers so that these students will get the opportunity to compare theory with practice. In addition, the learning process carried out based on PBL syntax directs students to problems that will hone students' skills in reading and understanding problems and being able to solve them (Mainake, Laamena, & Gaspersz, 2021).

The main principles of PBL are based on maximized learning by investigating, explaining, and started to solve the real and important problems. So, the PBL is problem solving art. PBL is challenging, motivating and fun. This process can build a broad and flexible knowledge base related to PBL disciplines (Nasar & Kurniati, 2020). This process allows students to improve their ability to learn to solve problems effectively, independently, and for life.

The PBL model makes education in schools more in line with life outside school, trains students' skills to solve problems critically and scientifically and trains students to think critically, analytically, creatively and comprehensively because the learning process students are trained to highlight problems from various perspectives.

In table 9, it will be seen whether students classified high communication skills get higher learning outcomes compared to students classified medium and low communication skills.

Table 9. The Average KKM student learning outcome are high, medium and low

KKM Level	Mean
High	54.5
Medium	40.5
Low	41.6

Based on the results in table 9, student learning outcomes were obtained with a high KKM of 54.5, a moderate KKM of 40.5, and a low KKM of 41.6. The learning outcomes of students with high KKM have the highest average compared to learning outcomes of students with medium and low KKM. This is because, mathematical communication skills have a very large impact on students' success in learning mathematics. When students have good mathematical communication skills, they will find it easier to solve mathematical problems. More than that, communication skills will also help students to explore their own potential, because in this case, students are expected to be able to express ideas mathematically through writing, orally or pictures relating to the concepts that have been taught. (Hafifah & Bharata, 2018).

The important thing of mathematical communication ability was raised by Baroody in(Aminah, Wijaya, & Yuspriyati, 2018) rationally a) mathematics is a fundamental language was not only a tool for thinking, finding formulas to solve problems, or drawing conclusions, but also has many uses. Unlimited ability to express ideas clearly, thoroughly and accurately; b) the center of human social activity. The example of mathematics learning was the interaction between teachers and students, between students and mathematics learning materials. The students were important factors in developing students' potential.

The results obtained from this research indicate that mathematical communication skills provide opportunities for students to develop the ability to communicate ideas through language and symbols to solve a mathematical problem. In other words, interesting, challenging and contextual problem situations can inspire students to develop creative ideas both individually and in groups to propose or create mathematical problems with varying levels of complexity.

In school realization, teachers can also develop more professionalism in teaching as an effort to realize student-centered learning in the teaching system so that it has an effect on improving students' mathematical communication skills.

CONCLUSION

The results from discussion of this researchcould be concluded that PBL learning model provides a better increase in learning outcomes compared to the conventional model. Students with high KKM levels have the best learning outcomes compared to students with medium and low KKM levels. In addition, there is also an influence between learning models and KKM on student learning outcomes in the Pythagorean theorem material.

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