

The Influence of *Project Based Learning Model* to Students' Problem-Solving Abilities on The Material of Cubes and Blocks

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Abstract

This study aimed to find out the influence of the Project Based Learning model on students' mathematical problem-solving abilities on cube and block lesson for eighth grade in SMP Negeri 8 Bengkulu City. This study was quasi-experimental research with The Nonequivalent Posttest Only Control Group Design. The population of this study was all eighth-grade students of SMP Negeri 8 Bengkulu City in academic year of 2022/2023. The samples of this study were students of class VIII-3 as the experimental class that used the Project Based Learning model and students of class VIII-4 as the control class that used a conventional learning method who were selected through purposive sampling. The instrument used in this study was a problem-solving ability test sheet. The results of hypothesis testing showed that the value $t_{count} > t_{table}$ which was $2.751 > 1.671$. The results of this study indicated that there was an influence of the application of the Project Based Learning model on students' mathematical problem-solving abilities on cube and block lesson for eighth grade in SMP Negeri 8 Bengkulu City.

Keywords: Problem Solving Ability, Conventional, Project Based Learning.

1. Introduction

One of the objectives of mathematics learning contained in Permendikbud Number 58 of 2014 is problem-solving ability, which includes students' ability to understand problems, build mathematical models, solve models, and interpret solutions obtained (Kemendikbud, 2014). Problem solving is one of the important mathematical abilities and needs to be mastered by students who learn mathematics (Hendriana et al., 2017). Polya (1973) Problem solving is an effort to find a way out of a difficulty in order to achieve a goal that is not so easy to achieve immediately. So it can be said that problem solving is a process related to efforts to solve a problem. As for troubleshooting indicators according to Polya (1973) are: understanding the problem, developing a plan, executing the plan, and re-examining.

In mathematics subject, students must have problem-solving skills to solve problem-based problems (Sumartini, 2016). But in fact, what is found in schools shows that students' mathematical problem-solving abilities are still low (Asih & Ramdhani, 2019). Related to measuring the interpretation of student learning outcomes including problem solving for other surveys, namely test results *Programme for Internasional Student Assesment (PISA) Indonesia* in 2022 is ranked 70th out of 81 countries participating in the test. The average math score of Indonesian students is 366, quite far below the average score *Organization for Economic Coopertaion and Development (OECD)* i.e. 472 (OECD, 2023). This fact shows that students' mathematics skills in Indonesia are still relatively low. This means that there are still many students in Indonesia who have difficulty in dealing with situations that require problem-solving skills using mathematics, this means that mathematics learning objectives have not been implemented optimally where one of the important components in mathematics learning objectives is problem-solving skills.

The low problem-solving ability of students at school can also be seen from the way students solve a problem, this is evidenced by the initial ability test by giving one question to grade VIII students of SMPN 8 Kota Bengkulu. The results showed that from a total of 27 students, 33.3% could not understand the problems given, as many as 56.8% could not plan problem solving, as many as 72.2% could not solve problems as planned, and as many as 83.3% could not re-examine the answers obtained and write down the conclusions of the answers. Based on the results of observations and interviews with one of the grade VIII mathematics teachers of SMP Negeri 8 Kota Bengkulu, it can be said that students' problem-solving abilities are still low, students are not used to doing non-routine questions, they are only used to doing questions using formulas and sample questions that the teacher gives. So that when given non-routine questions, students will have difficulty in understanding the concepts or information contained in the questions, and translating questions related to everyday life into mathematical language. This statement is in line with research Sulistiyorini & Setyaningsih (2016) It was found that, low problem-solving ability because students are not used to doing problems that require problem-solving steps, students do not understand the concept of the material, students cannot make mathematical models, and students have not been able to manage work time well, lack of accuracy and seem careless. This is also in line with the low ability of SMP/MTS students in Bengkulu City in solving TIMSS-based math problems, especially in mastery of geometry material with a percentage of 36.39% (Susanta et al., 2021). This fact shows that geometry material is a difficult material for students, even though geometry is closely related to everyday life, so it is not uncommon for problems to arise in everyday life that are related and require the application of geometry concepts (Imawan, 2015).

Students' mathematical problem-solving ability is still low due to several things, one of which is due to learning activities that are still teacher-centered and the use of learning approaches that are still irrelevant (Fatimah, 2016). So teachers should be able to choose and apply a more effective learning model to be presented in accordance with the form of material to be delivered in the ability to solve mathematical problems (Nurfitriyati, 2016). Learning that can be applied to overcome student problems in solving this problem is learning that is able to foster student independence, emphasize student participation and activity, and develop student skills in solving problems (Azizah & Wardani, 2019). One of the learning models that can be used and is expected to be able to overcome these problems is the learning model *Project Based Learning*.

Project Based Learning (PjBL) is a learning model that uses projects or activities as learning media. This learning model uses problems as the first step in collecting and integrating new knowledge based on their experience in real activities (Hosnan, 2016). In the process of solving problems, questions will arise in students about what is known from the given problem, what concepts are related to the problem, what is not yet known about the problem, and what is the core of the problem (Prasekti & Marsigit, 2017). So that by applying the PjBL model, it is hoped that student learning will be more meaningful, give a strong impression, and help students overcome difficulties in solving mathematical problems (Hasibuan et al., 2022).

The PjBL model has previously been studied by Nurlatifah (2019) and Maya Nurfitriyanti (2016) with the results of his research stated that there is an influence of the application of the PjBL model on problem solving ability, where the mathematical problem solving ability of students with the PjBL model is better than the mathematical problem solving ability of students with conventional learning.

Based on the background above, the researchers are interested in conducting a study entitled *The Influence of Project Based Learning Model to Students' Problem-Solving Abilities on The Material of Cubes and Blocks in Class VIII at SMP Negeri 8 Kota Bengkulu*.

2. Method

This research used pseudo-experimentation (quasi experiment). The design in this study used The Nonequivalent Posttest Only Control Group Design, i.e. by using two different groups. This study aims to see the influence of learning models *Project Based Learning* to students' problem-solving abilities. The research design that the researchers used was as follows:

Table 1. Research Design

Experimental	X	O_1
Control	-	O_2

Source : Modification (Sugiyono, 2022)

Information:

X : The practice given is the PjBL learning model

O_1 : *Posttest* experimental class after PjBL treatment

O_2 : *Posttest* control class that is not given treatment / conventional

This research was conducted at SMPN 8 Kota Bengkulu. The population in this study is all grade VIII students of SMPN 8 Kota Bengkulu for the 2022/2023 school year and the sample in the study, namely grade VIII 3 as an experimental class that is treated using a model *Project Based Learning* and class VIII 4 as a control class that uses conventional learning. Research samples were selected using techniques *purposive sampling*, namely by considering the results of the even midterm test for the 2022/2023 school year, then reviewing the average scores that are not much different and testing homogeneity and normality of data by obtaining the results of the data of the two classes are normal and homogeneous considering classes with almost the same average value (homogeneous). *Purposive sampling* is a sampling technique with certain considerations (Sugiyono, 2022).

In this study, there are two variables, they are independent variable and dependent variable. Independent variable are variable that affect a dependent variable. While the dependent variable is a variable that is influenced or that arises and becomes a result due to the existence of an independent variable (Lestari & Yudhanegara, 2015). The independent variable in this study is the learning model. In the experimental class using the PjBL model and in the control class using a conventional model. The dependent variable is the student's mathematical problem solving ability.

Data collection techniques in this study were carried out by providing problem-solving ability test questions at the end of learning (*posttest*). Before the test instrument sheet is given, the test instrument sheet is first carried out a logical validation test by three validators. After being declared valid by the validator, the test question instrument is tested in the trial class, to see the empirical validity calculated using the correlation coefficient formula *product moment pearson*, reliability of using *alpha cronbach* is in the high category, the level of difficulty with medium and difficult categories and the distinguishing power with minimal categories are sufficient. The test instrument used in this study was in the form of 5 questions in the form of descriptions. The scoring criteria for indicators of students' problem-solving ability can be seen in the table below:

Table 2. Problem Solving Ability Assessment Rubric

Assessed Aspects	Score	Analytic Rubric
		Information
Understanding the Problems	0 :	No answer at all
	1 :	All description which are being asked is incorrect
	2 :	All description which are being asked is incompletely/inaccurately
	3 :	All description which are being asked is right and complete
Devising Plan	0 :	Didn't write down a resolution plan at all.
	1 :	The settlement plan made is incorrect.
	2 :	Write a solution plan accurately but incompletely.
	3 :	Write down the settlement plan correctly and completely.
Carrying Out the Plan / Getting Answers	0 :	No answer at all.
	1 :	Wrong answer because the plan is not appropriate
	2 :	Carrying out the problem solving with appropriate but incomplete plans.
	3 :	Carrying out the problem solving with a precise and complete plan but incorrect in calculations
Rechecking the truth of the answers and conclude the answers	4 :	Carrying out the problem solving and correct answers
	0 :	Not rechecking the answers and not concluding the answers
	1 :	Write down the conclusions but the answers are incorrect.

Analytic Rubric		
Assessed Aspects	Score	Information
	2 :	Write down the conclusions and the answer are clear and correct.

Source: Modification (Ariani et al., 2017)

Furthermore, the results of the problem-solving ability test that students have done are calculated using:

$$P = \frac{\text{Scores obtained by students}}{\text{Maximum score}} \times 100$$

Source: (Hermawati et al., 2021)

Based on the results of the problem-solving ability test obtained by students, the percentage of students' mathematical problem-solving ability is grouped according to the following qualifications:

Table 3. Category of Problem-Solving Skill

Percentage of Value Achievement	Category
$75 < P \leq 100$	High
$60 < P \leq 75$	Medium
$0 < P \leq 60$	Low

Source: (Hermawati et al., 2021)

Data analysis techniques in this study use descriptive statistical analysis and inferential statistical analysis which will be carried out in two stages, namely analysis prerequisite tests and hypothesis tests. The prerequisite tests of the analysis carried out are normality tests and homogeneity tests. The data normality test is carried out to find out whether the data is normally distributed or not, while the homogeneity test is carried out to find out whether the data variance is homogeneous or not. The normality test in this study was calculated using Shapiro Wilk's formula as follows:

$$T_3 = \frac{1}{D} [\sum_{i=1}^n a_i (X_{n-i+1} - X_i)]^2 \text{ with } D = \sum_{i=1}^n (x_i - \bar{x})^2$$

The calculation of the data normality test is practiced using *software* SPSS. The normality of the data can be seen from the significance value, if the significance value $>$ the real level (α) = 0.05 then both data are normally distributed and if the significance value is $<$ real level (α) = 0.05 then the two data are not normally distributed. After the data normality test was carried out, the homogeneity test was carried out using the Fisher formula as follows:

$$F = \frac{\text{Largest variance}}{\text{Smallest variance}}$$

Source: (Sugiyono, 2022)

If $F_{count} \leq F_{table}$ then variance is homogeneous, whereas if then variance data is not homogeneous $F_{count} > F_{table}$ (Anwar, 2009). The real rate used is 5% with and $dk_1 = n_1 - 1$ $dk_2 = n_2 - 1$. After calculating the prerequisite analysis test and finding that the data is normally distributed and homogeneous, then the hypothesis test calculation is carried out. The hypotheses in this study are as follows:

H_0 : $\mu_1 = \mu_2$ There is no influence on the application of the Project Based Learning model on the mathematical problem solving abilities of class VIII students at SMP Negeri 8 Bengkulu City

$H_1 : \mu_1 > \mu_2$ There is an influence on the application of the Project Based Learning model on the mathematical problem solving abilities of class VIII students at SMP Negeri 8 Bengkulu City

The hypothesis test in this study was carried out using a two-sample independent t-test with the following formula:

$$t_{count} = \frac{\bar{X}_1 - \bar{X}_2}{S_{combination} \sqrt{\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \text{ with } S_{combination} = \sqrt{\left(\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1 + n_2 - 2}\right)}$$

Source: (Lestari & Yudhanegara, 2015)

The significance of the t-count value is compared to the t-table value. The criteria used for hypothesis testing are H_0 accepted if $t_{count} \leq t_{table}$ and H_0 rejected if $t_{hitung} > t_{tabel}$ where the t-table is obtained from the distribution list t with $dk = n_1 + n_2 - 2$ and $\alpha = 0.05$.

3. Results and Discussion

This research was conducted at SMP Negeri 8 Kota Bengkulu in the even semester of the 2022/2023 academic year starting on May 15, 2023 until May 27, 2023. The research sample is class VIII 3 as an experimental class using the PjBL learning model and VIII 4 as a control class using conventional learning, each class totaling 31 students. In the learning process in the experimental class using the PjBL model, it is carried out with the help of student worksheets (LKPD) the project to be produced is in the form of props for cube and block parts (skeletons), cube and block nets, and cube and block volume props. After the learning process was carried out in class VIII 3 as an experimental class and VIII 4 as a control class, then both classes were given *posttest questions* (problem solving ability tests). The results of descriptive calculations of *posttest* data in both sample classes calculated using SPSS are presented in Table 4.

Tabel 4. The Result of Descriptive Data (Post-test)

Description	Information	
	Experiment Class	Control Class
Total Students	31	31
Average	68,76	52,90
Median	75	50
Highest Score	100	93
Lowest Score	25	15
Experiment	X	23,91
Control	-	571,82
Skewness	-0,538	0,156

Based on Table 4, it can be seen that the results of the problem-solving ability test in the experimental class are higher than in the control class. Analysis of the achievement of students' problem-solving abilities is carried out by looking at the results of the final test (*posttest*) that has been given to the experimental and control classes. Data analysis in this study showed that the average *posttest results of the experimental class (VIII 3) with the PjBL model were higher than the average obtained by the control class (VIII 4) with conventional models*. The average *posttest* results of both classes were 68.76 for the experimental class and 52.90 for the control class.

From value *posttest* It was also found that the achievement of the problem-solving ability level of experimental class students as many as 15 students were in the high category, as many as 6 students were in the medium category, and as many as 10 students were in the low category. While the level of problem solving ability of students in the control class as many as 7 students were in the high category, as many as 5 students were in the medium category, as many as 19 students were in the low category. In addition, the achievement results for each student problem solving indicator in the experimental class

were higher than the control class. The following is presented the percentage of achievement of students' mathematical problem solving ability in Table 5.

Table 5. Percentage of KPM Indicator Achievement

Indicator	Experiment Class			Control Class		
	Σ Score Question Items	Total Score	Percentage of Correct (%)	Σ Skor Question Items	Total Skor	Percentage of Correct (%)
Understand the Problem	374	465	80%	294	465	64%
Arrange the plan	332	465	71%	263	465	57%
Implement the plan	447	620	72%	354	620	57%
Re-checking	126	310	41%	71	310	23%
Average			66%			50%

Based on Table 5, it shows that the average achievement of the experimental class is 66% with the medium category and the average achievement of the control class is 50% with the low category. In addition, we can also see that the lowest percentage of indicators is in the fourth indicator, which is checking back, because there are still many students who do not check again to ensure the answers obtained. The low ability of students in the fourth indicator is to re-examine in line with research conducted by Fitriani (2020) Where 56.72% of students are less able to re-examine.

After obtaining the results of descriptive statistics of the problem-solving ability test, then the result data *posttest* In both classes, the sample will be tested for analysis prerequisites before the hypothesis test is carried out. The prerequisite tests carried out before the hypothesis test are the normality test and the homogeneity test. The summary of prerequisite test results is presented in Tables 6 and 7.

Table 6. The Result of Normality Test (Post-test)

Class	Sig. Value	Sig. Level	Remark
Experiment	0,082	0,05	Normally Distributed Data
Control	0,076	0,05	Normally Distributed Data

Based on Table 6, it was found that from the results of the problem solving ability test of students, the significant value of the experimental class was $0.082 > \alpha = 0.05$ and the significant value of the control class was $0.076 > \alpha = 0.05$, so that the experimental class and control class data could be declared normally distributed.

Table 7. The Result of Homogeneity Test (Post-test)

Sig. Score	Sig. Level	F_{count}	F_{table}	Remark
0,328	0,05	1,25	1,84	Homogen Data

Based on Table 7, it is found that the data from post-test of problem solving ability have a sig value. = $0.328 >$ significant level (α) = 0.05 and it is also obtained that the value of \leq so that it can be concluded that the variance of both data from the sample class is homogeneous. $F_{count} = 1,25 F_{table} = 1,84$

After the prerequisite test analysis is met, it proceeds to hypothesis testing. Hypothesis testing in this study uses t tests for two independent samples or independent Sample t-Test. The calculation results of the t test are as follows:

Table 8. Hypothesis Test Results

t_{count}	t_{table}	Status
2,751	1,671	Rejected H_0

Based on the hypothesis test that has been carried out on the results of the problem-solving ability test of experimental class students and control classes which show that the value $t_{count} = 2,751 > t_{table} = 1,671$ so that the results are H_0 rejected and H_1 accepted means that the mathematical problem solving ability of students taught using the PjBL model is higher than the problem-solving ability of students taught using conventional models. Therefore, it can be concluded that there is an influence of the application of the *Project Based Learning* model on students' problem-solving abilities in class VIII cube and beam material of SMPN 8 Bengkulu City.

Based on the results of the study, it can be seen that this research is in line with previous research. In previous studies, similar results were obtained by Nurfitriyanti (2016) that Mathematical problem solving skills taught using *Project Based Learning* better than what is taught with expository learning models and research conducted by Sasmita et al. (2021) That is, there is a significant increase in problem-solving skills for classes that use learning models *Project Based Learning*. Relevant research studies prove empirically that project-based learning has a positive impact on students' thinking skills, where one of these abilities is problem-solving skills.

The problem-solving ability of experimental class students is better than the problem-solving ability of control class students because of learning *Project Based Learning* Students are directly involved in finding their own solutions to complete projects, besides that learning is carried out in groups making it easier for students to work together and exchange information (Sasmita et al., 2021). The learning process using this model motivates students to get the best experience about a particular task or project (Gunawan et al., 2017).. In the first syntax of PjBL, namely: *start with the essential question*, learning begins with the fundamental question of how to solve a problem. So students must first understand the problem and then students plan a project that will be made to help them solve the given problem. This is because PjBL has characteristics that support student activities in solving problems (Solong et al., 2022). Therefore, through learning with LKPD which is equipped with PjBL stages can make students become more trained in understanding problems. The second syntax is *design a plan for the project* After being given a problem, students then plan a project that will be made to help them solve the problem. After the project is completed, students are able to find concepts/formulas that can be used. So that at this stage it can lead students to become more trained in preparing plans in the form of formulas that will be used in solving problems. This is in line with research Sofyan et al. (2021) where at the stage *design a plan for the project* The teacher makes plans that include the rules of the game, the selection of activities that support answering essential questions, and determining the tools and materials needed. The achievement of indicators of implementing plans in higher experimental classes is due to the application of the PjBL learning model. Where in PjBL students are required to be able to solve problems in accordance with the plan that has been made before. This is in line with research Nurfitriyanti (2016) where in the implementation of PjBL learning students are encouraged to use their knowledge that they already have to find solutions to existing problems, while teachers only facilitate and supervise the course of the learning process. So that students with PjBL learning are better trained in solving contextual problems. As with other indicators, the indicator of re-examining the experimental class is also higher than the control class, because in PjBL learning students are accustomed to solving contextual problems in LKPD according to the stage of problem solving indicators. So that students in the experimental class are more accustomed to re-examining and writing down the conclusions of the answers to the problems that have been solved.

Project Based Learning can affect students' problem-solving abilities because project-based learning raises a contextual problem that is proven to be able to train students to identify problems, formulate problems, analyze problems, make conclusions, and make problem-solving solutions (Solong et al., 2022). In the PjBL model, learning is designed in the form of groups given a problem so that students will be more active, both in terms of cooperation, expressing opinions, and presenting the results of projects that have been made. Meanwhile, in the control class using conventional learning, the class is only dominated by teaching from the teacher, thus causing a lack of reciprocity between teacher and student so that students tend to be passive. In the conventional teaching and learning process, learning generally takes place in one direction which is the transfer or transfer of information, norms, values, and others from a teacher to students. This kind of process is built on the assumption that the student bottles blank or white paper. Where the teacher must fill the empty bottle or white paper (Helmiati, 2012). This results in students being passive, easily saturated, lacking initiative, and

dependent on the teacher (Amin & Sumendap, 2022). Based on the discussion above, it can be concluded that there is an influence of the application of learning models *Project Based Learning* to students' mathematical problem-solving abilities

4. Conclusion

Based on the results of data analysis, value is obtained $t_{count} = 2,751 > t_{table} = 1,671$ With a real level of 0.05 so that the results are obtained that the mathematical problem solving ability of students taught using a learning model *Project Based Learning* higher than the mathematical problem-solving ability of students taught using conventional learning. Therefore, it can be concluded that there is an influence on the application of learning models *Project Based Learning* to students' problem-solving abilities. Thus, based on the results of research that has been conducted at SMP Negeri 8 Kota Bengkulu using the learning model as an independent variable and problem solving ability as a dependent variable, it is stated that there is an influence of mathematics learning using the model *Project Based Learning* (PjBL) on students' mathematical problem solving abilities, so that the learning model can be an alternative mathematics learning that teachers can apply.

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