

META-ANALYSIS OF THE INFLUENCE OF PROJECT BASED LEARNING (PjBL) MODEL ON PHYSICS LEARNING OUTCOMES IN SENIOR HIGH SCHOOL

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ABSTRACT

Many studies related to the application of the PjBL model to student learning outcomes have been published in national and international journals. One of the studies that is able to summarize the results of existing studies as a whole is meta-analysis research. Meta-analysis research is quantitative in nature because it uses statistical calculations to summarize all research results which are not possible with other research methods. The data analysis technique used in meta-analysis research is to calculate the effect size of the related research. Based on the results of the study, three research results were obtained, namely the use of the PjBL model on high school physics learning outcomes had an effective influence on learning outcomes of knowledge and skills, class X and XI levels as well as physics subject matter units in high school, namely optical devices, simple harmonic motion, static fluid, dynamic fluid, newton's law, impulse and momentum, straight motion, heat, and work and energy. However, the use of the PjBL model is less effective for dynamic electric matter units, elasticity, and Kepler's law due to certain factors.

Keywords: Meta Analysis; PjBL Model; Physics Learning Outcomes



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I. INTRODUCTION

In the learning process, teachers are required to be more sensitive to the conditions or factors that affect the low quality of education, namely student learning outcomes. In an effort to improve quality, both the process and the results of teaching are the responsibility of the teacher. The teaching system that is seen as capable of giving hope and improving the learning situation is a teaching system with active learning. The active learning model is a learning model that is able to create certain conditions that motivate students to be active in the learning process.

The PjBL model is a learning model that is centered on student activity in the learning process. According to [1] the advantage of the PjBL model is that it can improve problem solving abilities, critical thinking skills, creativity, creative thinking skills and student achievement. This PjBL model is expected to be able to provide a more meaningful learning experience for students during the learning process in the classroom. Thus, student learning outcomes in the classroom can improve better than before.

In article [2] it was stated that there was an increase in student learning outcomes, where previously the control class average value was 61.29 to 70.24 higher after using this PjBL model. In line with this research, [3] in the article it was stated that the use of the PjBL model was able to increase student learning outcomes by 29.67 compared to the control class which only increased by 21. Then [4] in the article it was stated that students' creative thinking abilities increased by applying the model PjBL is 74.46 compared to conventional learning which is 68.30 lower.

Many studies related to the application of the PjBL model to student learning outcomes have been published in national and international journals. Various attempts to summarize the results or conclusions of these studies have been carried out. One of the studies that is able to summarize the results of existing studies as a whole is

meta-analysis research. Meta-analysis research is a research method that is increasingly popular to be used to summarize research results using existing research data.

The meta-analytic research was chosen for several reasons, including: 1) First, previous studies only determined the effect of the PjBL model on physics learning outcomes in high school in only one aspect, 2) Second, previous research only examined one grade level in high school, and 3) Third, previous research only examined one subject matter only. Therefore, this study is entitled "Meta Analysis of the Influence of Project Based Learning (PjBL) Models on Physics Learning Outcomes in Senior High School".

II. METHODS

The type of research used is meta-analytic research with a quantitative approach. Meta-analysis research is quantitative in nature because it uses statistical calculations to summarize all research that is not possible with other research methods. According to [5] meta-analysis research is research conducted by summarizing, reviewing and analyzing research data from several previous research results. Research data collection was carried out by researchers by browsing articles in national and international accredited journals online starting from 2011-2021.

There are 3 variables in this study, namely the independent variable, the dependent variable, and the moderator variable. The independent variables of this study are the PjBL model, the dependent variable is the learning outcomes of physics in high school and the moderator variable is the learning outcomes in aspects of knowledge and skills, class level, and subject matter units. The data analysis technique used in this meta-analysis research is to calculate the effect size of several related articles. The following are the steps for determining the effect size in meta-analytic research:

1. Calculating effect size using Cohen's d equation contained in the book "Introduction to Meta Analysis" by H. Retnawati, et.al [6].
2. Calculating the mean effect size using the Random Effect (RE) model or the Fixed Effect (FE) model.
3. Interpret the results of the calculation of the effect size of each study which can be stated as follows [7]:
 - a. If $ES \leq 0,15$, in category negligible;
 - b. If $0,15 < ES \leq 0,40$, in category low;
 - c. If $0,40 < ES \leq 0,75$, in category medium;
 - d. If $0,75 < ES \leq 1,10$, in category high; and
 - e. If $ES > 1,10$, in category very high.

III. RESULTS AND DISCUSSION

Based on the research that has been done, the results obtained from data processing for this research. The following is the result of calculating the effect size value of the large influence of the PjBL model on high school physics learning outcomes on learning outcomes of knowledge and skills, grade X and XI levels, and subject matter units.

1. Effect Size Effect of PjBL Model Based on Learning Outcomes of Knowledge and Skills

Table 1. Result Data Mean Effect Size Effect of PjBL Model on Physics Learning Outcomes In Senior High School Based on Learning Outcomes of Knowledge and Skills

Student learning outcomes	N	ES	SE	Category	p	95% Confidence Interval	
						Lower	Upper
Knowledge	18	0.788	0.066	High	0.000	0.660	0.917
Skills	2	1.225	0.214	Very high	0.000	0.318	2,132

Based on the results of the analysis using the RE model, the mean effect size of the influence of the PjBL model on high school physics learning outcomes in the aspects of knowledge and skills is 0.788 and 1.225. The results of testing the hypothesis for learning outcomes in the aspects of knowledge and skills show that the hypothesis was rejected because the p test value obtained was smaller than the value of α (0.05).

2. Effect Size Effect of PjBL Model Based on Class Level

Table 2. Result Data Mean Effect Size Effect of PjBL Model on Physics Learning Outcomes In Senior High School Based on Class Levels

Class Levels	N	ES	SE	Category	p	95% Confidence Interval	
						Lower	Upper
X	10	0.811	0.097	High	0.000	0.620	1,002
XI	11	0.856	0.105	High	0.000	0.651	1,061

Based on the results of the analysis using the RE model, the mean effect size of the PjBL model in physics learning in class X was 0.811 with a 95% confidence interval between 0.620 and 1.002. The results of the analysis for the mean effect size of the influence of the PjBL model on learning outcomes of high school physics in class XI are 0.856 with 95% confidence intervals ranging from 0.651 to 1.061. The results of hypothesis testing for both grade levels showed that the hypothesis was rejected because the p test value obtained was 0.000 which was smaller than the value of α (0.05).

3. Effect Size Effect of PjBL Model Based on Subject Matter Unit

Table 3. Result Data Mean Effect Size Effect of PjBL Model on Physics Learning Outcomes In Senior High School Based on Subject Matter Units

Subject matter	N	ES	SE	Category	p	95% Confidence Interval	
						Lower	Upper
Optical Tools	2	0.822	0.302	High	0.006	0.231	1.413
Simple Harmonic Motion	3	0.754	0.153	High	0.000	0.453	1.055
Dynamic electricity	1	0.403	0.251	Low	0.108	-0.089	0.895
Static Fluids	2	0.815	0.208	High	0.000	0.407	1.223
Dynamic Fluids	3	1.124	0.299	Very high	0.000	0.538	1,710
Newton's laws	2	0.803	0.222	High	0.000	0.369	1.238
Impulse and Momentum	1	0.967	0.276	High	0.000	0.427	1.507
Straight Motion	1	1.315	0.281	Very high	0.000	0.764	1,866
Elasticity	1	0.635	0.310	Currently	0.040	0.028	1,242
Heat	1	1.124	0.274	Very high	0.000	0.587	1,661
Kepler's law	1	0.427	0.237	Low	0.071	-0.037	0.891
Worl and Energy	1	0.768	0.228	High	0.001	0.321	1.215

Based on the results of the analysis using the RE and FE models, it was obtained the mean effect size of the influence of the PjBL model on high school physics learning outcomes in each subject matter unit. The results of testing the null hypothesis for material optical devices, simple harmonic motion, static fluid, fluid dynamics, Newton's law, impulse and momentum, straight motion, elasticity, heat and work and energy show that the hypothesis is rejected because the test value is p-value obtained is smaller than the value α (0.05). However, the results of testing the null hypothesis for dynamic electric matter and Kepler's law show that the null hypothesis is accepted because the p-value test value obtained is greater than the value α (0.05).

From the results of the study, three categories of research results were obtained based on the calculation of the effect size results of each related study. First, the effect of using the PjBL model on high school physics learning outcomes has a high effect on knowledge learning outcomes and a very high effect on skills learning outcomes. This shows that the use of the PjBL model for high school physics learning outcomes has a positive effect on knowledge and skills learning outcomes. According to [8] learning with the PjBL model can solve problems in everyday life because students can directly discover concepts through practicums that are carried out. In accordance with the opinion of [9] which suggests that the PjBL model can increase student understanding so that learning outcomes increase.

Second, the effect of the PjBL model on high school physics learning outcomes based on class level has a very high effect on class XI compared to class X. This is because students in class XI are able to be independent by age. If students are already independent, then applying the PjBL model is certainly no longer difficult to do in the learning process. In addition, according to [10] the application of the PjBL model with a more mature age can take place in an orderly and regular manner so as to create learning that describes the environment in which students learn. This is in accordance with the results of research [11] which states that the application of the PjBL model is effective for improving student learning outcomes.

Third, the effect of the PjBL model on high school physics learning outcomes based on subject matter units has a very high effect on fluid dynamics, rectilinear motion and heat material units and has a high effect on optical equipment material units, simple harmonic motion, fluid statics, law newtons, impulse and momentum, and work and energy. This is in accordance with research conducted by [12] that there is a significant influence between students' physics learning outcomes in straight motion material through the application of project-based learning models. This is because examples of applying straight motion material are easy to find in everyday life. In the unit of matter elasticity, dynamic electricity, and Kepler's laws have a very low effect due to certain factors. This means that the use of the PjBL model for high school physics learning outcomes provides different effect sizes for high school physics learning outcomes.

The limitations in this research are expected to be learning and experience for further research. The limitations of this meta-analysis research that is, the articles analyzed in this study are only 20 articles so the scope of articles analyzed in this study is not too broad. This is because many researchers find articles that do not explain the standard deviation or the number of research samples so that effect size calculations cannot be done in this study. It is hoped that subsequent researchers will find reliable websites that contain various articles needed for research. The mean effect of the PjBL model on physics learning analyzed at the high school education level is only at the level of class X and class XI, while for class XII there is none. This is because the article that discusses the influence of the PjBL model on class XII physics learning is very small and does not meet the criteria for selecting articles for analysis.

The articles in each material in physics learning using the PjBL model there are 7 articles that can only be analyzed 1 article per subject matter and articles on skill learning outcomes only 2 articles can be analyzed, so the standard error of the calculation of the mean effect size of the article is greater because the sample used is small. Such are some of the limitations in the meta-analysis research that researchers found. The limitations of this research can be minimized for further research with the right solution so that the research objectives are well met by the researcher.

IV. CONCLUSION

Based on the results of the meta-analysis research that has been done, three research results are obtained. First, there is an effective influence on the application of the PjBL model on high school physics learning outcomes in the aspects of knowledge and skills. Second, there is an effective influence on the implementation of the PjBL model on the learning outcomes of high school physics based on grade X and XI levels. Third, there is an effective influence for the application of the PjBL model on the learning outcomes of high school physics in the unit material for optical instruments, simple harmonic motion, static fluid, fluid dynamics, Newton's law, impulse and momentum, rectilinear motion, heat, and work and energy. However, the effect of applying the PjBL model on high school physics learning outcomes in the unit of elasticity material, electrodynamics, and Kepler's laws are less effective due to certain factors.

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