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The Effectiveness of Project-Based Learning (PjBL) on Learning Outcomes; A Meta-Analysis Study

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ABSTRACT
This study aims to analyze the effectiveness of the effect of the Project-Based Learning (PjBL) learning model on student learning outcomes. There were 26 articles analyzed in this study. The articles collected have been published in national journals, international conferences, and international journals for the last 3 years from 2018 to 2021 related to Project-Based Learning (PjBL) and learning outcomes. This research uses a meta-analysis method by calculating the effect size value in each article. Four formulas are used to calculate the effect size value for each article. This research is meta-analysis research based on the form of learning outcomes with the Project-Based Learning (PjBL) model, Year, Type of Integration, Effect Size Value, and Type of Publication. The meta-analysis results show that the average effect size of PjBL on student learning outcomes is high and significant. The Project-Based Learning (PjBL) model is mostly integrated with the Conventional Learning (CvL) model. The order of most publications starts from national journals, international journals, and international conferences, all three of which have an average effect size value in the high category, and there is no publication bias. Based on data analysis, Project-Based Learning (PjBL) can increase students' creativity in learning. Besides, it helps students to be able to think more critically in solving problems. This model can also improve students' skills to help them compete in the 21st century and the era of society 5.0.

Keywords: *Meta-Analysis, Project-Based Learning, Learning model, Learning outcomes.*

1. INTRODUCTION

The Society 5.0 is a technology-based social concept on people/communities. In the 20th century, education focused on information obtained from books. But in the 21st century [1], it focuses on all age groups. Today, people learn not only from books but also from the Internet, information technology platforms, and other sources. Technology and information are sources of knowledge needed in society 5.0 era and the 21st century in preparation for the challenges of the world of work [2].

Success in the world of work is the achievement of the knowledge obtained during education. With education, students will get various experiences in practicing skills and abilities [3]. Everyone needs education because education will make excellent, noble, and intelligent human resources. Integrating Project-Based Learning (PjBL) into education can produce superior skills to increase competitiveness in the 21st century and be able to face challenges in the era of society 5.0 [4].

Project-Based Learning (PjBL) is a learning model that focuses on the students themselves and makes them create a product at the end of their learning. In other words, students are free to move and be active during learning by working on a project to create a product in groups. With the Project-Based Learning (PjBL) model, students will be trained to be active in solving problems and describing those problems in class as well as collaborating with other students [5]. In this model, the teacher states a basic

question or case that exists in the real world and explores it deeper. Students learn the material and compile a project design in groups to overcome the problem. This learning method will be able to encourage students' knowledge and skills. The teacher acts as a moderator and motivator. Students are free to work individually and in groups while the teacher monitors them in class.

Students' creative thinking ability is still low or lacking, so students find it hard to solve a given problem [6]. Lack of creative thinking affects student learning outcomes [7]. In addition, learning in schools is still conventional learning centered on the educators. It affects the students' low ability in understanding the concept of material. The learning activities are less active. Students' critical thinking ability is also low. Therefore, it is difficult to analyze, conclude, and evaluate problems [8].

Many previous studies have been carried out but still, have some limitations. The learning approach with the PjBL model potentially equips students with creative and critical thinking skills. In addition, it can also improve students' work skills through their learning outcomes. Therefore, researches needed in the form of a meta-analysis on the impact of PjBL on student learning outcomes.

2. MATERIALS AND METHODS

This study is meta-analysis study. The articles collected are in English. The journal articles taken were about Project-Based learning (PjBL)'s effect on learning outcomes from Google Scholar. A coding category sheet is a research tool used in conducting the meta-analysis. This coding aims to make it easier to analyze and collect data.

The stages in the meta-analysis can be seen as follows:

1. Collecting articles from 2018-2021 with the keywords Project-Based Learning (Independent Variables) and Learning Outcomes (Dependent Variables).
2. Collecting pretest, posttest, standard deviation, number of samples, and t-test scores for each experimental and control class.
3. Analyzing the value of variance if the standard deviation value is not found in the article.
4. Calculate the effect size value for each item (article) in Table 1 and interpreting it into some criteria in Table 2.

Table 1. Effect Size and Code Formula (Tenti, 2020)

No	Statistical Data	Equation	Formula
1	Average (1 group)	$\mathrm{ES} = \frac{\overline{\mathrm{x}}_{\mathrm{post}} - \overline{\mathrm{x}}_{\mathrm{pre}}}{\mathrm{SD}_{\mathrm{pre}}}$	Fma-1
2	Average (2 groups), Posttest	$\mathrm{ES} = \frac{\overline{\mathrm{x}}_{\mathrm{eks}} - \overline{\mathrm{x}}_{\mathrm{kon}}}{\mathrm{SD}_{\mathrm{kon}}}$	Fma-2
3	Average (2 groups), Pretest & Posttest	$\mathrm{ES} = \frac{\left(\overline{\mathrm{x}}_{\mathrm{post}} - \overline{\mathrm{x}}_{\mathrm{pre}}\right)_{eks} - \left(\overline{\mathrm{x}}_{\mathrm{post}} - \overline{\mathrm{x}}_{\mathrm{pre}}\right)_{eks}}{\left(\frac{\mathrm{SD}_{\mathrm{pre\ kon}} + \mathrm{SD}_{\mathrm{pre\ eks}} + \mathrm{SD}_{\mathrm{post\ kon}}}{3}\right)}$	Fma-3
4	t count	$\mathrm{ES} = \mathrm{t}\sqrt{\frac{1}{n_{eks}} + \frac{1}{n_{kon}}}$	Fma-4

Table 2. Effect Size Category (Tamur & Juandi, 2020)

Effect Size (ES)	Category
-0.15 ≤ *Effect Size*< 0.15	No Effect
0.15 ≤ *Effect Size*< 0.40	Low
0.40 ≤ *Effect Size*< 0.75	Moderate
0.75 ≤ *Effect Size*< 1.10	High
1.10 ≤ *Effect Size*< 1.45	Very High
Effect Size ≥ 1.45	Extremely High

3. RESULTS AND DISCUSSIONS

The basis of this research is the analysis of the effect of the PjBL model on student learning outcomes. The articles carried out in the meta-analysis are articles published in national journals, international conferences, and international journals. There are 26 articles published in the last three years (2018-2021) chosen for this research and coded as MA 1 to MA 26. Below are the results of grouping articles based on statistical data and the effect size of each article on learning outcomes in Table 3. There are six effect size categories in analyzing this article. They are effect size based on the type of overall learning outcomes, the average value of ES based on the type of learning outcomes by integrating PjBL and several other learning models, and the average value of ES based on the type of publication used.

Table 3. Meta-Analysis and Effect Size Recapitulation

No	Meta Analysis Source	Year	Type of PJBL Integration	Effect Size (ES) of Information Data			Type of Journal	Formula
				N_{Tot}	ES	Category		
1	MA 1 [9]	2019	PjBL	38	2.41	EH	Int	Fma-1
2	MA 2 [10]	2021	PjBL	42	1.36	VH	Int	Fma-1
3	MA 3 [11]	2020	DL	40	0.48	Mo	Natl	Fma-2
4	MA 4 [12]	2019	PS	70	1.58	EH	Conf	Fma-2
5	MA 5 [13]	2019	CvL	40	1.08	Hi	Conf	Fma-2
6	MA 6 [14]	2019	CvL	71	0.39	Lo	Conf	Fma-2
7	MA 7 [15]	2020	CTL	70	0.77	Hi	Natl	Fma-2
8	MA 8 [16]	2021	CvL	62	0.76	Hi	Natl	Fma-2
9	MA 9 [17]	2019	CvL	54	0.59	Mo	Natl	Fma-2
10	MA 10 [18]	2019	BBL	30	0.60	Mo	Int	Fma-2
11	MA 11 [19]	2020	HB	50	1.43	VH	Conf	Fma-2
12	MA 12 [20]	2021	CvL	40	1.05	Hi	Int	Fma-2
13	MA 13 [21]	2021	CvL	30	3.69	EH	Natl	Fma-2
14	MA 14 [22]	2019	DLM	284	2.33	EH	Int	Fma-2
15	MA 15 [23]	2018	CvL	54	4.77	EH	Conf	Fma-2
16	MA 16 [24]	2020	CLM	60	0.86	Hi	Natl	Fma-2
17	MA 17 [25]	2021	CvL	48	0.77	Hi	Int	Fma-2
18	MA 18 [26]	2018	PBL	60	0.45	Mo	Natl	Fma-2
19	MA 19 [27]	2021	DL	133	-0.04	NE	Natl	Fma-3
20	MA 20 [28]	2019	CvL	28	1.28	VH	Natl	Fma-3
21	MA 21 [29]	2019	CvL	60	0.32	Lo	Conf	Fma-3
22	MA 22 [30]	2020	CvL	56	0.87	Hi	Natl	Fma-3
23	MA 23 [31]	2020	CvL	65	1.21	VH	Int	Fma-3
24	MA 24 [32]	2019	CvL	40	1.24	VH	Int	Fma-4
25	MA 25 [33]	2020	CvL	36	1.12	VH	Conf	Fma-4
26	MA 26 [34]	2018	CvL	48	1.32	VH	Natl	Fma-4
Average Effect Size(ES)					**1.26**	**Very High**		

Explanation : PjBL: Project-Based Learning; DL: Direct Learning; PS: Problem Solving; CvL: Conventional Learning; CTL: Contextual Teaching and Learning; BBL: Brain Based Learning; HB: Handbook; DLM: Demonstration Learning Model; CLM: Cooperative Learning Model; PBL: Problem Based Learning; Natl: National; Conf: Conference; Int: International; NE: No effect; Lo: Low; Mo: Moderate; Hi: High; VH: Very High; EH: Extremely High; Fma: Formula.

To prove whether the size of the effect size in each study has a difference, a heterogeneity test is carried out. From the results, we can determine what model can be used to calculate the summary effect. From Table 4, the degrees of freedom is (df): 26-1=25. The results of the analysis show that the value of the Q parameter is 20,248 and $p < 0.001$ so that the distribution of the effect size analyzed is heterogeneous with the level of variation in the effect size between studies I^2 = 32,692. It means 32 % of the observed effect sizes have a percentage of viability due to true

heterogeneity. Therefore, a random-effects model can be used to calculate the combined effect size.

Table 4. Fixed and Random Effects

	Q	df	p	I^2
Omnibus test of Model Coefficients	20.248	1	<.001	32.692
Test of Residual Heterogeneity	31.013	25	0.189	

From Table 5, the findings from the meta-analysis can be explained that the impact of using PjBL on student learning outcomes has a high overall effect, the average effect size is 1.26 (very high category). It proved that the PjBL model has a positive impact on student learning outcomes. After using the JASP software, Table 4 shows that the estimated value is 1.263. It means there is a positive and significant correlation between the use of PjBL on student learning outcomes ($z = 4.500$; $p < 0.001$; 95% CI [0.713; 1.813]). The impact of using the PjBL model on student learning outcomes is high (1.263). Overall, with the help of the software, the effect size and confidence interval limits for all meta-analyzed articles are shown in Figure 1. The average confidence interval for all articles was 0.71-1.81, and the average effect size was positive.

Table 5. Mean Of Effect Size Coefficient Using Random Effect Model

					95% Confidence Interval	
	Estimate	SE	z	p	Lower	Upper
intercept	1.263	0.281	4.500	< .001	0.713	1.813

The recapitulation of Project-Based Learning (PjBL) integrated with several other learning models is shown in Table 6. The average effect size result of PjBL integrated into several learning models are in 5 categories, namely low, moderate, high, very high, and extremely high. Two articles only use 1 class group, namely the PjBL model to learning outcomes with an average ES value of 1.89 (extremely high). Two class groups are integrated PjBL model with several other learning models as shown in Table 6. Integration of PjBL with Conventional Learning (CvL) has 15 published articles with an average ES value of 1.36 (extremely high).

Table 6. PjBL Integration Recapitulation

No	Learning Model	Article	Number of Study	Average effect size	Category
1	Only Pjbl	MA 1 and 2	2	1.89	EH
2	PJBL and CvL	MA 5, 6, 8, 9, 12, 13, 15, 17, and 20-26	15	1.36	VH
3	PjBL and DL	MA 3 and 19	2	0.22	Lo
4	PjBL and PS	MA 4	1	1.58	EH
5	PjBL and CTL	MA 7	1	0.77	Hi
6	PjBL and BBL	MA 9	1	0.59	Mo
7	PjBL and HB	MA 11	1	1.43	VH
8	PjBL and DLM	MA 14	1	2.33	EH
9	PjBL and CLM	MA 16	1	0.86	Hi
10	PjBl and PBL	MA 18	1	0.45	Mo

There are three types of article publications, as shown in Table 7. There are 11 articles published in national journal publications with an average 1.00 (high) effect size value. Seven articles are published in international conferences withan average ES of 1.53 (high). Eight other articles are published in international journals with an average ES of 1.37 (high).

The publication bias analysis on this meta-analysis can be seen in Figure 2. It is significant because, in a meta-analysis study, there is usually a bias caused by subjective publications [35-38]. In Figure 1, several studies are out side the graph. However, this funnel plot is not convincing, and it is difficult to conclude whether there is a bias of publication or not. It can be concluded that the funnel plot is symmetrical. This research uses Egger's Test (statistical method) to test the symmetric funnel plot [39-42]. The result is in Table 8.

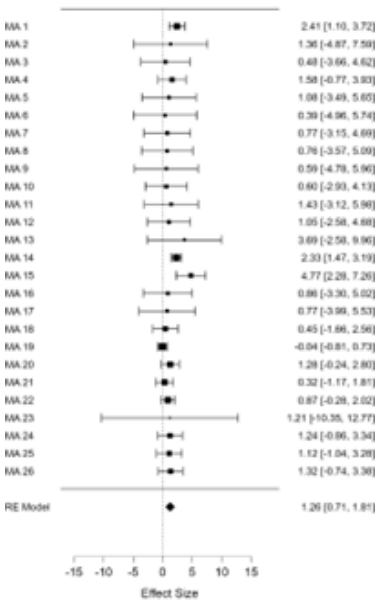

Figure 1. Confidence Interval of Each Article

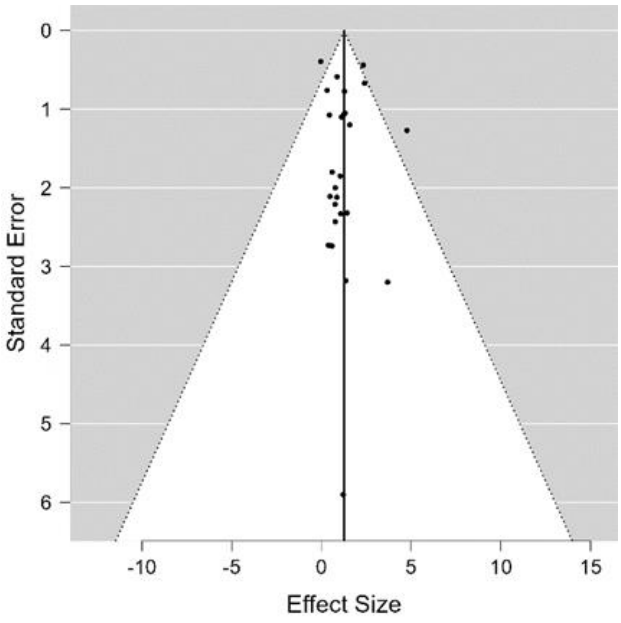

Figure 2. Funnel Plot

Table 7. Publication Type

No	Publication	Article	Number of Research	Average effect size	Cate gory
1	National	MA 3, 7, 8, 9, 13, 16, 18, 19, 20, 22 dan 26	11	1.00	Hi
2	Conference	MA 4, 5, 6, 11, 15, 21, dan 25	7	1.53	EH
3	International	MA 1, 2, 10, 12, 14, 17, 23, 24	8	1.37	VH

Table 8. Egger's test

	z	**p**
sei	0.057	0.954

In Table 8, p is higher than 0.05, it can be concluded that the *funnel plot* is symmetrical and there is no bias publication in this meta-analysis. PjBL is a learning activity that includes a project in helping the students to obtain knowledge. In learning, students are given problems as the first step in collecting and integrating new knowledge [43-46]. After analyzing the problem, they have to solve it, and new knowledge is obtained. Then, it is done in the form of projects. In making this project, students can collaborate with their friends and support each other during team work. Thus, learning will focus on students [47]. Students will be challenged to be more active during learning and also think critically [48] to solve problems.

4. CONCLUSIONS

From the research, the overall effect size is in the very high category. The PjBL model affects learning outcomes, namely in the high category. The magnitude of the effect size and effect of the PjBL model can improve students' skills. Besides, it also increases student creativity and can think critically in solving problems quickly. Project-Based Learning (PjBL) is integrated more with Conventional Learning (CvL) with an extremely high effect size category. Publication bias did not occur in the articles in this meta-analysis.

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