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Effects of the Project-Based Learning Model on Students' Learning Outcomes: A Meta Analysis

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ABSTRACT

Twenty first century education faces a major challenge to prepare students with relevant skills in facing the rapid advancement of technology. One approach that is widely recognized as being able to answer this challenge is the project-based learning model or Project-Based Learning (PjBL). This model emphasizes contextual learning, where students are actively involved in designing, developing, and completing projects that are relevant to the real world. With this approach, students not only learn cognitively but also develop critical thinking skills, collaboration, communication, and creativity. However, although many studies show the advantages of PjBL, the results reported are often diverse and sometimes contradictory. Several studies show that PjBL significantly improves student learning outcomes, both in cognitive, affective, and psychomotor aspects. In contrast, other studies report less significant or even inconsistent impacts. This raises questions about how much influence PjBL has overall on learning outcomes, and what factors influence the effectiveness of this model. To answer this question, a synthesis of data from various studies is needed through a meta-analysis approach. This approach allows researchers to integrate quantitative data from various studies and produce more comprehensive conclusions. This study aims to evaluate the influence of the PjBL model on student learning outcomes as a whole, as well as to identify moderator variables that influence the success of its implementation. The results of the study are expected to provide significant contributions to the development of educational policies and teaching practices at various levels of education.

INTRODUCTION

Education is aspect important in the formation ability of individuals and the development public. Education isn't only a necessity, but also essential things that are capable produce capable generations to compete and adapt on an ever-changing world stage to change and develop (González-Pérez, L. I., & Ramírez-Montoya, M. S., 2022). In the 21st century, education is not only focused on giving information, but also purposeful for developing Skills

and practical and in-depth understanding. One of approach to outstanding learning is Project-Based Learning (PjBL) or learning-based project.

This Project -Based Learning (PjBL) learning model emphasizes experience direct, involvement of active students, and application knowledge in real-world context. The PjBL model directs students to learn through direct experience by designing and completing projects that are relevant to the real world, thus encouraging active engagement and more meaningful learning. PjBL has the potential to improve students' critical thinking skills, creativity, collaboration, and problem-solving abilities, which are important elements in the 21st century learning framework (Almulla, 2020; Chen & Yang, 2019). Several studies have shown that PjBL has a positive effect on student learning outcomes. For example, Chen and Yang (2019) in their meta-analysis revealed that PjBL can improve academic achievement with an average effect size of 0.71. Another study by Maros et al. (2023) showed that the implementation of PjBL in Slovakia resulted in a significant increase in students' critical thinking skills, especially in the context of STEM learning. In Indonesia, Dinantika et al. (2019) also found that PjBL increased students' creativity in renewable energy materials, creating a more interactive and applicable learning atmosphere.

In the learning process, students tend passive Because student only write and listen of course, students also find it difficult for understand concepts given by the teacher because student only memorize principal learning (Mayuni, Rati, & Mahadewi, 2019). Learning model PjBL emphasizes implementation knowledge in context project real, which is possible student for develop Skills collaboration, solving problems, and creativity (Kokotsaki et al., 2016). Research by(C. L. Chiang and H. Lee, 2016) show that learning model PjBL own impact positive to motivation learning and abilities solution problem students at school intermediate vocational. Apart from that, research by Usmeldi & Amini also highlights this enhancement creativity student school intermediate vocational through application of learning models PjBL (Usmeldi & Amini, 2022). Electronic learning media and PjBL integrated with STEM also strengthen the benefits of PjBL in improving creativity, science literacy, and student learning outcomes (Nurhasanah dkk, 2022).

Not only that is, the influence of the learning model PjBL has also researched in context education environment, where approach PjBL effective in increase understanding student to issues environment (Genc, 2014). Besides that, the use of the Project Based Learning model is also influential significant in increase Skills think creative student (Antika & Nawawi, 2017). The project-based learning (PjBL) model can also be used role as step considered alternatives effective for student understand material something eye lesson (Fatimah, Makki, & Umar, 2023). Based learning project (PjBL) provides impact positive for participant educate (Aprida & Mayarni, 2023). From various study it is visible that learning model PjBL own significant impact to results Study students, motivation learning, skills solution problems, creativity, and understanding issues environment.

Although many studies have investigated the effectiveness of PBL in different contexts, this comprehensive analysis of PBL shows its overall impact on student achievement. Research conducted by (Prabawati & Agustika, 2020) learning models-based project only not enough influential in meaning alain only small influence from the project based- learning model. Success learning is not only be measured by how much good students can remember information, but also to what extent they are capable apply knowledge in situation life daily. Therefore, that's important to understand what is the learning model PjBL give contribution significant to enhancement Skills practical and understanding draft student. Meta-analysis is

an effective approach to address the differences in existing research results. This approach allows the synthesis of quantitative data from various studies to provide a more comprehensive picture of the effectiveness of PjBL. Therefore, this study aims to evaluate the impact of PjBL on student learning outcomes from various levels of education through meta-analysis. In addition, this study also aims to identify factors that moderate the effectiveness of PjBL, such as level of education, field of study, and project duration. This study is expected to provide significant contributions to the development of educational policies and the implementation of project-based learning in schools and universities. By understanding the influence of PjBL comprehensively, educators can design learning strategies that are more effective and relevant to the needs of students in the modern era.

METHODS

Study This use meta-analysis method. Meta analysis is research conducted with method summarize, review, and analyze data from a number of research that has been done (Sari, 2020). Objective from meta- analysis research is for now trend quantitative with measure results effect size will be measured difference between group control and group experiment (Antonio & Castro, 2023). Research methods involve collecting studies, grouping them, and calculating effect sizes (Tawfik, 2019). In meta- analysis research this, researcher gather article related to learning models published project-based learning range 2017 to 2023. Search literature done with using the Google Scholar database and assisted with Publish or Perish (Pop) software.

Order Criteria Eligibility and Selection Process fulfil condition for entered in meta-analysis, researchers set criteria inclusion and exclusion explicit for chosen relevant studies. Criteria inclusion is as following: (1) Topic study must about the influence of the project based-learning model; (2) design study must method experimental, quasi-experimental, or mixture with pre-test / post-test; and (3) complete research data must available for meta- analysis. After filtering and no including literature that does not fulfil terms, 20 results article or relevant studies entered for meta- analysis.

RESULTS AND DISCUSSION

Results

As much two tens article fulfil condition in conduct meta- analysis of 500 articles in the literature search. Two tens article This is articles published in 2017 to in 2023. Table 1 summarizes information about related articles with a project based-learning model.

Table 1. The Article Will Analyzed

No	Author & Year	Code	Effect Size
1	Antika & Nawawi, 2017	AR 1	0.552
2	Nahdiah & Handayani, 2021	AR 2	2,266
3	Prabawati & Agustika, 2020	AR 3	0.557
4	Wahyuningtyas, et.al, 2023	AR 4	2.926

5	Pasaribu & Simatupang, 2020	AR 5	0.814
6	Mayuni, et.al, 2019	AR 6	1.222
7	Zahroh, 2020	AR 7	1.027
8	Umamah & Andi, 2019	AR 8	0.564
9	Nugroho, et.al, 2019	AR 9	1.072
10	Roziqin, et.al, 2018	AR 10	1.424
11	Tusyadi, et.al, 2021	AR 11	6.366
12	Kamariah, et.al 2023	AR 12	0.712
13	Fatimah, et.al, 2023	AR 13	0.926
14	Rahmawati, et.al, 2021	AR 14	1.071
15	Fauzi, et. al, 2019	AR 15	1.570
16	Murdani, et.al, 2022	AR 16	0.645
17	Hadi, et. al, 2022	AR 17	0.964
18	Handoyono, et.al, 2020	AR 18	1.628
19	Putra, et.al, 2021	AR 19	1.001
20	Alotaibi, 2020	AR 20	3.622

Heterogeneity Test

The following presents the results of statistical analysis related to testing model coefficients and residual heterogeneity calculated using the Restricted Maximum Likelihood method. (Restricted ML)

Table 2. Fixed and Random Effects

Parameters	Q	df	p
Omnibus test of Model Coefficients	29,264	1	< .001
Test of Residual Heterogeneity	163,997	19	< .001

Note: p - value is estimation.

The model is estimated use Restricted ML method. Analysis results in table 2 show that A total of 20 effect size studies were analyzed is heterogeneous (with Q = 163.997; p < 0.001). With Thus, the random effect model is more suitable used for estimated the average effect size of the 20 studies analyzed. Analysis results This also indicates that there is potency for investigate influencing moderator variables connection between the project based-learning model and results Study.

Table 3. Summary Effect/Mean Effect Size

Coefficients							
		95% Confidence Interval					
Estimate	Standard Error	Estimate	SE	z	p	Lower	Upper
intercept		1,489	0.275	5.410	< .001	0.950	2.029

Note. Wald test.

The results of the random effect model analysis show that there is influence significant positive between the project based-learning model and results Study student (z = 5.410; p < 0.001; 95% CI [0.950;2.029]).

Forest Plot

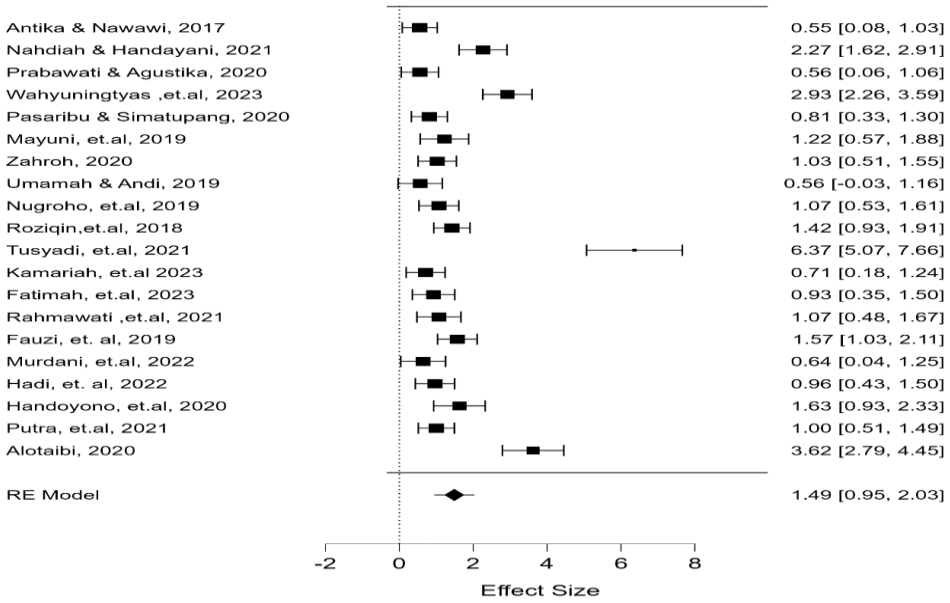

Figure 1. Forest Plot Results

Figure of forest plot above show that effect size of the studies analyzed varying in size between 0.55 to 6.37. This forest plot contains information about names of studies analyzed or writer from the analyzed study. Forest plot also contains information about size of the effect size of each study. There is colored box black in the picture. That box show size from the effect size. The more to right position from box that, then the effect size the taller. As for big and small from size box the show significance from the size effect. The larger size box, then the taller significance from the study, and vice versa the smaller size box, then the lower significant from this study.

Funnel Plots

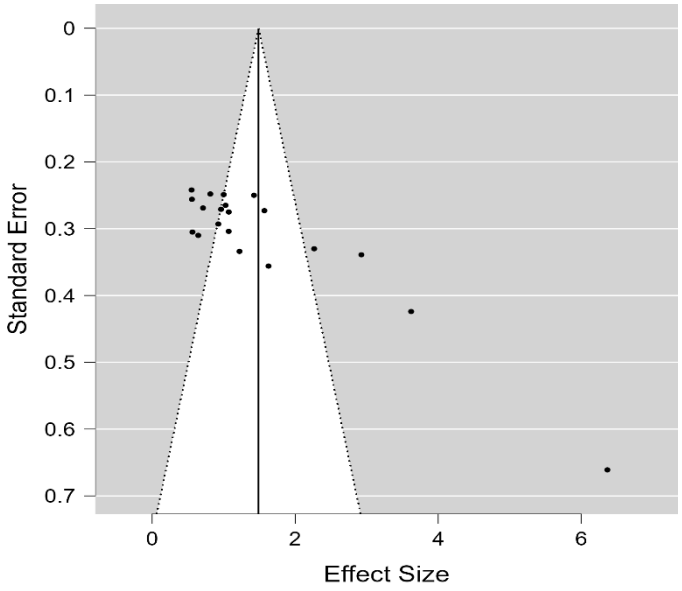

Figure 2. Funnel Plots

The results of the Funnel plot are as in Figure 2 above difficult for concluded is the function of the funnel plot symmetrical or No. So that Egger's test is required for test what is a funnel plot, symmetrical or No. Figure 2 shows a funnel plot commonly used in meta-analyses to detect publication bias. Here is an analysis of this plot: (1) Plot Asymmetry: The funnel plot should ideally be symmetrical if there is no publication bias. In this figure, there is a slight asymmetry, especially in the large effect sizes (bottom right). This could indicate the possibility of publication bias, where studies with small or negative results may be underreported; (2) Spread of Points: The points at the top of the plot (closer to the horizontal axis) are closer together, indicating that studies with small standard errors (large or high-quality studies) have more consistent results. Conversely, the points at the bottom are more spread out, indicating that studies with large standard errors (small or lower-quality studies) tend to be more variable in their results; (3) Interpretation of Large Effects: There are several points very far to the right (large effects). These studies may have very significant results, but it is also important to note whether these effects are supported by a large enough sample size.

Discussion

The results of the meta-analysis show that Project-Based Learning (PjBL) significantly affects student learning outcomes at various levels of education and fields of study. This learning model not only improves cognitive learning outcomes but also contributes to the development of affective and psychomotor aspects. This is in accordance with the findings of Chen and Yang (2019), which showed that the average effect size of PjBL on academic achievement reached 0.71, indicating a strong influence. Although effective, the implementation of PjBL often faces obstacles such as lack of teacher skills in designing projects, time constraints, and lack of infrastructure support. Research by Nurhikmayati and Sunendar (2020) shows that teacher training is essential to improve the quality of PjBL implementation.

The results of this meta-analysis have an important influence on educators. First, the integration of PjBL into the curriculum must be carried out by considering student needs factors. Second, intensive training for teachers needs to be prioritized to improve their skills in designing and implementing projects. Third, the provision of adequate infrastructure,

including access to technology, is essential to support the success of PjBL. With these findings, it is hoped that this research can become a basis for developing more innovative educational policies that are relevant to the demands of the 21st century.

CONCLUSION

Study This find that learning model effective project-based learning in increase results Study student. Although thus, research on several topic Still limited show necessity exploration more carries on. This result offer outlook valuable about the impact of the project based-learning model in learning. Study more carries on must explore learning models project-based learning is carried out more deep analysis subgroups, and investigate topic physics That Still not enough explored in literature. By overall, research This contribute to understanding the use of the project-based learning model in the learning process.

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