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# Combination of Project-based Learning and Flipped Classroom (PjBL-FC) Models on Student Learning Achievement: Meta-Analysis Study

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***Abstract***

*This study aims to examine the effectiveness of the combination of Project-based Learning and Flipped Classroom (PjBL-FC) models on student learning achievement through a meta-analysis approach. This learning strategy is considered potential in developing active and meaningful learning in the 21st century education era. The meta-analysis was conducted on 13 articles published between 2019 and 2024 and met the inclusion criteria, using a random-effects model to accommodate variations between studies. The results of the analysis showed that the PjBL-FC model had a significant impact on improving student learning achievement, with a combined effect size value of g = 1.22 (p <0.01), which is included in the large effect category. However, this study has limitations in the form of high heterogeneity between studies ($I^2$ = 79.61%), limitations in the experimental quantitative research design, and the lack of in-depth exploration of moderator factors, such as student background, digital infrastructure readiness, and quality of learning implementation. Therefore, it is recommended that further research explore the contextual factors that influence the effectiveness of the PjBL-FC model.*

***Keywords***: *project-based Learning, flipped classroom, learning achievement, meta-analysis*

## INTRODUCTION

The transformation of 21st-century learning demands a paradigm shift from traditional learning to learning that fosters critical, collaborative, creative, and communicative thinking skills in students. A one-way teacher-centered approach is considered less relevant to meet the needs of an increasingly complex and dynamic world of education (Dong et al., 2024). Therefore, innovative learning models such as Flipped Classroom and Project-Based Learning (PjBL) have begun to be developed and integrated as an effort to build an active, contextual, and student-oriented learning environment (Köpeczi-Bócz, 2024).

The PjBL-FC integrative model offers pedagogical advantages through meaningful project-based learning and student involvement in collaborative activities, after first studying the material independently outside the classroom through digital media (Zulkifli et al., 2024). This model has been shown to increase active participation, mastery of concepts, and high-level thinking skills such as problem solving and communication (Bashith et al., 2024). In addition, the freedom to learn in a flipped classroom also strengthens students' learning independence, especially in the development of self-regulated learning (Dewi et al., 2024).

Several experimental studies have tested the effectiveness of this combined model, and generally report significant improvements in student learning outcomes (Paramita, 2023; Mumtazah et al., 2024; Novfitri et al., 2024). However, most of these studies were conducted in limited contexts and small sample sizes, so the results cannot be generalized as a whole (Umar & Ko, 2022). In addition, the variation in results between studies and high standard error values make it difficult to draw statistically strong conclusions (Latif et al., 2024).

For this reason, a quantitative synthesis approach in the form of a meta-analysis study is needed to collect and analyze data from various relevant studies, and obtain more accurate and stable effect size estimates (Borenstein et al., 2009; Lipsey & Wilson, 2001). This meta-analysis is important to answer the diversity of previous study results and provide a more comprehensive understanding of the effectiveness of the PjBL-FC model in improving student learning outcomes across levels and subjects.

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Although the Flipped Classroom and Project-Based Learning models have been widely studied experimentally, meta-analytic studies that specifically analyze the integration of the two are still very limited. Most previous meta-analyses only focus on the effectiveness of each model separately, such as those conducted by Köpeczi-Bócz (2024), which highlighted the effect of flipped classroom on learning motivation, or Umar and Ko (2022), which assessed the impact of project-based learning on student engagement. Meanwhile, studies by Andrini et al. (2019) and Dong et al. (2024) have begun to move towards the integration of the two, but are still limited to experimental approaches in limited contexts and subjects. Comprehensive meta-analytic studies evaluating the combined effectiveness of the PjBL and FC models in various educational contexts are not yet sufficiently available, thus not providing a comprehensive picture of the size of their combined effects.

This study aims to quantitatively analyze the effect of the combination of Project-based Learning and Flipped Classroom models on student learning achievement. The results of this study are expected to provide a stronger empirical basis for teachers, curriculum developers, and policy makers in designing innovative, evidence-based learning strategies. In addition, these findings are expected to enrich the theoretical literature on the development of integrated learning models that are relevant to today's educational challenges.

## METHOD

### Research Design

This study uses a quantitative approach with a meta-analysis design, which is a statistical synthesis technique used to combine the results of various primary studies that test the effectiveness of the Project-based Learning and Flipped Classroom (PjBL-FC) combination learning model on student learning outcomes. This approach aims to calculate the overall effect size estimate and identify variations between studies. This meta-analysis refers to the systematic procedures of Borenstein et al. (2009) and Lipsey & Wilson (2001) as the main guidelines in planning, implementing, and reporting.

### Inclusion Criteria

The inclusion criteria in this study were strictly set to ensure that only relevant and quality studies were further analyzed. The included studies were quantitative studies with experimental or quasi-experimental designs that explicitly integrated the Project-based Learning (PjBL) and Flipped Classroom (FC) models in one learning scheme. The selected studies were required to present results in the form of adequate numerical data, such as mean and standard deviation values, t-values, F, or other statistical information that allows the calculation of effect sizes. In addition, only articles published between 2018 and 2025 were included, considering the relevance and sophistication of the integrative learning approach in the context of modern education. Articles must be published in reputable scientific journals in both Indonesian and English, and be available in full access for thorough review. Studies that only evaluated one model (PjBL or FC only), or did not involve a comparison group, were excluded from the analysis because they did not meet the strict criteria for integrating learning models that were the focus of this study.

### Literature Search and Screening

The article search was conducted through several electronic databases such as Google Scholar, ERIC, ScienceDirect, DOAJ, Garuda, and consensus.app. The keywords used include: "project-based learning", "flipped classroom", "student learning outcomes", "PjBL-FC", "combination learning model", and "meta-analysis". The selection process was carried out in stages through identification of titles and abstracts, examination of the full contents of the article, and assessment of suitability with the inclusion criteria. The results of the literature search and screening found nine research samples that met the inclusion criteria

### Data Exctraction

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The data extraction process was carried out systematically on all articles that met the inclusion criteria. Each study that passed the selection was analyzed using a previously prepared coding sheet to ensure data consistency and accuracy. Information collected from each article included author name and year of publication, study design, statistical information such as mean, standard deviation, and sample size in the experimental and control groups. The entire extraction process was carried out manually by reading each relevant article in full.

**Data Analysis**

OpenMEE software is used as the main tool to process and analyze data from various studies that have been collected. The analysis process is carried out through systematic stages. The first stage involves calculating the effect size of each study based on statistical data such as the mean value, standard deviation, and number of samples in the experimental and control groups. Furthermore, a heterogeneity test is carried out to evaluate the extent to which there is variation between the studies analyzed. The results of this test are the basis for selecting the appropriate estimation model, namely whether to use a fixed-effect or random-effect model. The third stage includes calculating the overall effect size that reflects the average impact of implementing the FL-PjBL strategy on student academic achievement. The effect size value is then interpreted referring to the criteria developed by Cohen (1988), as shown in Table 1.

**Tabel 1.** Classification of Effect Size

| **Effect Size (*d*)** | **Category** |
|---|---|
| $0.00 \leq d < 0.20$ | Ignored |
| $0.20 \leq d < 0.50$ | Small |
| $0.50 \leq d < 0.80$ | Moderate |
| $0.80 \leq d < 1.30$ | Large |
| $1.30 \leq d$ | Very Large |

## RESULTS AND DISCUSSION

Based on the results of the meta-analysis visualized in the forest plot (Figure 1), thirteen effect sizes sourced from nine research samples were analyzed to assess the effectiveness of the combined Project-based Learning and Flipped Classroom (PjBL-FC) model in improving student learning achievement. The effect size values obtained showed a range between 0.27 and 2.32, reflecting variations in the level of effectiveness between studies. Referring to Cohen's (1988) classification, five studies showed a very large effect category, namely research conducted by Hujjatusnaini et al. (2022), Ramadhani and Fitri (2020) a, Sumarmi et al. (2021) a, Sumarmi et al. (2021) b, and Telaumbanua (2022). Six studies are in the large effect category, namely Mursid et al. (2022) a, Mursid et al. (2022) b, Mursid et al. (2022) c, Putra et al. (2021), Silvi et al. (2019), and Sulistyowati et al. (2024). Meanwhile, one study falls into the moderate category, namely Ramadhani and Fitri (2020)b, and another study shows a small effect, namely Mufida et al. (2020). In general, these findings indicate that the PjBL-FC learning model has a high level of effectiveness in improving students' academic achievement, with most studies in the large to very large effect category. Figure 2 displays a summary of the effect size distribution of the thirteen studies in the form of a forest plot.

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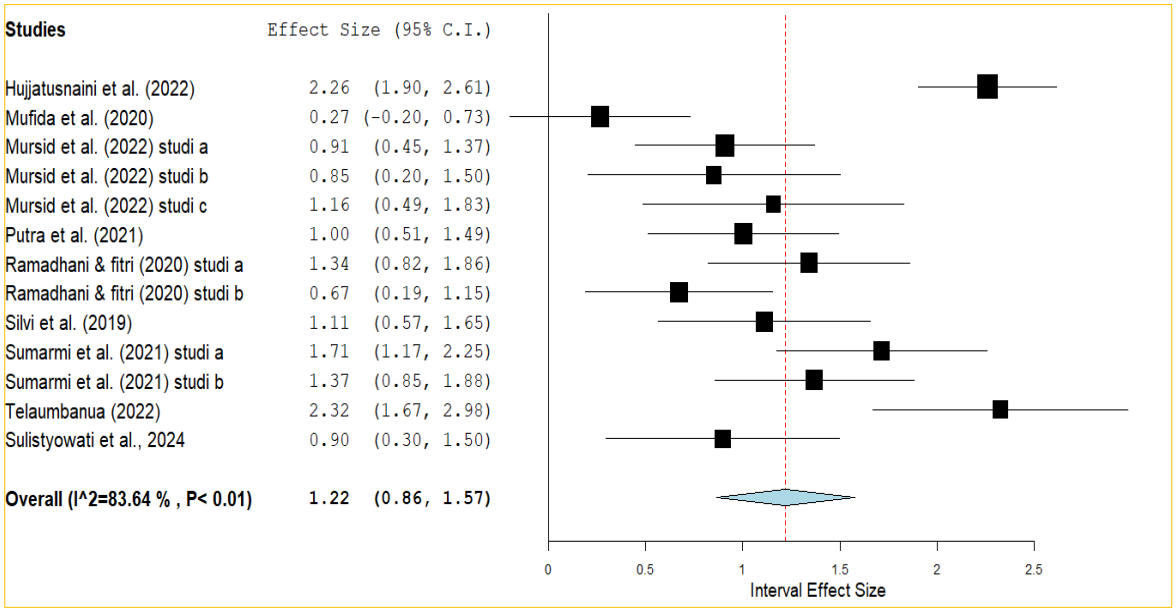


**Figure 1.** Forest plot

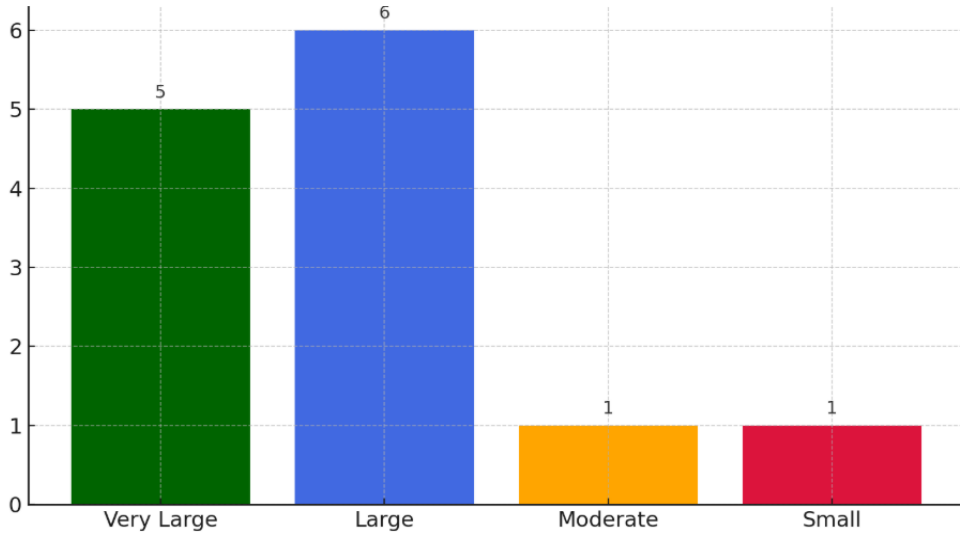


**Figure 2.** Distribution of Effect Size Categories Related to FL-PjBL

The results of the meta-analysis showed that the combination of Project-based Learning and Flipped Classroom (PjBL-FC) models had a significant effect on improving student learning achievement compared to traditional learning approaches. This is indicated by the combined effect size value of (g = 1.22; p <0.01), which is included in the "large effect" category based on Cohen's (1988) classification. This finding is in line with the results of previous studies such as those conducted by Cahyani et al. (2024), Sulistyowati et al. (2024), Zou et al. (2021), Ramadani et al. (2023), and Hwang et al. (2020), which stated that the integration of project-based learning models and flipped classrooms can create an active, collaborative learning environment, and encourage student involvement and deep understanding.

In further review, five studies showed a very large effect category, namely research by Hujjatusnaini et al. (2022), Ramadhani and Fitri (2020)a, Sumarmi et al. (2021)a, Sumarmi et al.

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(2021)b, and Telaumbanua (2022). Six other studies are in the large effect category, namely Mursid et al. (2022)a, Mursid et al. (2022)b, Mursid et al. (2022)c, Putra et al. (2021), Silvi et al. (2019), and Sulistyowati et al. (2024). Meanwhile, one study showed a moderate effect (Ramadhani and Fitri, 2020)b and another study showed a small effect (Mufida et al., 2020). These results generally indicate that the combination of PjBL-FC has high effectiveness in improving student learning outcomes.

This effectiveness can be explained through a combination of the advantages of each model. Flipped Classroom provides students with the flexibility to study basic material independently through digital sources before class meetings, so that face-to-face time can be focused on discussion activities, problem solving, and in-depth exploration. Meanwhile, Project-based Learning encourages student involvement in real projects that are contextual and challenging, allowing students to apply knowledge in authentic situations and develop creativity, responsibility, and reflective skills. However, several studies with small or moderate effect results are usually caused by the short duration of the intervention, the less than optimal quality of the flipped material, or the implementation of the project that is not fully based on real problems. This confirms that the success of the implementation of the PjBL-FC model is greatly influenced by mature instructional design, resource support, and the active role of teachers as learning facilitators.

The high level of heterogeneity in this meta-analysis ($I^2$ = 79.61%; $p < 0.01$) indicates significant variability between studies. Therefore, further moderator analysis is needed to identify the influence of factors such as educational level (junior high school, high school, college), subjects taught (Mathematics, Language, Science, etc.), duration of treatment, and the type of digital media used in flipped learning. Differences in students' socio-cultural backgrounds and the readiness of technological infrastructure in each research context may also contribute to variations in the results of the effectiveness of this model.

These findings provide empirical support for the relevance of using a combination of PjBL-FC models in improving 21st century competencies, such as critical thinking, collaboration, communication, and creativity (4C). In addition to strengthening conceptual understanding, this model also supports the development of independent learning and individual and group responsibility. Therefore, the integration of the PjBL-FC model is recommended to be adopted in curriculum policies, teacher training, and innovative learning strategies that focus on active and project-based learning.

## CONCLUSION

The results of this meta-analysis indicate that the combination of Project-based Learning and Flipped Classroom (PjBL-FC) models significantly improves student learning achievement compared to traditional learning models. The combined effect size value of 1.22, which is included in the large effect category (Cohen, 1988), indicates that this learning strategy has strong potential in creating a more meaningful, collaborative learning process and encouraging active student involvement. In general, most of the studies analyzed showed large to very large effects, which confirms the effectiveness of the PjBL-FC model in various educational contexts. Although these findings strengthen the empirical evidence of the superiority of the PjBL-FC model, this study has several limitations. First, the level of heterogeneity between studies is quite high ($I^2$ = 79.61%), indicating significant contextual variations, both in terms of educational level, subjects, intervention duration, and supporting technology used. Second, this study has not fully explored moderating factors that may influence the effectiveness of the model, such as the socio-cultural background of students, teacher readiness, and learning evaluation design. Third, because it only examines studies with quantitative experimental designs, broader insights from qualitative and mixed approaches have not been comprehensively explored. Therefore, further studies are needed that can examine moderator factors in more depth and use a mixed methods approach to

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obtain a more comprehensive picture of the effectiveness of the PjBL-FC model in various educational contexts.

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