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Integration of Flipped Learning Strategy and Project-based Learning in Higher Education: Overall Effect Size

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Abstract

This study aims to measure the overall effect size related to the effectiveness of the flipped learning strategy integrated with Project-Based Learning (FL-PjBL) on students' academic achievement in Higher Education. The method used is group contrast meta-analysis. A total of thirteen research samples (k = 13) that meet the inclusion criteria are included in this meta-analysis. The results of the meta-analysis indicate that the FL-PjBL strategy has a large and significant influence on students' academic achievement when compared to traditional learning strategies, with an overall effect size value of (d = 1.22; $p < 0.01$). However, the high level of heterogeneity (I^2 = 83.64%) indicates substantial variation between studies. Therefore, further research is recommended to investigate moderator variables such as educational level, subject area, intervention duration, and the quality of technology integration and project design in learning.

***Keywords*:** Effect size ; flipped learning; Meta-Analisis; project-based Learning

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1. INTRODUCTION

The transformation of learning in the 21st century is marked by the need to prepare students who are not only cognitively capable, but also able to think critically, creatively, collaboratively, and communicatively in solving real problems. In the midst of this paradigm shift, traditional one-way learning strategies are considered less able to respond to the challenges of the times. Therefore, various pedagogical innovations have begun to be developed and widely applied, including the integration of Flipped Learning and Project-Based Learning (FL-PjBL) strategies. The combination of these two approaches is a trend in the modern learning ecosystem because it is able to accommodate the needs of more active, independent, and student-centered learning.

FL-PjBL Learning has strong potential in improving student learning outcomes because it is able to create meaningful, contextual learning and facilitate active student involvement (Andrini et al., 2019; Chua & Islam, 2021; Fitrah et al., 2025; Hossein-Mohand et al., 2021). In this model, students learn basic concepts independently through digital materials before face-to-face meetings, which are then focused on collaboration in projects that require real-world application of knowledge (Hossein-Mohand et al., 2021). This approach allows for the strengthening of critical thinking skills, problem solving, and communication and collaboration skills through project-based activities (Andrini et al., 2019; Fitrah et al., 2025). In addition, the flexibility and autonomy in learning offered by FL-PjBL are very suitable for supporting the development of self-regulated learning in students (Pohan & Maulina, 2022; Zarouk et al., 2020).

Various experimental studies have been conducted to assess the effectiveness of the FL-PjBL model, both separately and in an integrative form. For example, the studies of Hujjatusnaini et al. (2022), Mufida et al. (2020), Mursid et al. (2022), Putra et al. (2021), Ramadhani and Fitri (2020), Silvi et al. (2019), Sumarmi et al. (2021), Telaumbanua (2022), and Sulistyowati et al., 2024). The results of these studies generally show positive results in improving student learning outcomes. However, most of these studies have small sample sizes and limited contexts, making it difficult to draw generalizable conclusions. High standard errors and variability between studies are also obstacles in interpreting the effectiveness of this model as a whole (Muhtadi et al., 2022; Samritin et al., 2023). For this reason, a quantitative synthesis approach in the form of a meta-analysis study is needed to obtain a more accurate estimate of the effect size compared to the single studies that have been conducted (Borenstein et al., 2009; Cahyani et al., 2024; Hukom et al., 2023; Kamsurya et al., 2022; Lipsey & Wilson, 2001; Martaputri et al., 2021; Mawardi et al., 2024; Muhtadi et al., 2022; Muhtadi et al., 2022; Purnomo et al., 2022; Samritin et al., 2023; Setiawan et al., 2022; Sulistyowati et al., 2023; Zuliana et al., 2025).

1.1. Purpose of study

This study aims to conduct a meta-analysis of the effectiveness of the FL-PjBL learning model in improving student learning outcomes. Through this approach, the study accumulates and analyzes data from various relevant experimental studies in order to obtain a comprehensive picture and a more stable estimate of the effect compared to the results of individual studies. Thus, this study is expected to provide statistically stronger conclusions regarding the effect of the integration of the two models on learning at various levels and subjects.

This study is important to strengthen empirical evidence related to the effectiveness of the FL-PjBL learning model in the context of today's education. The findings of this meta-analysis can be a foundation for teachers, curriculum developers, and policy makers in designing innovative and evidence-based learning strategies. In addition, the results of this study also contribute to the development of learning theories that are adaptive to

changing times and encourage the implementation of more effective, collaborative, and active learning-oriented learning models in various educational contexts.

2. METHODS AND MATERIALS

2.1. Research design

This study used a group contrast meta-analysis design to measure the overall effect size related to the effectiveness of the implementation of the FL-PjBL strategy on students' academic achievement. Meta-analysis was chosen as the research design because it allows the integration of quantitative data from various relevant studies to produce a more accurate and generalizable effect size estimate. By integrating the results of various previous studies, this approach aims to obtain a more comprehensive understanding of the extent to which the Flipped-PjBL strategy contributes to students' academic achievement. In addition, meta-analysis provides the advantage of increasing statistical power through the accumulation of larger sample sizes, which ultimately produces a more stable and objective effect estimate.

2.2. Procedure

2.2.1. Inclusion criteria

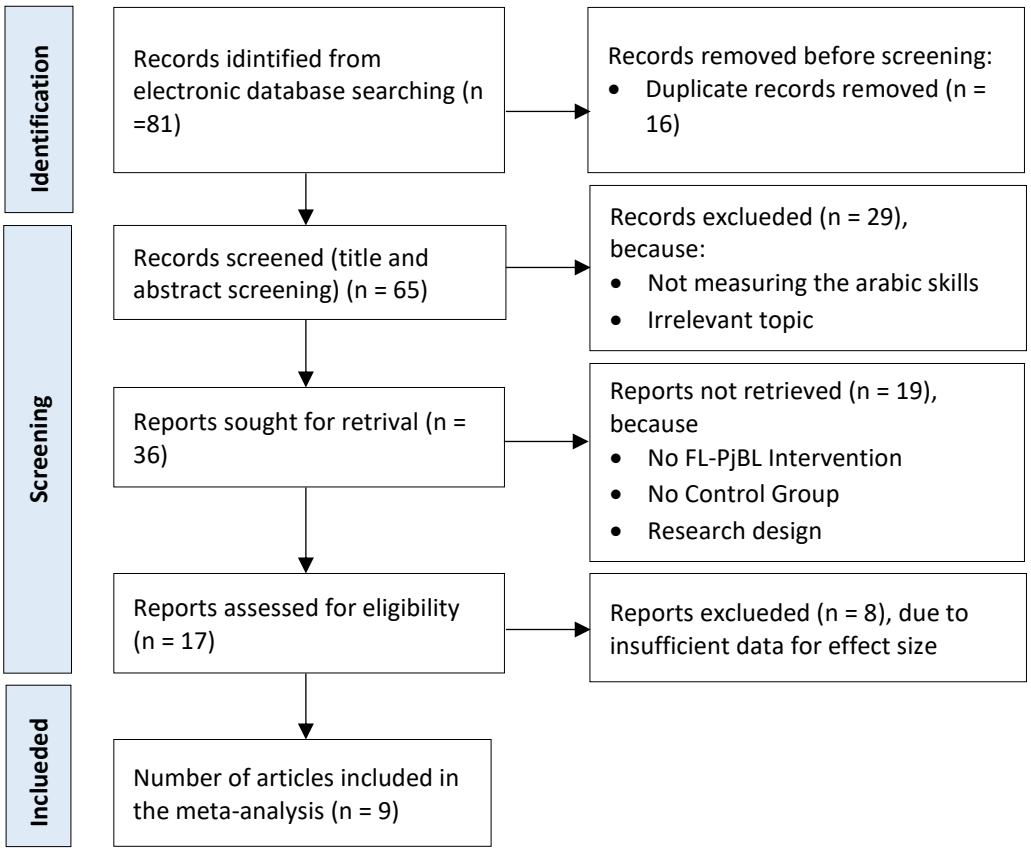
The inclusion criteria in this meta-analysis study include: (1) research articles published between 2019 and 2024; (2) using an experimental or quasi-experimental research design that clearly involves experimental and control groups; (3) studies evaluating the effectiveness of the Flipped-Project Based Learning (FL-PjBL) learning strategy on student learning outcomes at elementary, secondary, and higher education levels; and (4) studies reporting sufficient statistical data for calculating effect sizes, such as mean values, standard deviations (SD), and sample sizes from each group.

2.2.2. Literature collection

Data collection was carried out systematically through searches in the Google Scholar database and the Google search engine using combined keywords, such as ("Flipped Classroom" OR "Flipped Learning") AND ("Project-Based Learning" OR "PjBL") AND ("experimental" OR "quasi-experimental") AND ("learning outcomes" OR "student achievement"). The obtained articles were then selected using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines which include four stages, namely: identification, screening, eligibility, and inclusion. From the selection process, nine primary studies were obtained that met the criteria for further analysis. This process ensures that only relevant and quality studies are included in the quantitative synthesis to ensure the validity of the meta-analysis results. Figure 1 presents the data collection process using the PRISMA protocol.

Figure 1

Literature Screening Process Using PRISMA



2.2.3. Data extraction

Statistical information from the experimental group (FL-PjBL) and control group (Traditional) such as mean value, standard deviation, and sample size were collected to facilitate meta-analysis data analysis.

2.3. Data analysis

In this study, OpenMEE software was used as the main tool to process and analyze data from various studies that had been collected. The data analysis process was carried out through several systematic stages. The first stage was to calculate the effect size of each study using statistical data such as the average, standard deviation, and number of samples from the experimental and control groups. The second stage was to conduct a heterogeneity test, to determine the level of variation between the studies analyzed. The results of this test are the basis for determining the estimation model used, whether the fixed-effect or random-effect model. The third stage was to calculate the overall effect size which represents the average impact of the implementation of the FL-PjBL strategy on student academic performance. Interpretation of the effect size value was carried out by referring to the guidelines developed by Cohen (1988), as shown in Table 1.

Table 1

Effect size classification

Effect Size (*d*)	Category
0.00 ≤ *d* < 0.20	Ignored
0.20 ≤ *d* < 0.50	Small
0.50 ≤ *d* < 0.80	Moderate
0.80 ≤ *d* < 1.30	Large
1.30 ≤ *d*	Very Large

3. RESULTS

Based on the results of the meta-analysis visualized in the forest plot (Figure 2), thirteen studies were analyzed to evaluate the effectiveness of the (FL-PjBL) model in improving student learning outcomes. The range of effect size values ranged from 0.27 to 2.32, indicating variations in the level of effectiveness between studies. Referring to Cohen's (1988) classification, five studies showed a very large effect category, namely the studies of Hujjatusnaini et al. (2022), Ramadhani and Fitri (2020) a, Sumarmi et al. (2021) a, Sumarmi et al. (2021) b, and Telaumbanua (2022). Six studies were in the large category, namely the studies of 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). One study is in the moderate category, namely Ramadhani and Fitri (2020)b, and another study shows a low effect (small), namely Mufida et al. (2020). These findings indicate that in general the FL-PjBL learning model has high effectiveness in improving learning outcomes, with most studies showing a large to very large effect. Figure 2 presents a summary of the effect size summary of thirteen effect size distributions in the forest plot.

Figure 2

Forest plot

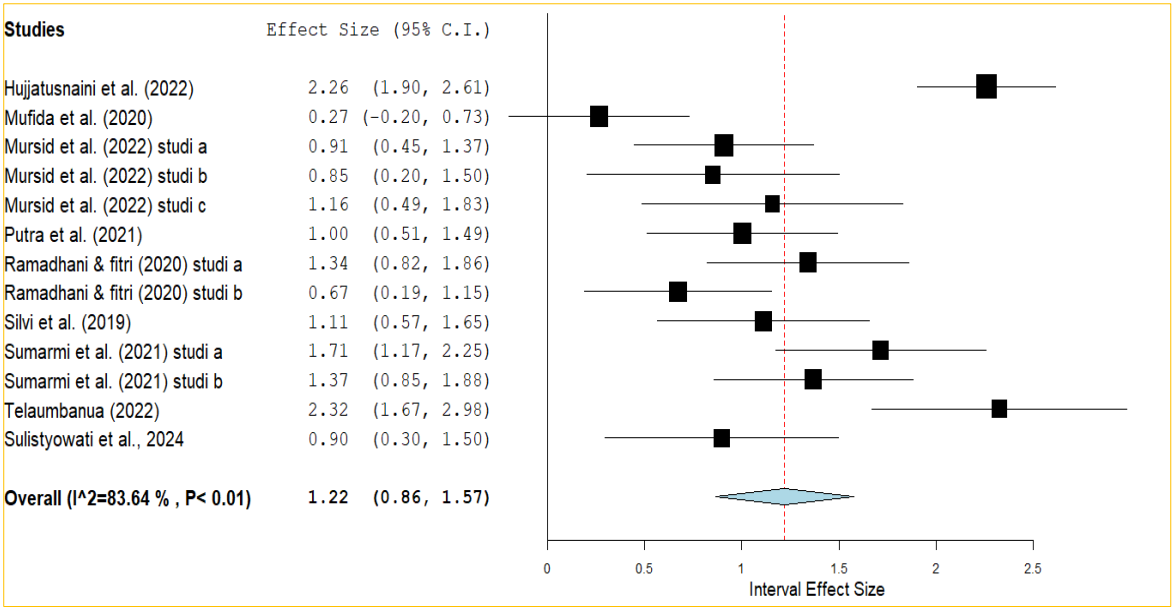
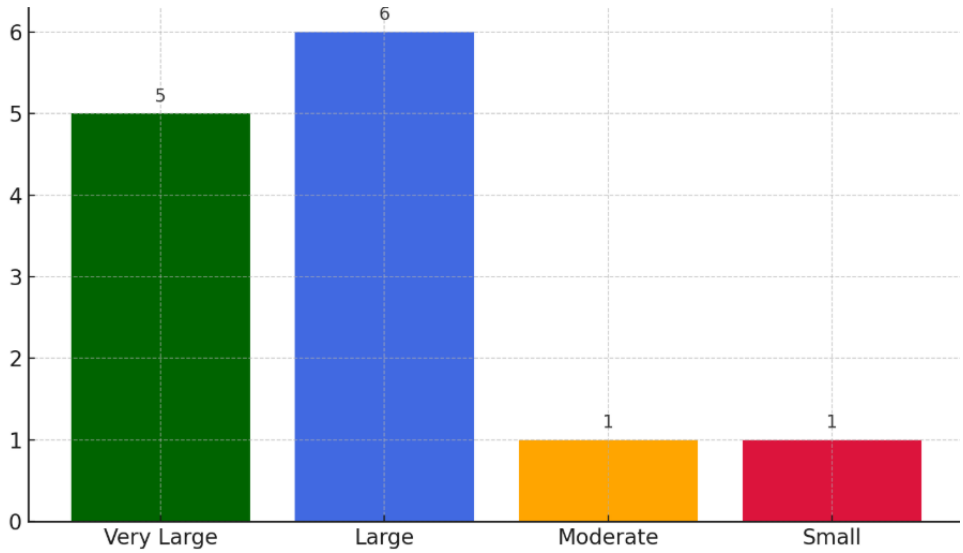


Figure 3

Distribution of Effect Size Categories Related to FL-PjBL



The results of the heterogeneity analysis in this study indicate that there is substantial variation between studies, with an I^2 value of 83.64% and a significance of $p < 0.01$, which indicates that the distribution of effect sizes from the thirteen studies analyzed is heterogeneous. Therefore, the estimation model used to calculate the combined effect size is the random-effects model to accommodate variation between studies. Based on the combined effect size analysis (See Figure 2), the combined effect size value is obtained as $d = 1.22$ with a significance of $p < 0.01$ and a standard error of 0.18. This value is classified in the large effect category according to Cohen's (1988) classification, which shows that overall, the application of the FL-PjBL model has a significant and strong influence in improving students' abilities when compared to traditional learning models. Thus, this learning model can be considered an effective and relevant approach in improving the quality of the learning process and outcomes in the 21st century learning era.

To verify the objectivity of the meta-analytic findings, an assessment of potential publication bias was conducted. Publication bias analysis aims to ensure that the distribution of effect sizes is normal and remains stable against changes in sample size and effect size (Bernard et al., 2014; Nugraha & Suparman, 2021). The results of the publication bias analysis (See Table 2) show that the p-value of the Z statistic < 0.05. This value indicates that there is no publication bias problem.

Table 2

Results of publication bias analysis

	Classic FSN
Z	15.67
p	0.00
FSN	1021

4. DISCUSSION

The results of the meta-analysis showed that the implementation of the FL-PjBL strategy had a significant impact on students' academic achievement compared to traditional learning strategies. This is reflected in the combined overall effect size value of ($g = 1.22$; $p < 0.01$), This value is included in the "large effect" category (Cohen, 1988). This finding strengthens the results of previous studies such as those conducted by Zou et al. (2021), Ramadani et al. (2023), and Hwang et al. (2020), which stated that the integration of flipped and project-based approaches can create a more active, collaborative, meaningful learning environment, and encourage student engagement and deep understanding.

Referring to Cohen's (1988) classification, five studies showed a very large effect category, namely the studies of 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 category, namely the studies of 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). One study is in the moderate category, namely Ramadhani and Fitri (2020)b, and one other study shows a low effect (small), namely Mufida et al. (2020). These findings indicate that in general the FL-PjBL learning model has high effectiveness in improving learning outcomes, with most studies showing a large to very large effect.

This significant increase can be explained by the synergy of the characteristics of the two learning models. Flipped Learning provides space for students to learn basic concepts independently before class through videos, modules, or other digital materials. This allows face-to-face class time to be used more productively for problem-solving and collaboration activities. Meanwhile, the Project-Based Learning approach encourages students to engage in real projects that are contextual and challenging, so that students are able to apply knowledge in authentic situations, develop creativity, and improve responsibility and metacognitive skills. However, the effectiveness of this integration is also influenced by various factors. Studies that produce small or moderate effects generally have short treatment durations, limitations in the quality of flipped content, or project implementation that is not entirely based on real problems. This shows that the success of the Flipped-PjBL model implementation is highly dependent on strong instructional design, resource support, and the active role of teachers in facilitating the learning process.

The high level of heterogeneity in this meta-analysis ($I^2 = 79.61\%$, $p < 0.01$) indicates that there is quite significant variability between studies. Therefore, further moderator analysis is needed to examine the influence of factors such as educational level (junior high school, senior high school, college), subjects (Mathematics, Language, Science, etc.), duration of intervention, and digital learning media used in flipped learning. Differences in the socio-cultural background of students and the readiness of digital infrastructure in each study context can also be determinants of the success of this model integration.

From a pedagogical perspective, these findings support the argument that the FL-PjBL approach can be a relevant learning strategy to improve 21st century competencies, such as critical thinking, collaboration, communication, and creativity (4C). This model not only strengthens conceptual understanding but also improves self-regulated learning skills and individual and group responsibility. Therefore, it is recommended that FL-PjBL integration be part of the curriculum reform strategy, teacher training, and the development of educational policies that are oriented towards active and project-based learning.

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5. CONCLUSION

The results of this meta-analysis study indicate that the FL-PjBL strategy generally has a large and significant effect on students' academic achievement compared to traditional learning strategies. This strategy is able to create a more active, collaborative, and student-centered learning experience, thus encouraging deeper understanding and the development of critical thinking and problem-solving skills. The integration of independent learning through flipped learning and contextual project-based learning makes this approach relevant to the demands of the 21st century curriculum. Students do not only learn passively, but are also involved in exploration, collaboration, and reflection through meaningful authentic tasks. However, given the high heterogeneity between studies, further research is needed to identify and analyze more deeply the moderating factors that influence the effectiveness of this model. These factors may include education level, field of study or subject, duration and intensity of intervention, and the quality of learning design and technology support used in the implementation of FL-PjBL. These findings are expected to be a basis for policy makers, educators, and researchers in designing innovative learning strategies that are more adaptive and effective for students in the digital era.

Conflict of Interest: The authors declare no conflict of interest.

Ethical Approval: The study adheres to the ethical guidelines for conducting research.

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