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Blended Project-Based Learning (BPjBL) on Students' Achievement: A Meta-Analysis Study

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Although many studies have investigated whether blended project-based learning (BPjBL) is more effective in increasing student achievement compared to traditional learning models, previous research has shown inconsistent results. The aim of this research is to evaluate the impact of the BPjBL model on student learning achievement compared to traditional learning models. This study utilizes a group contrast meta-analysis approach by analyzing data from 13 primary studies that meet the inclusion criteria. The analysis results indicate that the use of the BPjBL model has a significant effect on student learning achievement with a combined effect size of 1.23 (large effect). Therefore, it can be concluded that the BPjBL model has a significant influence on student learning achievement compared to traditional learning models. Furthermore, the analysis based on moderator variables shows that the effect of the BPjBL model on student learning achievement differs based on educational level groups ($Qb = 14.40$; $p < 0.05$) and year of publication ($Qb = 19.40$; $p < 0.05$). However, there is no significant difference based on group sample size ($Qb = 0.49$; $p > 0.05$). The findings of this meta-analysis provide more accurate results in depicting the inconsistent variation in research effect sizes.

Keywords: students' achievement, blended project-based learning, effect size, meta-analysis, learning

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INTRODUCTION

The development of information and communication technology has a significant effect on the learning process (Akgundus & Akinoglu, 2016; Bhakta & Dutta, 2016; Sharti, 2020). Information and communication technology has an important contribution to student academic achievement (Nora & Snyder, 2008; Suleman et al., 2017). The utilization of technology in the educational process has been found to enhance student learning motivation (Higgins et al., 2019; Lauc et al., 2020; Wouters et al., 2013), foster student collaboration (Keser et al., 2012), promote higher-level thinking among students (Kurt, 2010; Lim et al., 2003), and increase student engagement in learning (Baytak et al., 2011). As a result, it is essential for educators to adapt their teaching practices by incorporating technology and information resources. This shift is a reflection of the changing landscape of education in the 21st century, moving away from traditional approaches towards technology-driven learning. In order to accommodate the diverse learning needs of students, educators must be capable of implementing learning models that effectively integrate technology. One suitable learning model is blended project-based learning (BPjBL).

BPjBL is the integration of project-based learning models into blended learning. BPjBL enables students to develop their capability in addressing real-life problems within an optimal learning duration (Bruggeman et al., 2019; López-Pellisa et al., 2020). BPjBL is an innovative approach to student-centered education that highlights the importance of time efficiency. It combines blended learning methods, removing limitations of space and time, to promote an engaging and interactive learning experience. The BPjBL model seeks to facilitate students to be creative in producing a product without being limited by space and time (Husamah, 2018). The application of the BPjBL model can simplify and speed up the communication process between teachers and students. In this model, the provision of scaffolding by teachers to students can run with maximum time. If needed, students can communicate with teachers without being limited by space and time. In other words, this model can facilitate students' learning needs with flexible time.

Several studies have provided evidence of the positive impact of using a combination of blended learning and project-based learning on various aspects of learning. Silvi et al. (2019) found its effectiveness in increasing learning outcomes, while Aliftika et al. (2021) and Santyasa et al. (2021) highlight its contribution to the development of critical thinking skills. In addition, Yustina et al. (2020), Mursid et al. (2022), and Safitri & Suparwoto (2020) show a positive influence on the ability to think creatively. In addition, Putra et al. (2021) emphasizes improving spatial thinking skills. However, Mufida et al. (2020) obtained contradictory results, because they found no significant effect from the combination of the two approaches. The inconsistency of research findings on the same topic can lead to uncertainty in the decision-making process. Therefore a research approach is needed that combines several quantitative findings to provide more accurate conclusions (Higgins & Katsipataki, 2015; Muhtadi et al., 2022). For this purpose, a meta-analysis approach can be used.

The objective of conducting a meta-analysis is to enhance the precision of conclusions by evaluating the results of prior studies (Borenstein et al., 2021; Schmidt & Hunter,

2004). Compared to other review methods, meta-analysis is known for its greater objectivity. This is attributed to its emphasis on calculating effect sizes (Cleophas & Zwinderman, 2017; Shelby & Vaske, 2008). The effect sizes of each study will be combined to obtain an overall effect size (Borenstein, 2022; Schmidt & Hunter, 2004). The meta-analysis approach can overcome inconsistent research results from several research reports examining the same topic (Borenstein et al., 2021; Cleophas & Zwinderman, 2017; Schmidt & Hunter, 2004; Shelby & Vaske, 2008; Borenstein, 2022).

Based on the literature search we have investigated so far, there have been no meta-analytic studies that have examined the effectiveness of using the blended project based learning (BPjBL) model on student achievement. Therefore, the main objective of this research is to assess the effectiveness of the BPjBL model in improving student achievement through a meta-analysis approach. In addition, this research also explores the potential influence of moderator variables such as education level, year of publication, and sample size on the effectiveness of BPjBL in improving student achievement. This study was able to provide objective and accurate results regarding the confounding differences in effect sizes between the BPjBL model variables and student achievement. The results of this study are expected to provide a comprehensive picture of the influence of BPjBL on student achievement, so as to facilitate evidence-based policy making to improve the quality of education.

METHOD

Research Design

In this study, the effectiveness of BPjBL on student achievement was calculated using a meta-analysis design. The procedure followed in this meta-analysis study was based on the guidelines provided by Borenstein et al. (2021), as illustrated in Figure 1 below.

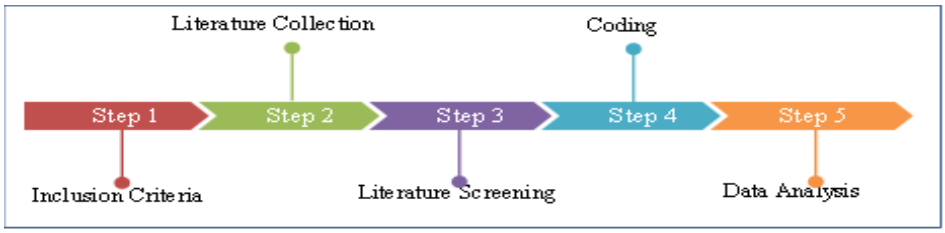

Figure 1
Steps in the meta-analysis study

Inclusion criteria

The inclusion criteria set to select relevant studies for this meta-analysis were:

- Studies must be published in a journal within the last four years (2019-2022);
- Studies can be accessed online;
- Studies conducted with experimental or quasi-experimental methods;
- Studies that compare 1 experimental group use the BPjBL model and another comparison group as the control group; and
- Studies must report sufficient data to calculate the effect size.

Literature Collection and Screening

Literature collection refers to the established inclusion criteria. Literature collection uses the Google Scholar database and the Google search engine. The keywords used to facilitate the search for studies are "effect project-based blended learning" or "effect blended project-based learning". The initial data collected was then screened. Screening is carried out through four stages, namely: identification, screening, eligibility, and inclusion. The screening results obtained from 9 primary studies were used as material for meta-analysis, but there were several studies involving more than one control group resulting in 13 effect sizes being analyzed.

Coding

Two raters were involved in the coding process of this study to minimize subjective errors. The coding encompassed education level, year of publication, and sample size information. A summary of the coding outcomes is provided in Table 1.

Table 1
Primary study coding results

Coding Content		Frequency	Percentage
Grade of Education	Senior High School (SHS)	6	46.15%
	College	7	53.85%
Year of Publication	2019-2020	4	30.77%
	2021-2022	9	69.23%
Sample Size	30 or less	4	30.77%
	31 or over	9	69.23%

Data analysis

The data analysis steps refer to Borenstein et al. (2021) which is shown in Figure 2 below.

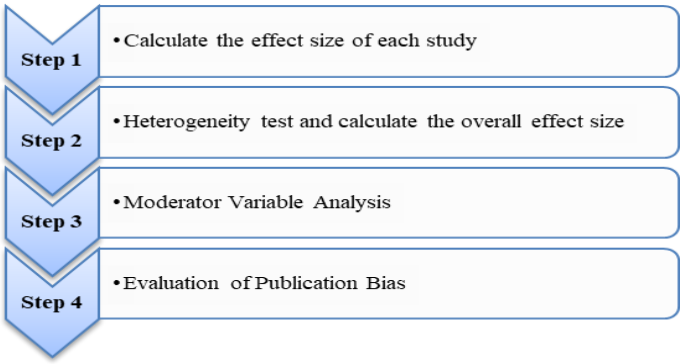

Figure 2
Data Analysis Steps

OpenMEE software was used for data analysis. The interpretation of the effect size follows the classification of Cohen (2018), as shown in Table 2. The Q parameter approach is used for the heterogeneity test, which aims to determine the appropriate estimation model to calculate the combined effect size. To ensure the objectivity of this meta-analysis, an assessment of publication bias was carried out, as mentioned in the study by Muhtadi et al. (2022); Setiawan et al. (2022); Purnomo et al. (2022); Kasurya et al. (2022); Martaputri et al. (2021); and Samritin et al. (2023). Evaluation can be performed using the File-Safe N (FSN) approach, as described by Borenstein et al. (2021) and Hunter & Schmidt (2004).

Table 2
Effect size (ES) classification

No	Classification	Interval
1	Ignored	$0.00 < ES \leq 0.19$
2	Small Effect	$0.19 < ES \leq 0.49$
3	Medium Effect	$0.49 < ES \leq 0.79$
4	Large Effect	$0.79 < ES \leq 1.29$
5	Very Large Effect	$ES > 1.29$

FINDINGS

Effect sizes of each study

In order to conduct a meta-analysis, the initial stage involves determining the effect size for each study. A summary of the effect sizes for each study, obtained through the utilization of the OpenMEE software, can be found in Table 3.

Table 3
Effect size of each study

Study Number	Author	Effect Size	95% Confidence Interval	
			Lower Bound	Upper Bound
1	Aliftika et al. (2021)	1.07	0.59	1.55
2	Hujjatusnaini et al. (2022)	2.26	1.90	2.61
3	Mufida et al. (2020)	0.27	-0.20	0.73
4	Mursid et al. (2022) studi a	0.91	0.45	1.37
5	Mursid et al. (2022) studi b	0.85	0.21	1.50
6	Mursid et al. (2022) studi c	1.16	0.49	1.83
7	Putra et al. (2021)	1.00	0.51	1.49
8	Ramadhani & fitri (2020) studi a	1.34	0.82	1.86
9	Ramadhani & fitri (2020) studi b	0.67	0.19	1.15
10	Silvi et al. (2019)	1.11	0.57	1.65
11	Sumarmi et al. (2021) studi a	1.71	1.17	2.25
12	Sumarmi et al. (2021) studi b	1.37	0.85	1.88
13	Telaumbanua (2022)	2.32	1.67	2.97

Based on Table 3 above, out of a total of 13 effect sizes analyzed, the smallest effect size was 0.27 with a lower limit of -0.20 and an upper limit of 0.73, while the largest effect size was 2.32 with a lower limit of 1.67 and an upper limit of 2.97. When categorized according to Cohen's (2018) classification, there are five studies (n = 5) that fall under the category of very large effects, six studies (n = 6) classified as large effects, one study (n = 1) classified as having a moderate effect, and one study (n = 1) categorized as having a small effect. These results indicate that the use of the blended project-based learning (BPjBL) model has various effect sizes on student achievement, so it is necessary to calculate the overall effect size.

Heterogeneity and overall effect size

The next phase involves examining heterogeneity and selecting an appropriate estimating model to determine the combined effect size. The summary of the heterogeneity test and the estimated combined effect size are shown in Table 4 below.

Table 4
Heterogeneity test results and combined effect sizes

Model	K	Effect Size (d)	[95% CI]	p	Df	Heterogeneity		
						Q	p	I^2
Random	13	1.23	[0.88, 1.58]	< 0.001	12	72.58	< 0.001	83.46
Fixed	13	1.26	[1.13, 1.40]	< 0.001	12			

Based on Table 4 above, a Q value of 72.58 > chi-square (df = 12) is obtained. In conclusion, the variations in effect sizes found in the 13 studies are diverse. Therefore, a random-effect estimation model was used to calculate the combined effect size. The results of the random-effect estimation model show that the combined effect size is (d = 1.23; p < 0.001). This effect size value is in the large effect category. Thus, it can be concluded that the use of the BPjBL model has a major influence on student achievement.

Moderator variable analysis

The next step is the analysis of moderator variables. Moderator variable analysis was carried out to find out what factors can influence the use of the BPjBL model on student achievement. The study examined several moderating variables such as educational level, publication year, and sample size. The findings of the moderator variable analysis are presented in Table 5.

Table 5
Effect size based on moderator variable

Moderator Variable	k	Effect Size (d)	P	Heterogeneity			
				Q	df	Qb	P
Grade of Education							
Collega	6	1.40	< 0.01	29.24	1	14.40	0.00
Senior High School (SHS)	7	1.09	< 0.01	28.94			
Year of Publication							
2019-2020	4	0.84	< 0.01	10.79	1	19.40	0.00
2021-2022	9	1.41	< 0.01	42.39			
Sample Size							
30 or less	4	1.35	< 0.01	11.78	1	0.48	1.00
31 or over	9	1.18	< 0.01	60.32			

Based on the educational level moderator variable. The effect size for the College group was in the very large effect category ($d = 1.40$; $p < 0.01$), and the SHS group effect size was in the large effect category ($d = 1.09$; $p < 0.01$). The results of the comparison test between the two groups revealed a statistically significant difference ($Qb = 14.40$; $p < 0.05$). This value concludes that the effectiveness of using the BPjBL model on learning achievement compared to traditional learning differs based on the educational level group. The use of the BPjBL model is most effective when applied at the college level.

Based on the moderator variable of the year of publication. The effect size for publications in the years 2019-2020 falls within the large effect range ($d = 0.84$; $p < 0.01$), while the effect size for publications in the years 2021-2022 falls within the very large effect range ($d = 1.41$; $p < 0.01$). The results of the two groups' difference test showed that there was a significant difference ($Qb = 19.40$; $p < 0.05$). This value concludes that the effectiveness of using the BPjBL model on learning achievement compared to traditional learning differs based on the year of publication group. The use of the BPjBL model is reported to be most effective in the 2021-2022 publication year.

Analysis of the moderator sample size variable revealed that the effect size for the sample group of 30 or less was very large ($d = 1.35$; $p < 0.01$), whereas the effect size for the group sample of 31 or more, included in the large effect category ($d = 1.18$; $p < 0.01$). However, the results of the comparison of the two groups showed that there was no significant difference ($Qb = 0.48$; $p > 0.05$). These findings indicate that the effectiveness of using the BPjBL model in terms of learning achievement does not differ based on the size of the sample group. This means that the use of the BPjBL model is equally effective when applied to a sample of 30 or less and 31 or more.

Publication bias

In the final stage of this meta-analytic study, an assessment of publication bias was carried out. Table 5 provides a brief overview of the findings from an evaluation of publication bias using the file-Safe N (FSN) method.

Table 5
File-Safe N

File Drawer Analysis				
	k	Fail-safe N	Target Significance	Observed Significance
Rosenthal	13	1404	0.05	< 0.001

Based on Table 6, the value of FSN = 1404 is obtained. This value is greater than 5k + 10 = 5 (13) + 10 = 75. From this value, it can be concluded that this meta-analytic study maintains scientific objectivity and validity due to the absence of publication bias.

DISCUSSION

This meta-analysis analyzed 13 effect sizes using a random-effect estimation model. The combined effect size found was 1.23 (Large Effect). These results indicate that the use of the BPjBL model has a major effect on student achievement compared to traditional learning models. This discovery aligns with the meta-analysis conducted by Setiawan et al. (2022), which revealed a significant impact of blended learning on mathematics learning achievement among Indonesian students. Similarly, the findings of Samritin et al.'s meta-analysis (2023) provided further support for the effectiveness of blended learning compared to traditional learning models. Moreover, Balemen and Keskin's meta-analysis study (2018) demonstrated that the implementation of project-based learning significantly enhances students' academic performance. Therefore this meta-analysis research provides strong evidence that integration between blended learning and project based learning (BPjBL) has a major influence on student achievement.

The use of the BPjBL model gives students active involvement in finding and solving problems through investigations and experiments facilitated by blended learning. Blended learning emphasizes the aspect of time intensity with unlimited concepts, both space and time so that active learning can be carried out optimally. Learning becomes more meaningful with BPjBL, because students are actively involved in solving problems during the learning process, and learning is linked to students' daily conditions (Yustina et al., 2020; Wahyudi, 2020; Tong & Wei, 2020). This model also gives students the freedom to express opinions, make questions, make conclusions without feeling embarrassed and afraid during the learning process. Telaumbanua (2020) states that the learning process will be more effective and efficient if students are given more opportunities to be directly involved and work. BPjBL facilitates students to be able to exchange ideas with their friends and seek in-depth information to support the ideas conveyed (Mutakinati et al., 2018). BPjBL awakens students' curiosity through an orientation phase. In the orientation phase, students are given authentic problems so as to generate student interest (Tika et al., 2021). BPjBL makes students' critical thinking better (Pérez-Escolar et al., 2021; Putri & Hendawati, 2018).

BPjBL is able to increase learning motivation. High learning motivation makes students more effective and efficient in completing project assignments so as to create learning efficiency (Chu et al., 2017). In addition, Sidik and Sobandi (2018) said that BPjBL which is supported by strong motivation will guide students to actively seek information about the material being taught by the teacher, as well as use higher cognitive processes

to learn and absorb lessons. Ledward and Hirata (2011) revealed that BPjBL is able to increase learning independence, with independent learning it is expected that students' responsibilities can be better and can generate creative ideas. To be able to apply the blended learning model, the teacher must have knowledge of how to arrange the content of learning materials, choose and apply learning strategies, as well as knowledge about how to integrate technology into learning activities. Teachers must be able to facilitate learning by providing teaching materials such as videos and learning resources in the form of interesting images, so that students do not feel bored (Dziuban et al., 2018).

Based on the educational level moderator variable. The effect size for the College group was in the very large effect category ($d = 1.40$; $p < 0.01$), and the SHS group effect size was in the large effect category ($d = 1.09$; $p < 0.01$). The results of the two groups' difference test showed that there was a significant difference ($Qb = 14.40$; $p < 0.05$). This value concludes that the effectiveness of using the BPjBL model on learning achievement compared to traditional learning differs based on the educational level group. This means that the use of the BPjBL model for student achievement is most effective at the college level compared to the SHS level. These results are in line with the findings of Samritin et al. (2023) which revealed that the use of blended learning has a greater effect at the college level. This is because the higher the level of education, the higher the level of student involvement (Purnomo et al., 2022; Paloloang et al., 2020). Even though there were significant differences, the application of the BPjBL model to learning achievement proved to be effective in both groups.

Based on the moderator variable of the year of publication. The group effect size for publications in 2019-2020 is in the large effect category ($d = 0.84$; $p < 0.01$), and the group effect size for publications in 2021-2022 is in the very large effect category ($d = 1.41$; $p < 0.01$). The results of the two groups' difference test showed that there was a significant difference ($Qb = 19.40$; $p < 0.05$). This value concludes that the effectiveness of using the BPjBL model on learning achievement compared to traditional learning differs based on the year of publication group. The use of the BPjBL model is reported to be most effective in the 2021-2022 publication year compared to the 2019-2020 publication year. This shows that research related to the use of BPjBL has a higher effect on student achievement in recent years compared to previous years. This result is similar to the findings of Purnomo et al. (2022) who found that blended learning with a flipped classroom approach was reported to have a larger effect size in the most recent year of publication. Even though there were significant differences, the application of the BPjBL model to learning achievement proved to be effective in both groups.

Based on the moderator variable sample size. The effect size of the sample group of 30 or less is in the very large effect category ($d = 1.35$; $p < 0.01$), and the effect size of the sample group of 31 or over is in the large effect category ($d = 1.18$; $p < 0.01$). The results of the two groups' difference test showed that there was no significant difference ($Qb = 0.48$; $p > 0.05$). This value concludes that the effectiveness of using the BPjBL model on learning achievement compared to traditional learning does not differ based on the sample size group. This means that the use of the BPjBL model is equally effective when applied to a sample of 30 or less and 31 or more. This result is in line

with the findings of Samritin et al. (2023) who found that the group sample size affects the effectiveness of using blended learning on learning achievement. On the other hand, unlike the results reported by Purnomo et al. (2022) where they concluded that the group sample size had no impact on the effectiveness of blended learning with the flipped classroom approach, this disparity in findings serves as the foundation for subsequent investigations that incorporate a larger number of primary studies and broader inclusion criteria.

CONCLUSION

BPjBL is the integration of project-based learning models into blended learning. The BPjBL model seeks to facilitate students to be able to learn and be creative in producing a product without being limited by space and time. This study investigates the effectiveness of the BPjBL model on student achievement, and investigates whether the moderator variables are level of education, year of publication and sample size affect the effectiveness of BPjBL on student achievement. Overall, the application of BPjBL has a major effect on student achievement when compared to traditional learning models. The results of the analysis based on the moderator variable show that the effect of the BPjBL model on learning achievement is different based on the educational level group and the year of publication. However, there were no differences based on the sample size group. The results of this research are expected to be the basis for making the right decisions for educators and stakeholders.

The limitation of this study is that this study only analyzed 13 effect sizes from 9 primary studies that met the inclusion criteria, future studies can carry out a meta-analysis by analyzing more primary studies, so that the results of the analysis become more accurate and in-depth. This research also only analyzes student achievement in general, further research can examine the dependent variable specifically, for example the ability to think critically, creatively, and others. In addition, further research can focus on student achievement based on the field of study being taught.

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