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Integration of Blended Learning and Project-Based Learning (BPjBL) on Achievement of Students' learning goals: A Meta-analysis study

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Abstract

Many studies have identified differences in the effectiveness of the integration of blended learning and project-based learning (BPjBL) models on student achievement. However, the results of previous studies showed different results. Therefore, this study aims to determine the differences in the effectiveness of the integration of blended learning and project-based learning (BPjBL) models on student achievement, compared to traditional learning. The design used in this study was a contrast group meta-analysis. The studies analyzed to calculate the effect size were 11 primary studies that met the established inclusion criteria. To be more accurate, data analysis was performed with the help of JASP software version 0.16.3. The results of the analysis using the random effects approach obtained an overall effect size ($d = 1.28$; $p < 0.05$). This effect size is included in the large effect category. It can be concluded that the use of the BPjBL model has a major effect on student achievement when compared to traditional learning. The meta-analysis in this study has no problem with publication bias, so this meta-analytic research is objective and scientifically justifiable. The results of this meta-analysis research show more accurate information, which can be used as a basis for policymaking, so as to improve the quality of learning.

Keywords: Diversity of Learning Needs, blended project-based learning, effect size, meta-analysis

Introduction

Students are assigned to classes in Indonesian schools according to their chronological age, and they get the same level of instruction and amount of study time. Though the ability of each student is different in understanding the material as a whole. Students with high academic abilities certainly have less time to understand the material than students with lower academic abilities (Prayitno et al., 2013; Prayitno et al., 2022). This can cause a gap in the achievement of learning objectives between high-ability students and low-ability students. Students with lower academic abilities can master subject matter like students with higher academic abilities if given study time as needed (Adeyemo & Babajide, 2014; Siddaiah-Subramanya et al. 2017). This shows that the allocation of learning time has an important contribution to the achievement of learning objectives. Sanuaka et al. (2017) also stated that the use of inappropriate strategies and limited time can make it difficult for students to develop their skills. Setiawan et al. (2022) revealed that teachers need to implement learning strategies that can facilitate learning time according to student needs. Based on these problems, the integration of blended learning and project-based learning (BPjBL) models can be applied. The integration between blended learning and project-based learning facilitates students to be the ability to solve contextual problems with maximum learning time. Providing scaffolding in this model can also run optimally because students with high academic ability can provide scaffolding with more optimal time to students with low academic ability. Collaborative work with maximum study time can increase student learning achievement (Paristiowati et al., 2018).

Integrating blended learning and project-based learning (BPjBL) is something new in the learning process. This model facilitates students to solve project-based problems through e-learning. BPjBL becomes a new model in the learning process. BPjBL is a combination of two learning models that

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emphasize flexible (synchronous and asynchronous) and project-based learning processes (Bruggeman et al., 2019; López-Pellisa et al., 2020). This learning model emphasizes the aspect of time intensity, facilitated by blended learning with unlimited concepts, both space and time so that it can support an active learning process. BPjBL is considered capable of facilitating diverse learners' speed and learning needs (Prescott et al., 2018). Through a combination of the teacher's role as a facilitator along with the use of technology in the BpJBL model, students can adjust their learning abilities according to their needs. BPjBL provides opportunities for students to be creative and learn anywhere without being limited by space and time. This model can help students to be actively involved in the learning process (Vesikivi et al., 2020), and build an attitude of inquiry by working collaboratively on a project-based approach with a comprehensive approach (Bell, 2010).

Many studies have identified that Blended Project-Based Learning can improve learning outcomes (Silvi et al., 2019), critical thinking skills (Aliftika et al., 2021; Santyasa et al., 2021), creative thinking (Yustina et al., 2020; Mursid et al., 2022; Safitri & suparwoto., 2020), spatial thinking skills (Putra et al., 2021). However, the results of previous studies reported inconsistent results on the same topic. Whereas mathematics teachers want to obtain accurate and mutually supportive information to be considered in applying the BPjBL model effectively to improve student achievement. Based on these problems, efforts are needed to combine previous findings related to the effect of the BPjBL model on student achievement to be evaluated quantitatively, so that it can provide broader and more accurate results. in this case, a meta-analysis approach can be used to evaluate the results of previous studies to reach in-depth and accurate conclusions (Schmidt & Hunter, 2004; Retnawati et al., 2018; Tamur & Juandi, 2020). The main aim of the meta-analysis was to find the effect size. The effect size is a measure of the magnitude of the influence, the magnitude of the difference, and the relationship of a variable with other variables (Schmidt & Hunter, 2004; Retnawati et al., 2018).

Based on the literature review that we have investigated so far, there has been no meta-analysis study related to the effect of the blended project-based learning (BPjBL) model on the Achievement of Learning Goals. Therefore, this study aims to measure the effect of the BPjBL model on student achievement using a meta-analysis approach. This study can provide clear results that the confusing effect size differences between the BPjBL model variables and student achievement based on various kinds of literature (some fall into the category of not having too large an effect) become apparent after the meta-analysis. In addition, the results of this study are expected to provide an overview of the influence of BPjBL on the achievement of student learning goals, so that it can be used as a basis for policy-making to improve the quality of learning.

Method

Research Design

The design of this study used a Contrast Group meta-analysis approach. This approach is used to test the effectiveness of the BPjBL model on the achievement of student learning goals. In general, the procedure in this meta-analysis study refers to Borenstein et al. (2009) and Retnawati al. (2018), among others; 1) Determining inclusion criteria, 2) Data collection and coding, and 3) Data analysis.

Inclusion criteria

Determination of inclusion criteria to facilitate the search for studies at a later stage. the studies collected in the initial search were then examined and assessed using the inclusion criteria defined for inclusion in meta-analysis and further evaluation. The inclusion criteria established in this meta-analysis included: 1)The year of publication ranges from 2013 to 2022; 2) Articles must be written in English; 3) Studies using experimental or quasi-experimental research methods; 4) There is at least 1 experimental group with blended project-based learning and the comparison group as a control group with conventional learning; 5) The study must report the mean, standard deviation and sample size of each experimental group and control group; or sample size and t-value; or sample size and p-value; or sample size with F-value.

Collection and screening of Literature

The stage of collecting relevant studies uses online databases such as Google Scholar, ERIC, Elsevier, SAGE, and SpringerLink. The keywords used in searching the relevant literature are "Effect or Impact or Effectiveness of Blended project-based Learning". Literature screening is used to assess whether the collected literature is eligible or not to be used as material for meta-analysis. Literature screening was carried out with reference to the established inclusion criteria. Liberati et al., (2009) revealed that the screening process can go through four stages which are guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The PRISMA protocol can improve reporting quality. The PRISMA protocol in this study is visualized in Figure 1.

The results of the identification resulted in 119 studies that were successfully collected on the effect of implementing the integration of blended learning and project-based learning. The screening phase resulted in primary studies, but 95 studies were excluded due to duplication and not meeting the inclusion criteria (study design and publication type did not match). Then, 13 studies were excluded due to insufficient statistical

information and inappropriate language in the body of the article. The process resulted in 11 primary studies that met the eligibility criteria. However, some studies involved more than one control group, resulting in 15 effect sizes being analyzed. Table 1 describes information on primary studies that have been published by various journals.

Data analysis

Data analysis in this meta-analysis study was analyzed using the JASP 0.16.3 application. The data analysis procedure followed the following steps: 1) Calculating the effect size of each study; 2) Perform heterogeneity test; 3) Calculate summary or combined effects; 4) Publication bias test. The classification of each effect size or combined effect of this meta-analysis study follows the classification of Cohen et al. (2018) which is shown in Table 2.

Before calculating effect sizes from meta-analytical studies, heterogeneity was first tested. The heterogeneity test aims to select the appropriate effect size measurement model. The heterogeneity test in this study uses the Q parameter. The decision-making criteria is if the p-value <0.05, then the measurement model used to calculate the effect size is a random effect, and if the p-value> 0.05 then the fixed effect is used (Retnawati et al., 2018; Borenstein et al., 2009). Furthermore, to ensure that the research included in the meta-analysis has shown results that are in accordance with field conditions (objective), a publication bias test is carried out (Muhtadi et al., 2022; Retnawati et al., 2018; Tamur & Juandi, 2020; Setiawan al., 2022). The approach used to evaluate publication bias is File-Safe N (FSN). if the FSN value is greater than 5k + 1, where k is the number of studies, it can be concluded that there is no publication bias problem.

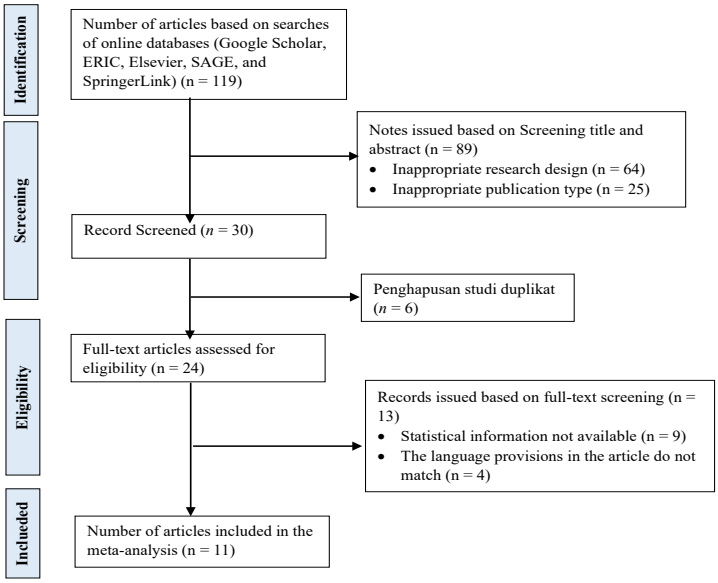

Fig. 1: Flow chart detailing the implementation of PRISMA.

Table 1: List of Journals that Meet the Inclusion Criteria.

No	*Journal Name*	*URL*
1	Jurnal Ilmiah Sekolah Dasar	https://ejournal.undiksha.ac.id/index.php/JISD
2	Jurnal Pendidikan IPA Indonesia	http://journal.unnes.ac.id/index.php/jpii
3	Al-Ishlah: Jurnal Pendidikan	https://journal.staihubbulwathan.id/index.php/alishlah
4	International Journal of Education in Mathematics, Science, and Technology (IJEMST)	https://www.ijemst.net/index.php/ijemst
5	Journal of Physics: Conference Series	https://iopscience.iop.org/journal/1742-6596
6	International Journal of Instruction	https://www.e-iji.net/
7	Universal Journal of Educational Research	https://www.hrpub.org/journals/jour_info.php?id=95
8	Biosfer: Jurnal Pendidikan Biologi	http://journal.unj.ac.id/unj/index.php/biosfer/index
9	International Journal of Emerging Technologies in Learning	https://online-journals.org/index.php/i-jet
10	Journal of Education and Learning	https://edulearn.intelektual.org/index.php/EduLearn
11	Advances in Social Science, Education and Humanities Research	https://www.atlantis-press.com/proceedings/series/assehr

Findings

Characteristics of each study

Once the primary studies have been found, the first step in a study meta-analysis is to calculate the effect size of each study. Table 3 provides a summary of effect size calculations from the primary studies in this meta-analysis.

Effect sizes of each study

The first step in this meta-analysis was to calculate the effect size of each study. Study effect sizes were calculated with the help of JASP 0.16.3 aplication. Table 4 provides a summary of the effect size values, for each study. Based on Table 4 above, out of a total of 14 effect sizes from the studies conducted, the effect size values ranged from 0.27 to 2.32, with a 95% confidence level. Referring to the classification of Cohen et al.

Table 2. Categories of effect size (ES) groups using the Cohen interpretation

No	*Classification*	*Interval*
1	No Effect	0.00 < ES ≤ 0.19
2	Small Effect	0.19 < ES ≤ 0.49
3	Moderate Effect	0.49 < ES ≤ 0.79
4	Large Effect	0.79 < ES ≤ 1.29
5	Very Large Effect	ES > 1.29

Table 3: Characteristics of each study

No	*Author*	*Dependent Variable*	*Educational Stage*	*Field of Study*
1	Tika & Agustina (2021)	Learning Outcomes	Primary School	Biology
2	Hujjatusnaini et al. (2022)	HOTS	University	Biology
3	Telaumbanua (2022)	Negotiation Text Writing Ability	Senior High School	Language
4	Mursid et al. (2022)[a]	Learning Outcomes	University	Mechanical Engineering Education
5	Mursid et al. (2022)[b]			
6	Mursid et al. (2022)[c]			
7	Aliftika et al. (2021)	Critical Thinking	Senior High School	Physics
8	Putra et al. (2021)	Spatial Thinking	Senior High School	Geographic
9	Ramadhani & fitri (2020)[a]	Statistical Thinking	Senior High School	Mathematics
10	Ramadhani & fitri (2020)[b]			
11	Mufida et al. (2020)	Science Process Skills	Senior High School	Biology
12	Sumarmi et al. (2021)[a]	Learning Outcomes	University	Geographic
13	Sumarmi et al. (2021)[b]	Spatial Thinking	University	
14	Husamah (2015)	Cognitive Knowledge	University	Biology
15	Silvi et al. (2019)	Learning Outcomes	Senior High School	Graphic Design

Table 4: Summary of Effect size per Study

No	Author	Effect Size	Varians	Category
1	Tika & Agustina (2021)	1.45	0.08	Very Large Effect
2	Hujjatusnaini et al. (2022)	2.26	0.03	Very Large Effect
3	Telaumbanua (2022)	2.32	0.11	Very Large Effect
4	Mursid et al. (2022) studi a	0.91	0.06	Large Effect
5	Mursid et al. (2022) studi b	0.85	0.11	Large Effect
6	Mursid et al. (2022) studi c	1.16	0.12	Large Effect
7	Putra et al. (2021)	1.00	0.06	Large Effect
8	Ramadhani & fitri (2020) studi a	1.34	0.07	Very Large Effect
9	Ramadhani & fitri (2020) studi b	0.67	0.06	Moderate effect
10	Mufida et al. (2020)	0.27	0.06	Small Effect
11	Sumarmi et al. (2021) studi a	1.71	0.08	Very Large Effect
12	Sumarmi et al. (2021) studi b	1.37	0.07	Very Large Effect
13	Husamah (2015) studi a	1.55	0.06	Very Large Effect
14	Silvi et al. (2019)	1.11	0.08	Large Effect
15	Aliftika et al. (2021)	1.07	0.06	Large Effect

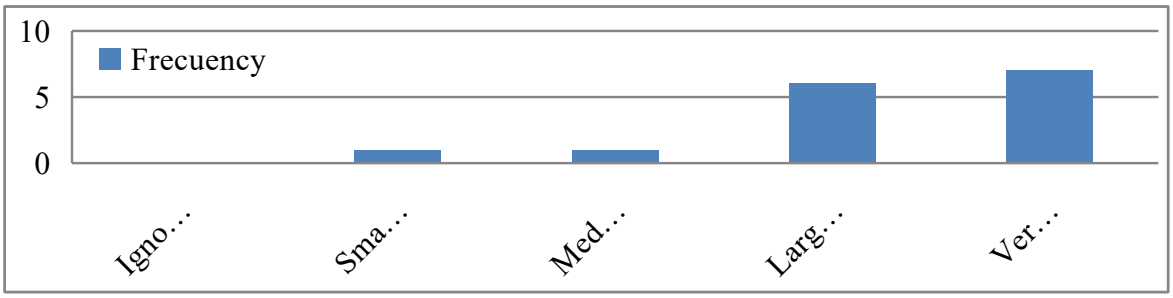

Fig. 1: Comparison of effect size classifications between studie

Table 5. Heterogeneity test summary and combined effect sizes

					Heterogeneity		
Model	*k*	*Effect Size (d)*	*[95% CI]*	*p*	*Q*	*p*	*I2*
Random	15	1.28	[0.96, 1.61]	< 0.001	73.28	< 0.001	82.26%
Fixed	15	1.32	[1.18, 1.45]	< 0.001			

Note. k = the number of studies; CI = Confidence Interval; Df = degree of Freedom

Table 6. File-Safe N

	File Drawer Analysis			
	k	*Fail-safe N*	*Target Significance*	*Observed Significance*
Rosenthal	15	1760	0.05	< 0.001

(2018), there is one effect size (n = 1) classified as a small effect, one effect size (n = 1) classified as a moderate effect, six effect sizes (n = 6) were classified as large effects, and the seven effect sizes (n = 7) were classified as very large effects. For clarity, figure 1 visualizes a comparison of the effect size classifications between studies.

Heterogeneity test and overall effect size

The heterogeneity test aims to select a suitable model to calculate the combined effect size. There are many approaches used to test for heterogeneity, but in this study the Q parameter approach was used or by looking at the p value. If the p value < 0.05 then the effect size variance is heterogeneous so a random effects model is used, and if the p value > 0.05 then the effect size variance is homogeneous so the model used is a fixed effect. Table 5 presents a summary of heterogeneity tests and combined effect sizes.

The results of the heterogeneity test (see Table 5) show the Q value is 73.28. Since this value is greater than the chi-square value (df = 14) and the p-value < 0.05, it can be concluded that the studies conducted to calculate the effect size were heterogeneous. The I^2 value found to reach 82.26% reflects high heterogeneity (Higgins et al., 2003). Since the studies used were heterogeneous, the overall effect size value was based on the random effects model. Based on the random effects model, the effect size value is 1.28. This effect size belongs to the large effect category (Cohen et al., 2018). Thus, these results reveal that the use of blended project-based learning has a large effect on students' achievement.

Evaluation of publication bias

Meta-analytical studies that are scientifically justified and reflect objectivity can be assessed by evaluation of publication bias. this study examines publication bias with the File-Safe N (FSN) approach. The results of the analysis (see Table 6) were obtained (FSN = 1760 > 5k+10= 110). These results suggest that this meta-analysis study does not have publication bias issues. The following table provides a summary of the evaluation of publication bias.

Discussion

The results of the analysis show that the combined effect size using the random effects approach is (d = 1.28; and k = 15). This effect size is included in the large effect category. These results indicate that the application of the BPjBL model has a major effect on student learning outcomes compared to the traditional learning model. Although there has been no meta-analysis regarding the effect of the blended project-based learning model on student achievement, the findings of previous meta-analyses found that blended learning is more effective than conventional learning, such as math skills (Setiawan et al., 2022), student learning outcomes (Lusa et al., 2021), learning achievement (Vo et al., 2017; Li et al., 2022), medical education (Liu et al., 2016; Vallée et al., 2020; Li et al., 2019), and multiple intelligences and student character education (Oktarina et al., 2021). In addition, other meta-analysis studies also found that the effect of the project-based

learning model (PjBL) on academic achievement is better than conventional learning models (Chen et al., 2019; Ayaz et al., 2015; Baleman et al., 2018). The integration between blended learning and project-based learning models is expected to be a solution to the needs of innovative learning models in improving current student achievement.

Based on the 15 studies analyzed (see Table 4), it shows that all studies report that BPjBL is more effective than traditional learning. However, research conducted by Muftida et al. (2020) found that the application of BPJBL had little effect on science process skills, while the results of other studies found that BPjBL had a large influence on learning outcomes (Tika & Agustina, 2021; Husamah, 2015), higher order thinking skills (Hujjatusnaini et al., 2022), critical thinking (Aliftika et al., 2021). Although the previous findings represented different results, BPjBL was identified as better than traditional learning. Meanwhile, the mathematics learning conducted by Ramadhani & Fitri (2020) also showed different results. In their experiments, they found that BPjBL had a moderate effect when compared to blended learning (BL), but BPjBL had a large effect when compared to direct learning. Even though the experimental results were different, the BPjBL mathematics learning was better than the BL and direct learning. Furthermore, in other fields of study, such as learning geography (putra et al., 2021; Sumarmi et al., 2021), technology learning (Mursid et al., 2022; Silvi et al., 2019), and language learning (Telaumbanua, 2022), it was found that BPjBL has a large impact when compared to traditional learning. These results indicate that overall BPjBL is better than the traditional learning model.

BPjBL is an integration of blended learning and project-based learning models. This model was developed with a student-centered learning approach. Students actively discover and solve problems through investigation and experimentation. This model emphasizes the aspect of time intensity which is facilitated by blended learning with unlimited concepts, both space and time so that it can support an active learning process (Yustina et al., 2020; Tong & Wei, 2020). This learning model has the characteristics of utilizing online resources to support the implementation of the project learning process (Muhtar & Iskdandar, 2019).

The application of BPjBL is a solution that is relevant to current environmental conditions so that it can support an increase in student learning achievement compared to traditional learning models. BPjBL can provide a flexible learning environment, increase student motivation, and facilitate review and study control. Besides that, it can solve problems professionally independently and improve student collaborative work projects (Wahyudi, 2020). BPjBL Facilitates maximum student study time to be involved and work directly so that learning is more effective and efficient. This is in accordance with Telaumbanua's statement (2020) which states that the learning process will be more effective and efficient if students are given more opportunities to be involved and work directly (Telaumbanua, 2022). BPjBL also facilitates maximum learning time to be able to exchange ideas with friends and seek in-depth information to support the ideas conveyed (Mutakinati et al., 2018). BPjBL provides opportunities for students to be creative and learn anywhere without being limited by space and time (Telaumbanua, 2022). Therefore, it can be said that the learning process will be more effective and efficient if students are given more opportunities to be directly involved and work.

This study gives clear results that the confusing effect size differences between the BPjBL model variables and student achievement based on various kinds of literature (some fall into the small to very large categories) become clear after the meta-analysis, namely the medium category. Schools must be able to implement BPjBL properly according to student needs, thus the quality of the learning process will increase. In addition, the results of this study will provide an overview of the influence of BPjBL on student achievement, so that it can be used as a basis for policy-making to improve the quality of learning. In addition, the results of this study can also be used as a reference to compare the implementation of BPjBL on achievement in various places/locations or countries in responding to the importance of implementing BPjBL in the classroom learning process.

Conclusion

BPjBL is an integration of blended learning and project-based learning models. The BPjBL model emphasizes a flexible (synchronous and asynchronous) and project-based learning process. This model emphasizes the aspect of time-intensity which is facilitated by blended learning with unlimited concepts, both space and time so that it can support an active learning process. The results of the analysis of 11 primary studies show that overall, the application of BPjBL has a major effect on student achievement when compared to traditional learning. This meta-analysis also has no publication bias so this meta-analysis research is objective and scientifically acceptable. The findings of this meta-analysis show the consistency of the publication of research results on the effect of using the BPjBL model on student achievement.

This research also has limitations. This study only analyzed 15 effect sizes from the 11 primary studies analyzed. This study also only analyzes learning achievement in general. Future research can conduct studies by focusing on the subject areas being taught (for example Mathematics, Physics, Biology, and others), as well as expanding the research sample and analyzing the dependent variable more specifically (for example critical thinking skills, creative thinking, and others).

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