

The effectiveness of flipped classroom based blended learning on students critical thinking skills

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Abstract: This study aims to determine the effectiveness of flipped classroom-based blended learning on students' critical thinking skills. This study is a type of meta-analysis research. Data sources come from 14 national and international journals published in 2018-2023. The process of finding data sources comes from Google Scholar, ERIC, DOAJ, EBSCO, ProQuest, ScienceDirect and PLoS ONE. Keywords search for blended learning data, blended learning based on flipped classroom, and the effectiveness of blended learning based on flipped classroom on students' critical thinking skills. Data analysis techniques with the help of JSAP applications. The results of the study concluded that the average value of effect size (ES = 0.838) high sizeeffect category and standard error of 0.109 . These findings explain that the flipped classroom-based blended learning model has a positive influence on students' critical thinking skills.

Keywords: Blended Learning; Flipped Classroom; Critical Thinking; Meta-analysis

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INTRODUCTION

Students need to be able to think critically in order to deal with the effects of the industrial revolution. In order to face the industrial revolution, students need to be able to think from 4.0 to 5.0 in terms of society. 4.0 moving society toward 5.0 Critical (Warsah et al., 2021); (Palavan, 2020); (Zulyusri et al., 2023) One of the most essential things critical thinking does for pupils is assist them solve problems (Yulitriana et al., 2023); (Tuaputty et al., 2023) The goal of critical thinking abilities is to offer answers for resolving difficult issues. (Chimmalee & Anupan, 2023). Critical thinking abilities enable students to assess the accuracy of the information they have been given (Priyambodo et al., 2023); (Jamaludin et al., 2022). Students that possess critical thinking skills find it easier to comprehend the things they are studying (Ercan & Hakkoymaz, 2022); (Hacioğlu & Gülhan, 2021).

However, kids' critical thinking abilities are actually rather low in the classroom. Because learning activities are teacher-centered, it is challenging for pupils to comprehend the subject matter (Rahman et al., 2023); (Suryono et al., 2023); (Zulkifli et al., 2022); (Kuncoro et al., 2023). Teachers do not actively involve pupils in the learning process (Al-Fikry et al., 2018); (Bahar et al., 2023) because learning is only possible to the extent that low-level thinking can reach cognitive limits (Kurniahtunnisa et al., 2016) Additionally, the findings of the TIMSS study Students' critical thinking abilities in science and math had a score of 396 in 2015, which was lower than the global average of 500 (Miterianifa et al., 2019);(Utomo et al., 2023). Furthermore, the OECD's PISA 2018 results revealed that Indonesian pupils' literacy levels are remained comparatively low when compared to those of other member nations (Ichsan et al., 2023); Hudha et al., 2023). The use of unsuitable learning models has an impact on pupils' limited critical thinking abilities as well (Sihaloho et al., 2017)

One type of learning that can help students develop their critical thinking abilities is blended learning (Korkmaz & Karakuş, 2009);(Ernawati & Sari, 2022). With the use of certain technologies, blended learning is a learning paradigm that may be used both online and offline (Nida et al., 2020); (Yapici & Akbayin, 2012). Students may study autonomously, creatively, and endlessly with the support of blended learning (Fazal & Bryant, 2019); (Wuxue, 2023); (Supriyadi et al., 2023) In addition, blended learning trains students to learn more actively both inside and outside the classroom (Setiawan et al., 2022)

Additionally, blended learning with a flipped classroom can help students become more adept at critical and creative thinking (Zulhamdi et al., 2022); (Sya'roni et al., 2020). Students' learning process is made more engaging with blended learning and flipped classroom abscissa (Rahmani & Samira Zitouni, 2022). Moreover, flipped classroom-based blended learning is an innovative approach to education that facilitates the completion of learning tasks by teachers and students (Low et al., 2021); (Guicai et al., 2015).

Using a blended learning strategy that is based on flipped classrooms helps students become more creative and collaborative learner (Tan et al., 2022)2; (Ahmad & Lukmanul Akhsani, 2023). Flipped classrooms, the foundation of blended learning, can encourage student motivation during the learning process (Atmojo & Ismaniati, 2020). Furthermore, (Schmid et al., 2023) Flipped classroom instruction has the potential to boost students' self-esteem. Many research findings are connected to the use of blended learning with flipped classrooms; however, meta-analysis is required to ascertain the impact size of using the paradigm. This serves as the foundation for the study's goal of evaluating how well blended learning based on flipped classrooms affects students' critical thinking abilities.

METHODS

The This research is a meta-analysis. One kind of study that can statistically derive a broad conclusion from earlier primary research is meta-analysis. (Öztop, 2023); (Razak et al., 2021);(Hidayah et al., 2023); (Taşdemir, 2022). The stages in the meta-analysis, according to Borenstein et al., (2009) are (1) establishing inclusion criteria, (2) gathering. The steps involved in the meta-analysis include selecting inclusion criteria, compiling and arranging study data, evaluating the quality of the research, and doing statistical analysis.

Literature Search

A search of the databases Google Scholar, ERIC, DOAJ, EBSCO, ProQuest, ScienceDirect, and PLoS ONE was conducted in order to gather data for the meta-analysis. The terms "flipped classroom-based blended learning," "critical thinking skills," and "blended learning"

are the keywords. Table 1 shows the results of 445 related studies that were found through a journal database search. Additionally, the PRISMA 2020 method—which consists of identification, screening, eligibility, and included—was used to choose the data.

Table 1. Data sources from journal databases

Database	Sum	Percentage (%)
Google Scholar	303	67.34
ERIC	30	6.74
EBSCO	14	3.14
DOAJ	9	2,02
ProQuest	46	10.34
ScienceDirect	37	8.31
Plos ONE	6	1.35
Total	445	

Inclusion Criteria

In order to get high-quality papers that are relevant to study variables sourced from journal databases, inclusion criteria must be established. Table 2 displays the inclusion criteria used in this meta-analysis.

Table 2. Inclusion Criteria

No.	Inclusion Criteria
1.	Research published in 2018-2023
2.	Research comes from Sinta and Scopus indexed journals or proceedings
3.	Research related to blended learning based on flipped classrooms in experimental classes and conventional learning control classes
4.	Open access research
5.	Research can report complete data to calculate the value of effect size

Statistical Analysis

The impact size value of each study, assessing heterogeneity and selecting estimate models, publication bias verification, and p-value calculation for testing research hypotheses are among the statistical analyses included in this meta-analysis (Borenstein et al., 2009). Statistical analysis of tests with the help of JSAP software. Furthermore, the effect size category is guided by the (Cohen et al., 2002) can see Table 3.

Table 3. Effect Size Value Category

Effect Size	Information
$0.00 \leq ES \leq 0.20$	Ignored
$0.20 \leq ES \leq 0.50$	Low
$0.50 \leq ES \leq 0.80$	Medium
$0.80 \leq ES \leq 1.30$	High
$ES \geq 1.30$	Very High

RESULTS AND DISCUSSION

Result

After doing a literature search on Google Scholar, 445 papers regarding the impact of blended learning with flipped classrooms on students' critical thinking abilities were found in databases including ERIC, DOAJ, EBSCO, ProQuest, ScienceDirect, and PLoS ONE. Only 1:1

research, nevertheless, were able to satisfy the preset inclusion requirements. Table 4 displays the computed effect size values for the data that satisfy the inclusion criteria.

Table 4. Article Effect Size Analysis

No.	Writer	Country	Effect Size	Standard Error
1.	(Radiah, 2022)	Indonesian	0.85	0.27
2.	(Nurhayati et al., 2017)	Indonesian	0.97	0.40
3.	(Sari et al., 2021)	Indonesian	0.39	0.17
4.	(Zulhamdi et al., 2022)	Indonesian	1.14	0.52
5.	(Neat et al., 2022)	Indonesian	0.93	0.30
6.	(Mohebbi et al., 2022)	Iran	1.28	0.35
7.	(Astawa et al., 2022)	Indonesian	0.94	0.39
8.	(Purba, 2021)	Indonesian	0.81	0.26
9.	(Pattimukay et al., 2023)	Indonesian	1.42	0.45
10.	(Fulgueras & Bautista, 2020)	Philippines	0.88	0.34
11.	(Sukma et al., 2022)	Indonesian	0.72	0.31

Table 4, shows the effect size analysis results from 11 journals. The standard error value ranges from 0.17 to 0.52 while the effect size values range from 0.39 to 1.42. There are three different effect sizes: low category (n = 1), medium criterion (n = 3), and high criteria (n = 7). Testing heterogeneity and choosing estimate models from the 11 journals that were part of the meta-analysis came next. Table 5. displays the outcomes of the heterogeneity test and the estimating models that were used.

Table 5. Heterogeneity Test Results

	Q	Df	p
Omnibus test of Coefficients Mode	45.018	1	< 0.001
Test of Residual Heterogeneity	114.413	10	< 0.001

Table 5, the heterogeneity test findings showed a value (Q = 114.413) higher than the value of 45.018. These findings indicate that there is unequal distribution of the effect size. The mean effect size of the 11 articles under analysis may be found using the random effect model. The next step is to test Rosenthal Fail Safe N and use the funnel plot to check for publication bias. Figure 1 shows the outcomes of using the funnel plot to check publication bias in 11 papers.

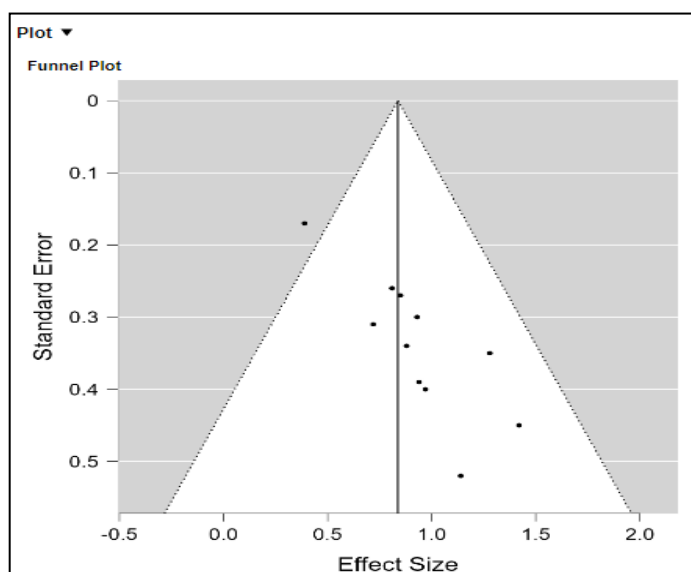


Figure 1. Funnel Plot Standard Error

Figure 1, Using funnel plots for publishing bias analysis, the shape's symmetry or asymmetry cannot be determined. The Rosenthal fail safe N test must therefore be carried out. Displays the outcomes of the safe N file test Table 6.

Table 6. Rosenthal Fail Safe N Test Results

	Fail Safe N	Target Significance	Observed Significance
Rosenthal	331.000	0.050	< 0.001

Based on Table 6, 331,000 is the safe N file result, while 0.050 is the significance value. The results demonstrated that there was no publication bias in 11 of the articles examined in the meta-analysis. The final phase entails conducting a hypothesis test to ascertain how well students' critical thinking abilities are affected by the blended learning paradigm based on flipped classrooms. Test the meta-analysis hypothesis with mean effect size can be seen in Table 7.

Table 7. Mean Effect Size Results

Coeficient	95 %Confidence interval					
	Effect Size	Standard Error	z	p	Lower	Upper
Intercept	0.838	0.109	7.720	0.001	0.626	1.051

Table 7, Results for the mean effect size yielded a 95% confidence interval with a lower of 0.626 and an upper of 1.051. Additionally, based on the high criteria of mean effect size (ES = 0.838) and value (z = 7.720; p < 0.001), the blended learning paradigm based on flipped classrooms has a noteworthy impact on students' critical thinking abilities. Consequently, the blended learning paradigm that utilizes flipped classrooms is successful in enhancing students' critical thinking abilities during the learning process.

Discussion

Students' critical thinking abilities in the classroom can be effectively enhanced by implementing a mixed learning paradigm that is based on flipped classrooms. The mean effect size value (ES = 0.838; SE = 0.109; p < 0.001) is visible. This result is consistent with (Listiqowati et al., 2022) Students' critical thinking abilities are effectively enhanced by learning based on the flipped classroom model. Students' critical thinking abilities are effectively encouraged by the blended learning paradigm that is based on flipped classrooms (Orhan, 2023) Flipped classrooms, which are the foundation of blended learning, encourage students to learn more autonomously and creatively (Garcia-Ponce & Mora-Pablo, 2020); (Qutieshat et al., 2020). Furthermore, blended learning has the potential to boost students' self-assurance in their ability to learn, hence promoting critical thinking skills (Bruggeman et al., 2021).

Moreover, online and in-person blended learning based on flipped classrooms is possible (Radulović et al., 2023); (Sujannah et al., 2022); (Katasila & Poonpon, 2022). Students' enthusiasm in learning and their ability to solve problems can be developed through the blended learning methodology (Budhyani et al., 2022) Furthermore, students may find it simpler to access learning resources thanks to the blended learning paradigm based on the flipped classroom (Alajmi, 2021); (Özyer & Altınsoy, 2023); (Yimer, 2022); (Çakır et al., 2020). According to (Ataizi & Kömür, 2021) In order to create a more engaging learning environment, the blended learning model might encourage students to persevere in their studies.

Students can master technology learning through the use of the blended learning paradigm based on flipped classrooms. In a flipped classroom, students watch videos that

have been provided by the teacher to help them develop their critical thinking abilities (Diningrat et al., 2023); (Saira et al., 2021); (Sengul & Bostanci, 2021); (Suryono et al., 2023). Students' capacity for critical thought is crucial in helping them make the best decisions while solving difficulties. As stated by (Yulitriana et al., 2023) Students who possess critical thinking abilities can reach conclusions more quickly and easily. Because of this, teachers can greatly benefit from the existence of a blended learning model based on flipped classrooms in order to help students develop their critical thinking abilities.

CONCLUSION

The meta-analysis yielded the following conclusions: the effect size category's average value ($ES = 0.838$) is large, and the standard error is 0.109. These results provide an explanation for the beneficial effects of the blended learning paradigm based on flipped classrooms on students' critical thinking abilities. Through the use of technology, the flipped blended learning paradigm empowers students to learn more autonomously and creatively. Students learn without time constraints using a blended learning strategy based on flipped classrooms. Teachers can use this knowledge to build blended learning methods in the classroom according to the findings.

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