The Effect Size of Blended Learning in Mathematics Learning

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Abstract

This study aims to determine the effect of blended learning in mathematics learning. This type of research is quantitative research with a meta-analysis approach. The inclusion criteria are research published in 2020-2023, research must be experimental methods or quasi-experiments, research related to the influence of blended learning in mathematics learning, research comes from SINTA indexed journals, Research data is obtained through google scholar, DOAJ, Mendeley and Sinta and research has complete data to calculate the value of effect size. The results of 23 studies concluded that there was a significant influence of blended learning in mathematics learning with an average effect size value of 0.83 with a large effect category. These findings provide more accurate information about the application of blended learning in mathematics learning.

Keywords: Blended learning; Effect Size, Math

Introduction

Mathematics learning is an important process in the intellectual and cognitive development of students at all levels of education (Geary, 2014). Through learning mathematics, students not only gain an understanding of basic concepts such as addition, subtraction, multiplication, and division, but also develop analytical, problem-solving, and logical thinking skills (Stanne &; Donovan, 2019). By understanding mathematics, students can apply their knowledge in a variety of contexts of everyday life, from managing personal finances to solving complex problems in science and technology(Lazic, 2021).

Furthermore, mathematics learning also helps students to develop critical and creative thinking skills (Asri et al., 2017; Sofianora et al., 2023). In solving mathematical problems, students are invited to think systematically, identify patterns, and find effective solutions (Elfira et al., 2023; Suryono et al., 2023). This process stimulates students' brain development,

strengthens connections between neurons, and improves short and long-term memory skills (Prasetya et al., 2020). Thus, learning mathematics is not only about mastering formulas and concepts, but also about honing thinking skills that can be applied in various aspects of life.

However, in fact, many students have difficulty in understanding mathematical concepts and lack of confidence in solving math problems (Mursid et al., 2022). In addition, there are also problems related to the use of technology in mathematics learning. The development of technology has opened up new opportunities in delivering mathematical material in a more interactive and interesting way. However, it is not yet clear to what extent the use of this technology can actually improve students' understanding and achievement of mathematics learning, as well as how to overcome potential technical barriers or access limitations that some students or schools may experience.

A deeper understanding of these issues can provide valuable insights into designing more effective and inclusive maths learning strategies (Rahman et al., 2023). Therefore, research that focuses on increasing students' interest and motivation in mathematics as well as evaluating the effectiveness of using technology in mathematics learning will provide valuable insights for the development of better and more effective learning approaches. By taking these challenges into account, research can produce practical recommendations for improving the quality of mathematics learning at various levels of education. In addition, in learning activities teachers apply inappropriate learning models to improve the quality of student learning (Rattanatumma & Puncreobutr, 2016; Nurtamam et al., 2023). Therefore, there is a need for a learning model that can improve the quality of students' mathematics learning.

Blended learning is one of the effective learning models applied in student mathematics learning (Setiawan et al., 2022; Rahman et al., 2023); (Tseng et al., 2014). Blended learning is a learning model that integrates two or more teaching methods, usually between online learning and offline learning, to create a holistic and integrated learning experience (Ahmad et al., 2018; Suana et al., 2019). In the blended learning model, students can access learning content independently through digital platforms, which are then combined with face-to-face interactions with teachers and fellow students. Flexibility in time and place and the use of diverse learning resources is one of the hallmarks of blended learning, allowing adaptation to students' individual learning styles (Ariswan et al., 2023). Through this combination, blended learning not only enables more personalized and student-centered teaching, but also encourages the development of digital and critical skills that are essential in today's information technology era (Bedebayeva et al., 2022; Mutya &; Masuhay, 2023).

Previous research has shown that the application of blended learning models is effective in improving student learning outcomes and understanding of concepts in mathematics learning (Indrapangastuti et al., 2021; Prawestri et al., 2020). Research by Attard & Holmes (2022) said the application of the blended learning model encourages students to be more active and creative in learning, Many studies related to blended learning are still few studies on the effect size of the blended learning model in mathematics learning. Therefore,

there is a need for meta-analysis to describe accurate and in-depth conclusions about blended learning models. Therefore, the study aims to influence blended learning in mathematics learning.

Research Methods

This research is a type of meta-analysis research, Meta-analysis is a research approach that collects and analyzes the results of primary research quantitatively to get a conclusion (Zulyusri et al., 2023; Oktarina et al., 2021; Razak et al., 2021; Juandi et al., 2021; Diah et al., 2022). This meta-analysis aims to determine the effect of the size of the blended learning model in student mathematics learning. The inclusion criteria are research published in 2020-2023, research must be experimental methods or quasi-experiments, research related to the influence of blended learning in mathematics learning, research comes from SINTA indexed journals, Research data is obtained through google scholar, DOAJ, Mendeley and Sinta and research has complete data to calculate the value of effect size. Data analysis by calculating the effect size value of each study with the JSAP 0.8.5 application. Furthermore, the effect size criteria in this study are guided by the effect size criteria (Cohen et al., 2007) can be seen in Table 1.

Table 1. Cohen's Effect Size Criteria

Effect Size	Effect Size Criteria
$0.0 \leq ES \leq 0.2$	Low
$0.2 \leq ES \leq 0.8$	Medium
$ES \geq 0.8$	High

Results and Discussion

From searching the literature through the Google Scholar database, DOAJ, Mendeley regarding the effect of blended learning in student mathematics learning obtained 23 studies that met the inclusion criteria. Data that have met the inclusion criteria are calculated effect size values which can be seen in Table 2.

Table 2. Effect size and Standard Error

Study Code	Year	Journal Index	Standard Error	Effect Size	Effect Size Criteria
Study 1	2020	SINTA	0.23	0.62	Medium
Study 2	2020	SINTA	0.45	0.97	High
Study 3	2023	SINTA	0.14	0.35	Medium
Study 4	2022	SINTA	0.20	0.58	Medium
Study 5	2023	SINTA	0.35	0.81	High
Study 6	2021	SINTA	0.29	0.77	Medium
Study 7	2021	SINTA	0.31	0.83	High
Study 8	2022	SINTA	0.25	0.65	Medium

Study 9	2022	SINTA	0.31	0.86	Medium
Study 10	2023	SINTA	0.52	1.78	High
Study 11	2021	SINTA	0.42	1.60	High
Study 12	2020	SINTA	0.38	0.84	High
Study 13	2020	SINTA	0.37	0.90	High
Study 14	2020	SINTA	0.40	0.88	High
Study 15	2020	SINTA	0.38	0.61	Medium
Study 16	2020	SINTA	0.29	0.85	High
Study 17	2020	SINTA	0.49	0.92	High
Study 18	2021	SINTA	0.51	1.19	High
Study 19	2022	SINTA	0.23	0.49	Medium
Study 20	2021	SINTA	0.35	0.72	Medium
Study 21	2020	SINTA	0.30	0.60	Medium
Study 22	2021	SINTA	0.19	0.48	Medium
Study 23	2023	SINTA	0.35	0.94	High
Average Effect Size			**0.33**	**0.83**	**High**

Based on Table 2, the effect size value of the study ranged from 0.35 to 1.78. According to the effect size criterion (Cohen et al., 2007) Of the 23 studies analyzed, eleven studies (47.82%) had medium effect size criteria and twelve studies or (52.18) studies had high effect size criteria. Furthermore, the average value of the effect size is 0.83 and the effect size value is 0.33. The results of the study concluded that the blended learning model has a significant influence on mathematics learning. Research by Hu et al., (2023) The blended learning model has a positive influence on the quality of students' mathematics learning. Teachers' blended learning models can leverage a variety of digital resources, such as learning videos, interactive games, and online learning platforms, to improve their understanding of mathematical concepts (Dardiri &; Siswoyo, 2022). Students can access learning materials anytime and anywhere, allowing them to learn independently and at their individual pace (Solehuddin et al., 2023;Rahman et al., 2023). In addition, face-to-face interaction in the classroom can be used to discuss more complex concepts, solve problems together, and provide immediate feedback, which can increase student engagement and strengthen their understanding.

However, although blended learning offers various advantages, there are some challenges that need to be overcome in its implementation in mathematics learning. One of the main challenges is the availability of adequate technology infrastructure in students' schools and homes, as well as the digital skills required by both teachers and students (Kadirbayeva et al., 2022). In addition, effective lesson planning and proper integration between online and face-to-face learning also require considerable time and resources (Tabieh &; Hamzeh, 2022). Therefore, research on the influence of blended learning in mathematics learning also needs to pay attention to aspects of technical implementation and management strategies to ensure

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success (Catalyla &; Poonpon, 2022). The next step, analyze the effect size based on the level of education that applies the blended learning model in student mathematics learning. The results of effect size analysis based on education level can be seen in Table 3.

Table 3. Effect Size Based on Education Level

Education Level	Effect Size	Criterion
SD	0.67	Medium
JUNIOR	0.82	High
SMA	0.89	High

Based on Table 3, the effect size value at the elementary level is 0.67 medium criteria, junior high school is 0.82 high criteria and SMA is 0.89 with high criteria. The results concluded that blended learning is effectively applied in students' mathematics learning. Blended learning can encourage students to learn independently and creatively by utilizing technology (Kurniawati, 2021). Blended learning, which integrates traditional face-to-face instruction with online learning activities, has gained significant attention in the realm of education, particularly in the teaching of mathematics. This research investigates the effectiveness of blended learning approaches in enhancing mathematical learning outcomes among students.

Firstly, blended learning offers a flexible and dynamic learning environment, allowing students to access a variety of resources and engage with content at their own pace. By combining traditional classroom instruction with online modules, students have the opportunity to reinforce their understanding of mathematical concepts through interactive multimedia materials, virtual simulations, and educational software (Yaghmour, 2016); . This multifaceted approach caters to diverse learning styles and promotes active participation, thus potentially improving students' comprehension and retention of mathematical concepts (Nugraheni &; Kiptiyah, 2019).

Conclusion

From this meta-analysis research, it can be concluded that sil research from 23 studies concluded that there was a significant influence of blended learning in mathematics learning with an average effect size value of 0.83 with a large effect category. These findings provide more accurate information about the application of blended learning in mathematics learning. The blended learning model encourages students to learn independently and creatively by utilizing technology, so that students learn more actively.

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