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The Effect of Blended Learning Model (BLM) on Student Achievements: A Meta-Analysis

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Abstract: The 21st-century learning requires teachers to develop the abilities of students and change the learning system from teacher-centered to student-centered. In fact, the learning process still uses conventional and teacher-centered methods, so that student learning outcomes are low. For this reason, the BLM (Blended Learning Model) is applied to improve student learning outcomes in physics subjects. This study aims to determine the effect of similar studies using the BLM on students' achievement. The type of research used is meta-analysis research with a quantitative approach. The results of this study are the first, namely the influence of similar studies from the BLM which shows that BLM has a significant influence on student achievement. Second, based on grade level, the effect of similar studies from the BLM shows that grade XI has a more significant impact. Third, based on the learning material, the effect of similar studies from the BLM shows that the optical topic has a significant impact. Fourth, based on learning media that has a more significant impact than similar studies, namely the schoology application. This research can be used as a reference for developing BLM on different materials, school levels, and various interactive media.

Keywords: Meta-analysis; Blended Learning Model; Student achievements.

Introduction

Advances in science and technology are the trigger for the success of the 21st century, so a learning process that is in accordance with the competencies of the 21st-century is needed (Mardianti et al., 2020; Azmi et al., 2021). The 21st-century competence is a combination of aspects of attitudes, knowledge, skills, and values (Asrizal et al., 2022; Saavedra & Opfer, 2021; Wang et al., 2018). The balance of all these aspects is important for students in achieving success in learning both in their daily lives and in their future. Teachers must be able to create learning that is able to develop student competencies holistically to suit the development of education in the 21st century (Asrizal et al., 2018). Physics learning must be able to answer the demands of 21st-century learning that is developing at this time, where teachers must be able to grow the mastery of students' generic competencies, namely critical thinking, creative, collaboration, communication, character education and literacy (Asrizal et al., 2018).

The main goal of 21st-century learning is to develop students' learning abilities, and to support their development into active and independent students (Yulkifli et al., 2019). The 21st-century learning also demands that everything is technology-based to balance the demands of the times in the millennial era so that students are familiar with life skills in the 21st-century (Indrawan et al., 2019; Khairil & Mokshein, 2018). The 21st-century learning makes teachers as facilitators and motivators for their students in finding and utilizing learning resources through digital progress. Students can maximize the role of technology in the learning process. This is what distinguishes conventional learning with 21st-century learning. Learning in the 21st-century is no longer centered on teachers, but centered on students (Rosnaeni, 2021). This 21st-century learning can be realized through the 2013 curriculum.

The curriculum 2013 is a new curriculum developed by the government as a complement to the previous curriculum (Syam et al., 2017). The 2013 curriculum is in accordance with the demands of 21st-century learning, where the 2013 curriculum requires

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teachers to develop the abilities of students and change the applied learning process. This learning process is changed so that students' abilities become more developed, and make students more active in the classroom, especially in learning physics. The 2013 curriculum also prioritizes changes in the learning process, where teachers must apply appropriate models or methods in the learning process (Samudra & Yulkifli, 2019; Retnawati et al., 2016). Therefore, the 2013 curriculum demands a major change in the learning process of students.

The facts found by previous researchers indicate that the learning outcomes obtained by students are still low and still under the minimum completeness criteria. This is because the physics learning process that occurs is still using conventional methods or lectures (Anggraeni et al., 2019; Inayatullah et al., 2021; Akhmalia et al., 2018; Sinaga & Simanjuntak, 2020; Suana et al., 2019). Several other researchers also found that the physics learning process was still dominated by teachers (Putri & Bukit, 2020; Gaol & Sirait, 2019; Najib & Jatmiko, 2022). This of course causes students to be passive in the class, and assume that physics is a boring subject. Students only accept the material presented by the teachers and do not take advantage of the opportunity they have to ask questions, so that the learning outcomes obtained by students are low. In response to these problems, previous researchers said that the BLM was the right solution in improving student learning outcomes.

The BLM is a learning model that combines a face-to-face learning system with modern learning to improve students' learning abilities (Garner & Oke, 2015; Elvianasti et al., 2022; Lestari et al., 2021). The BLM reduces the estimation of conventional learning time in the classroom to increase students' active and autonomous learning abilities by combining the best features of face-to-face learning with online learning (Husamah, 2014). The BLM combines face-to-face and online activities, so as to reduce direct learning in class (Zulhamdi et al., 2022). This model aims to make students more independent and active in learning (Doyan et al., 2022).

The BLM has the advantage that it can deliver learning materials anywhere and anytime, online or offline learning complements each other, learning becomes more effective and efficient, increases accessibility, and learning becomes flexible and not rigid (Hidayat et al., 2020). Besides that, online learning is that learning is not limited by space and time between teachers and students (Dakhi et al., 2020). The BLM affects student learning outcomes (Wong et al., 2014) and is able to improve student learning outcomes (Ceylan &Kesici, 2017). Osguthorpe (2005) explains that there are six reasons to apply the blended learning model in learning, including: (1) rich in teaching, (2) easier access to materials, (3) increased social interaction, (4) private institutions, (5) higher costs. cheap, and (6) the ease of revising learning materials.

There are several things that teachers must consider before implementing BLM, including (1) online learning will be fully or only partially accessed, (2) eliminating the need for study time, (3) preparing evaluations when needed, (4) requiring sufficient funds, (5) providing digital teaching materials, (6) providing student learning resources, and (7) supported by broad access (Dewi et al., 2018).

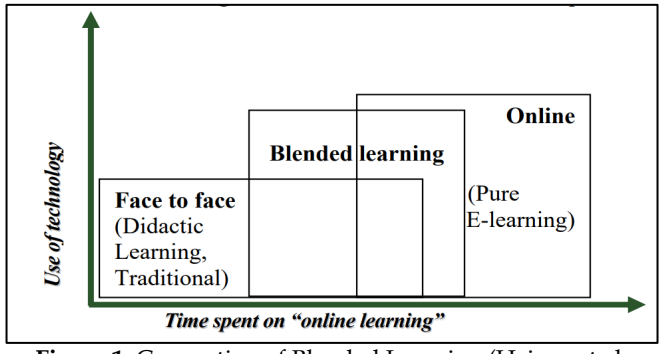

Figure 1. Conception of Blended Learning (Heinze et al., 2004).

To clarify about BLM, we can focus on looking at the BLM concept in Figure 1. The learning system consists of two kinds, namely direct learning or face to face learning in the classroom and online learning using E-Learning. Direct learning does not use many technological devices and vice versa. Online learning requires fast internet access so that learning can run effectively. Driscoll (2002) states that there are four concepts from the blended learning model, namely (1) to combine web-based technology modes in order to achieve educational goals, (2) to combine a scientific approach (constructivism, behaviorism, cognitivism, e) to produce optimal learning outcomes with or without learning technology, (3) to combine all forms of instructional technology with face-to-face training led by instructors, (4) to combine technology with actual study so as to make a synchronous effect of learning.

The results of previous studies have limitations. These limitations include, 1) the results obtained have not explained the effect of a number of similar studies of the BLM on students' physics learning outcomes, 2) only apply the BLM at one grade level, 3) only apply one learning material that uses BLM, 4) using only one learning media in the BLM. Based on these limitations, the researcher wants to integrate all existing similar studies to determine the effect of a number of similar studies from the BLM on students' physics learning outcomes by using the meta-analysis method.

Meta-analyses were performed to analyze the central trends and variations in study results, as well as to correct for errors and biases in the study (Littell et al.,

2018). Meta-analysis can solve the problem of various research findings that are contradictory or difficult to accumulate, and eventually become more systematic through meta-analysis. In addition, other advantages of meta-analysis are (1) it comprise a systematic review of existing research and allows for more insight into the assumptions, procedures, evidence, and conclusions of the researcher, (2) gives a more statistically based on conclusion taking into account the strength of the influence in each empirical study rather than a qualitative summary based solely on ratings, (3) a synthesized influence is calculated with more statistical power, as meta-analyses also investigate factors related to the study design, (4) they offer information processing methods organized from a large literature source (Lipsey & Wilson, 2001).

Meta-analysis research was chosen as the research method for several reasons. First, there are many articles that discuss the effect of the BLM on student achievements. Second, meta-analysis research does not depend on school conditions, thereby reducing the risk of research delays due to school conditions that are still not conducive due to the Covid-19 pandemic. Third, there is no research on the effect of a number of similar studies using the BLM on student achievement. Fourth, it is not known the effect of similar studies using the BLM on student achievements that have a significant impact based on grade level, learning materials, and learning media. In this regard, many previous researchers have proven it, but give different conclusions.

This paper will discuss the effect of BLM on overall student achievement. In addition, this paper will explain the effect of BLM on student achievement based on grade level, learning topics and learning media used including research limitations and research implications for future research.

Method

The type of research used is meta-analysis research with a quantitative approach. This study examines several similar articles from national and international journals. The criteria for the articles analyzed are, the articles are the latest publications in the 2011-2021 publication range, have information that supports the meta-analysis, and have descriptive statistical information to obtain an effect size.

The variables in this study consisted of 3 parts, namely the independent variable, the dependent variable, and the moderator variable. The independent variable of this research is the BLM. The dependent variable in this study is the student achievements. The moderator variables used are based on grade level, learning materials, and learning media.

The articles that have been collected are processed using meta-analysis techniques. The articles obtained were searched online with the steps suggested by David B. Wilson and George A. Kalley (Komalasari et al., 2021), namely defining the problem or topic under study, determining the period and criteria for the articles used, collecting articles related to the research topic, focusing research, categorize each study, record research data, and determine the effect size of each article. The data analysis technique used in calculating the effect size uses the Cohen's d equation and calculates the summary effect size using the random effects model and the fixed effect model. The effect size results are interpreted based on Table 1 (Dincer, 2015).

Table 1. Category of Effect Size

ES	Category
$ES \leq 0.15$	Ignore
$0.15 < ES \leq 0.40$	Low
$0.40 < ES \leq 0.75$	Medium
$0.75 < ES \leq 1.10$	High
$1.10 < ES \leq 1.45$	Very High
$ES > 1.45$	Superlative

Result and Discussion

Analysis of the effect of similar research on student achievements

Based on the results of heterogeneity testing that has been carried out, it is known that the random effects model is suitable to be used to calculate the effect of similar studies from the BLM on student achievements. Calculation of the effect of a number of similar studies on student achievements can be seen in Table 2.

Based on the presentation of Table 2, there are 20 similar studies that use the BLM to influence student achievements. The results of the Z value of 20 similar studies showed a Z value of 6.98. The results of hypothesis testing indicate that the value of $p < \alpha$, which indicates that the hypothesis testing H_0 is rejected. The results of H_0 rejected indicate that there is a significant effect of the BLM on student achievements.

The test results show that the BLM has a positive and significant impact on student achievements. The BLM makes the learning process more efficient and makes students more active (Neumeier, 2005). In addition, blended learning can improve students' knowledge abilities (Ceylan & Kesici, 2017) and have a positive influence on student knowledge compared to using conventional models (Putri & Bukit, 2020). The use of the BLM by varying the learning resources makes students more satisfied in learning (Kintu & Zhu, 2016) and improves students' problem-solving skills (Herayanti et al., 2020).

Table 2. Effect of Similar Research on Students' Physics Learning Outcomes

Article Code	Y_i	V_{Yi}	T^2	$V_{Yi} + T^2$	W_i^*	$W_i^*Y_i$
P1	3.895	0.208	0.794	1.002	0.998	3.887
P2	1.276	0.067	0.794	0.861	1.161	1.482
P3	1.800	0.085	0.794	0.879	1.138	2.048
P4	0.427	0.062	0.794	0.856	1.168	0.499
P5	0.349	0.066	0.794	0.860	1.163	0.406
P6	1.799	0.084	0.794	0.878	1.139	2.049
P7	0.996	0.063	0.794	0.857	1.167	1.162
P8	1.539	0.084	0.794	0.878	1.139	1.753
P9	0.502	0.067	0.794	0.861	1.161	0.583
P10	0.890	0.061	0.794	0.855	1.170	1.041
P11	2.160	0.103	0.794	0.897	1.115	2.408
P12	0.530	0.059	0.794	0.853	1.172	0.621
P13	2.440	0.112	0.794	0.906	1.104	2.693
P14	1.060	0.074	0.794	0.868	1.152	1.221
P15	0.150	0.065	0.794	0.859	1.164	0.175
P16	0.360	0.066	0.794	0.860	1.163	0.419
P17	1.390	0.071	0.794	0.865	1.156	1.607
P18	4.070	0.270	0.794	1.064	0.940	3.825
P19	3.850	0.164	0.794	0.958	1.044	4.019
P20	1.170	0.076	0.794	0.870	1.149	1.345
Total					22.563	33.242
M^*			1.473			
V_M^*			0.044			
SE_M^*			0.211			
LL_M^*			1.059			
UL_M^*			1.886			
Z^*			6.980			
p			0.000			

Analysis of the effect of similar research based on grade levels

Based on the results of heterogeneity testing, it can be seen that at 3 grade levels, Q > df, then the estimation of the variance between articles is quite large and heterogeneous. The model that is suitable for use at 3 grade levels is the random effect model. Calculation of the effect of a number of similar studies based on grade level can be seen in Table 3.

Based on the data in Table 3, the three grade levels show an influence on student learning outcomes with varying Z values. Grade X shows a Z value at 4.014 with a p-value of 0.000. Grade XI has a Z value of 5.07 with a p of 0.000. Grade XII has a Z value of 1.99 with a p of 0.023. These results indicate that hypothesis testing at 3 grade levels shows a p value $p < \alpha$, which indicates that the hypothesis H_0 is rejected. The test results obtained indicate that at 3 grade levels have an influence on student achievements. The grade level that shows the greatest influence on student achievements is grade XI.

The results of calculating the effect of similar studies based on grade level show that grade XI has a more significant impact on student achievements. Piaget's theory which states that cognitive development is related to a person's physical maturity, where the older a person gets, the better the way he thinks (Marinda, 2020). The BLM has an effect on students' knowledge, especially in grade XI, and is able to develop students' critical thinking skills (Sinaga & Simanjuntak, 2020; Saefullah et al., 2020).

Table 3. Effect of Similar Articles Based on Grade Levels

Grade Level	Article Code	M	SE_M	LL_M	UL_M	Z	*p*
Grade X	P1 P3 P5 P10	1.424	0.355	0.729	2.119	4.014	0.000

Grade Level	Article Code	M	SE_M	LL_M	UL_M	Z	*p*
	P13						
	P14						
	P15						
	P20						
Grade XI	P2	1.738	0.343	1.066	2.410	5.070	0.000
	P4						
	P7						
	P8						
	P11						
	P12						
	P17						
	P18						
	P19						
Grade XII	P6	0.878	0.440	0.016	1.740	1.990	0.023
	P9						
	P16						

Analysis of the effect of similar research based on learning materials

Calculation of the effect of a number of similar studies based on learning materials using two different models. Two learning materials, namely momentum and impulse, and static electricity using a random effect model. Meanwhile, nine other learning materials, namely temperature and heat, dynamic electricity, mechanical waves, thermodynamics, Kepler's laws, static fluids, dynamic fluids, optics, and work and energy use the fixed effect model. Calculation of the effect of a number of similar studies based on learning materials can be seen in Table 4.

A number of similar studies of the BLM show that all materials show varying Z values (Table 3). Testing the hypothesis of 11 learning materials obtained the results that $p < \alpha$, it shows that the hypothesis H_0 is rejected. The results of testing this hypothesis indicate that 11 learning materials that use the BLM have an influence on student achievements. However, the learning material that has the most significant impact on student achievements is optics.

The results of calculating the effect of a number of similar studies based on learning materials show that optical instrument materials have a more significant impact on student achievements. This is in line with the results of research (Sinaga & Simanjuntak, 2020) which states that the BLM has a significant impact on student achievements, and is able to improve students' critical thinking skills. The application of the BLM to the material of temperature and heat can reduce misconceptions in students (Kesuma et al., 2020).

Table 4. Effect of Similar Research Based on Learning Materials

Learning Topics	Article Code	M	SE_M	LL_M	UL_M	Z	*p*
Momentum and Impulse	P10 P13	1.649	0.775	0.130	3.167	2.13	0.016
Static Electricity	P9 P16	0.430	0.182	0.073	0.788	2.36	0.009
Temperature and Heat	P2	1.276	0.259	0.768	1.784	5.00	0.000
Dynamic Electricity	P6	1.799	0.289	1.233	2.365	6.20	0.000
Mechanical Waves	P11	2.160	0.320	1.533	2.787	6.75	0.000
Thermodynamics	P12	0.530	0.243	0.054	1.006	2.18	0.015
Kepler's Law	P14	1.060	0.272	0.527	1.593	3.90	0.000
Static Fluid	P17	1.390	0.267	0.867	1.913	5.20	0.000
Dynamic Fluid	P18	4.070	0.570	2.953	5.187	7.14	0.000
Optics	P19	3.850	0.405	3.056	4.644	9.50	0.000
Work and Energy	P20	1.170	0.276	0.665	1.711	4.24	0.000

Analysis of the effect of similar research based on learning media

Based on the results of heterogeneity testing of learning media, 4 learning media use the random effect model. Meanwhile, 2 other learning media use the fixed effect model. Calculation of the effect of a number of similar studies based on learning media can be seen in Table 5.

Learning media makes it easier for students to learn. The use of schoology media can increase the activeness of students (Hariadi, 2015), can improve learning achievement (Tsaniyah et al., 2019) and students' critical thinking skills (Ningsih et al., 2018;

Suana et al., 2019; Shishigu, 2022). In addition, the BLM with the help of schoology has a positive impact on students' knowledge (Gaol & Sirait, 2019) and can increase students' mastery of concepts (Irawan et al, 2017). Learning media is needed to achieve effective learning objectives (Widodo, 2018). Thus, the application of blended learning by integrating multiple media representations will support student achievements.

Table 5. Effect of Similar Research Based on Learning Media

Learning Media	Article Code	M	SE_M	LL_M	UL_M	Z	*p*
Schoology	P1 P2 P3 P4 P6 P9 P17 P18 P20	1.737	0.329	1.091	2.382	5.3	0.000
Quipper School	P5 P8 P11	1.337	0.543	0.273	2.401	2.46	0.007
Edmodo	P10 P13 P15	1.142	0.614	-0.062	2.346	1.86	0.031
Google Classroom	P12 P19	2.174	1.66	-1.079	5.428	1.31	0.05
WhatsApp	P16	0.36	0.257	-0.144	0.864	1.40	0.08
E-Learning	P7	0.996	0.251	0.504	1.488	3.97	0.000

Limitations and implication for future research

In the random effects meta-analysis model, the effect sizes in the studies that were completely performed is assumed to represent a random sample of a given distribution of this effect size (hence the term random effect) (Borenstein et al., 2010). However, the researcher realizes that there are still shortcomings and weaknesses in this article so that future research findings should be taken more carefully. First, the articles taken are only limited to Google Scholar and Eric. So, the source of the article is less varied. Even though there are still many database applications that can be used to obtain papers.

Second, only 3 moderator variables were investigated, namely grade level, learning materials, and learning media. This is because most research articles discuss one or almost all of these variables, so it is possible to investigate the effect of BLM on student learning outcomes.

Third, researchers only took articles from national and international journals published between 2011-2021. The goal is that the research results from each article are still classified as hot topics. But other researchers can obtain complete data since the beginning of the emergence of the BLM so that the data obtained is more complex.

In meta-analysis research, many things can be compared such as research methods, sample size, country of origin of the author, the specific journal articles published, and the shortcomings of each article. The researcher recommends that for future meta-analyses, more articles should be analyzed, investigating each of the advantages and disadvantages of implementing BLM, showing the possibility of better BLM implementation, and the challenges that teachers or lecturers must face in implementing BLM. Thus, there will be more insights that can be taken to facilitate the design of BLM according to the needs in the field.

Conclusion

Based on the results of the analysis, four conclusions can be drawn from this study. First, the effect of a number of similar studies of the BLM shows that the BLM has a significant influence on students' physics learning outcomes. Second, the effect studies of the BLM based on grade level shows that grade XI has a more significant impact on students' learning outcomes. Awake's findings (2022) also stated that blended learning can improve student achievement. Third, the effect of similar studies of BLM based on learning materials shows that optical optics have a more significant impact on students' learning outcomes.

Fourth, based on learning media that has a more significant impact than similar studies, namely the schoology application. This research can be used as a reference for developing BLM on different materials, school levels, and various interactive media.

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