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The Effect of Blended Learning on Students' Creative Thinking Ability: A Meta-Analysis

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Abstract

This study aims to investigate the influence of technology-based learning, particularly blended learning, on students' creative thinking abilities. Through quantitative analysis, data comprising sample size, mean, and standard deviation extracted from Google Scholar indexed journals were examined. Employing a group contrast analysis design with a random effects model, effect sizes were corrected using JASP software. The analysis revealed a summary effect of 6.74 with a confidence interval ranging from 4.68 to 8.80, indicating a significant difference between groups utilizing blended learning and those employing conventional methods. Notably, students engaged in blended learning exhibited superior creative thinking skills compared to their counterparts. These findings underscore the pressing need to integrate blended learning methodologies to enhance the learning process effectively.

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A. Introduction

The 21st century is a challenge for the Indonesian nation, especially in the field of education in shaping the younger generation to be skilled in creative thinking [1], problem solving and wise in making decisions. In addition, education aims to educate the younger generation and develop their competencies [2]. With proper education, the younger generation will be able to develop their own potential more effectively [3] and will increase the development of a country in the field of human resources. With the educational goals set, the target to be achieved is the focus that must be the concern of the relevant government [4]. In line with that, other abilities that must be possessed in the 21st century are the ability to think critically [5], creatively and innovate in solving a problem so as to be able to communicate well with other individuals [6].

The challenge that must be faced by educators in facing the rapid development of the times is how to combine knowledge and expertise to develop a high-level skills mindset (HOTS) that will prepare young people to face global competition [7]. With the revolution 4.0 which requires the replacement of conventional learning methods with skill methods in the field of technology [8]. One learning model that emphasizes higher order thinking is the blended learning model.

Blended learning is an educational approach that combines traditional face-to-face instruction with online learning activities. It seeks to integrate the best aspects of both in-person and virtual learning to create a comprehensive and flexible learning experience [9], [10]. That is, in a blended learning environment, students typically engage in a combination of classroom-based activities and online learning activities. This could involve attending lectures or discussions in a physical classroom setting while also accessing online resources, completing interactive multimedia modules, participating in virtual discussions, or submitting assignments online [11]. Blended learning offers several benefits. It allows students to have more control over the time, place, and pace of their learning, as they can access online materials and complete activities at their convenience. It also provides opportunities for personalized learning, as students can receive individualized instruction and support through online platforms. Additionally, it promotes the development of digital literacy skills, which are essential in today's technology-driven world [12].

Blended learning has become a learning model oriented towards debriefing efforts in the younger generation, how students can think deeply about a theory or learning with effective learning and the provision of innovative bhaan. Thus, in applying the blended learning model, educators need to understand and know the influence of blended learning on effectiveness in the development of students' creative thinking abilities in the learning process. To see this picture, the author needs to conduct a meta-analysis of the influence of blended learning models on students' creative thinking ability. Researchers are trying to map out several articles relating to what will be the topic of discussion of researchers in this paper.

B. Research Method

A meta-analysis is a statistical method used to summarize and combine the results of multiple individual studies on a particular research question or topic. By

analyzing the combined data from multiple studies, researchers can draw more robust conclusions and gain a broader understanding of the overall effect or relationship being studied [13]. In this research, an examination is conducted on the integration of blended learning and traditional learning methods in the educational process. The analysis focuses on scholarly articles published between 2015 and 2022, which are globally indexed by Google Scholar. The selection criteria for these published articles are outlined as follows:

1. Articles that examine the effect of blended learning on the ability to think creatively in learning
2. This article is analyzed quantitatively
3. In the reviewed articles, these are sample size, mean and standard deviation
4. Articles reviewed are articles indexed by Google Scholar

In this research, a random effects model is employed to enable generalization of research findings beyond mere data compilation. The decision to adopt a random effects model is based on the presence of information heterogeneity, indicated by I2 > 25%. This meta-analysis employs a contrast group approach to assess discrepancies between blended learning and conventional learning methodologies. Given the variability in the data obtained, encompassing differences across minimum and maximum intervals, a rigorous data manipulation process is warranted. Subsequently, a technical analysis is provided as a sequential step.

Sample mean effect size estimates (d) were standardized by the equation:

$$d = \frac{x_1 - x_2}{s_{within}}, s_{within} = \sqrt{\frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{(n_1-1)(n_2-1)}} \quad (1)$$

The formula for finding the standard error d (Sed) is:

$$SE_d = \sqrt{V_d}, with\ V_d = \frac{n_1+n_2}{n_1 n_2} + \frac{d^2}{2(n_1+n_2)} \quad (2)$$

To minimize bias, the following formula is used:

$$g = j\ x\ d, with\ j = 1 - \frac{3}{4df-1} \quad (3)$$

$$df = degree\ of\ freedom\ (n_1 + n_2 - 2) \quad (4)$$

$$SE_g = \sqrt{V_g}, with\ V_g = J\ x\ V_d \quad (5)$$

The analytical process is conducted using JASP software, where the effect size (represented by g) and standard error (SE) are inputted to generate a Forrest plot. This plot illustrates value intervals and standard errors for each study, facilitating conclusions to be drawn. Additionally, JASP aids in calculating heterogeneity and assessing publication bias through funnel plot analysis. From these analyses, conclusions regarding the impact of blended learning on creative thinking ability can be drawn.

C. Result and Discussion

The discussion can be structured into several subsections for a comprehensive analysis. In this particular study, examination was conducted on 32 articles characterized by data homogeneity in terms of sample size, mean, and standard deviation.

Table 1. Data Meta-analysis

Study	Experiment			Control		
	n	X	Sd	n	x	SD
Mariati Purnama Simanjuntak [14]	68	75	9	64	62	7
Nurfitha Kusumaningtyas [15]	36	87	8	36	75	9
Safriana [16]	36	88	5	36	86	4
Rinia Surya Nita [17]	31	79	9	33	67	10
Rina Putri Utami [18]	32	83	6	31	77	5
Rindi Novitri Antika [19]	35	90	7	35	85	9
Eka Titik Pratiwi [20]	21	76	8	21	71	7
Milla Minhatul Maula [21]	36	86	5	32	70	12
Andri Tri Nugroho [22]	30	75	0	30	65	0
Ni Made Risa Kusadi [23]	32	81	15	32	69	15
Elok Deswiana Hayati [24]	32	78	9	32	63	8
Gadis Hayuhana Siskawati [25]	32	87	3	32	83	3
Rika Mawarni [26]	35	74	8	35	68	9
Siti Maysyaroh [27]	30	76	9	30	63	14
C Fauziah [28]	32	86	3	32	83	3
Angga Risnaini Uswatun Chasanah [29]	32	76	9	32	63	14
Rena Surya Rohana [30]	33	83	8	33	74	11
Aniswati Nahdiah [31]	30	95	7	30	82	6
Lilin Triani Putri [32]	31	76	7	31	62	13
R. D. Anazifa [33]	32	70	11	32	59	17
Ari Septian [34]	39	78	15	34	49	18
Dhia Octariani [35]	32	84	11	31	53	8
Rani Nur Arifah Agus Fajrina [36]	32	82	10	32	68	11
S. Ida Kholida [37]	30	89	7	30	81	8
Alimah Nuryanti [38]	31	59	12	32	52	13
Ihah Parihah [39]	32	52	4	32	52	3
N Khoiri [40]	35	78	8	40	75	8
Akbar Handoko (1) [41]	35	81	9	34	64	7
Akbar Handoko (2) [42]	35	73	9	34	64	7
Fatma Choirunnisa Widyaningrum [43]	30	84	5	30	81	8

Based on table 1, the number of journals analyzed was 32 with the description of the research samples in the experimental class as follows: (1) the highest number of data (n) was 68; (2) the highest average of research data (mean) is 95.00; (3) the highest standard deviation is 15.050. Meanwhile, the research sample in the control class is described as follows: (1) the highest number of data (n) is 64; (2) the highest average of research data (mean) is 83.4; (3) the highest standard deviation is 15.203. The results of the heterogeneity test, indicating I2 > 25%, are presented in Table 2 as follows:

Table 2. Heterogeneity Test Results

Fixed and Random Effects			
	Q	**df**	**p**
Omnibus test of Model Coefficients	41.284	1	< .001
Test of Residual Heterogeneity	3337.762	31	< .001

Note. *p* -values are approximate.

Note. The model was estimated using Restricted ML method.

Based on table 2, the analysis results show that the 32 effect size studies analyzed were heterogeneous (Q = 3337.762; p <0.0001). Thus, the Random Effects model is more suitable for estimating the average effect size of the 32 studies analyzed. The results of this analysis also indicate that there is potential to investigate moderator variables that influence the relationship between blended learning and students' creative thinking skills.

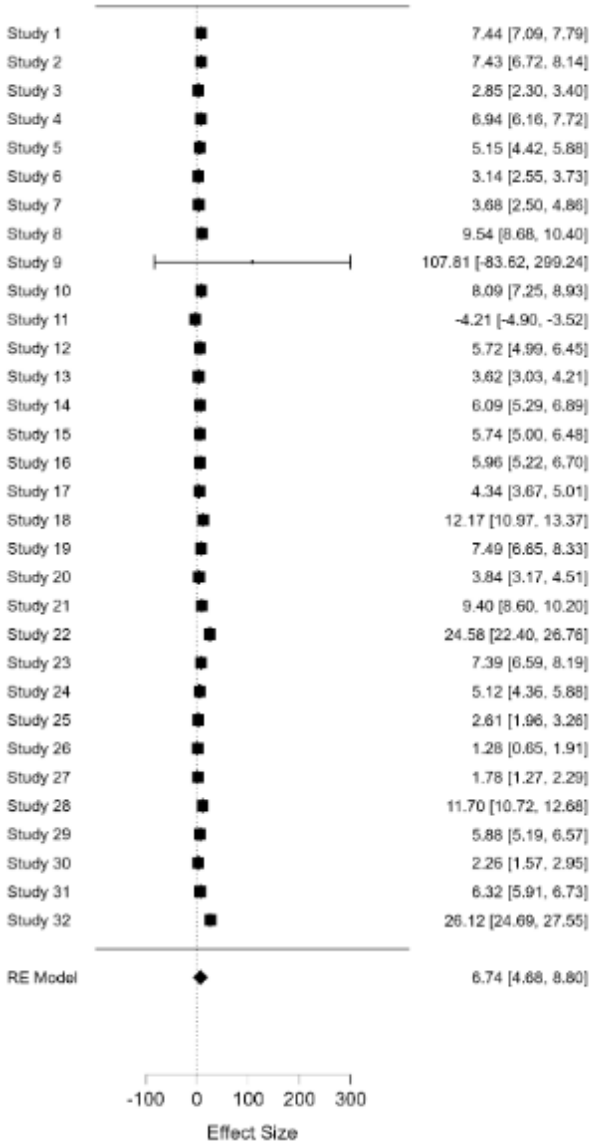

Figure 1. Forest Plot

Based on Figure 1, it shows that the effect size in the case-study studied is high and the summary effect is 6.74. This suggests variations in the creative

thinking capabilities of students undergoing blended learning, exhibiting higher creative thinking outcomes compared to those engaged in conventional learning models. Also, the total effect range of 4.68 to 8.80 includes zero, indicating a significant difference between mixed and conventional learning. Additionally, a bias analysis will be performed in the meta-analysis to demonstrate the validity of the study results. This is because meta-analyses consider only studies with desirable results and can be considered biased if they show none. Studies that accept the null hypothesis or provide negative conclusions.

In this meta-analysis, publication bias was assessed employing the trim-and-fill method. This method iteratively eliminates the most extreme small studies from the positive side of the funnel plot, recalculating the adjusted effect size. This process aims to reduce effect size variance and narrow confidence intervals. Analysis reveals changes in effect sizes upon inclusion of unpublished studies in the meta-analysis. Presented below are the results of data trimming and imputation using JASP software.

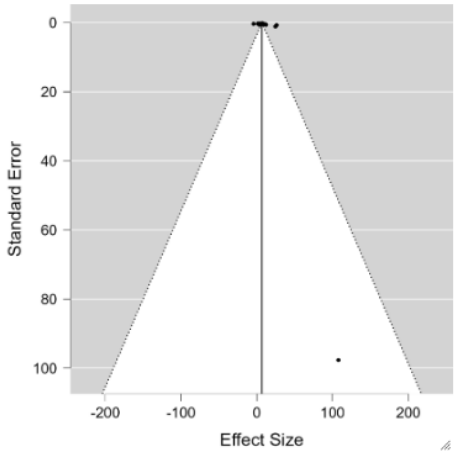

Figure 2. Funnel Plot

The funnel plot with the fixed-effect model shown in Figure 2 above shows that of the 32 studies there are no blank dots, meaning that all studies are published, therefore research on the relationship between blended learning and conventional learning does not have the potential for publication bias. This is reinforced by the forrest plot images before and after the trim fill analysis which are not different, this shows the conclusions made based on the fixed-effect model regarding the relationship between blended learning and conventional learning with valid students' creative thinking abilities.

D. Conclusion

The analysis results indicated a notable disparity in creative thinking abilities between groups utilizing blended learning and those employing conventional methods in the learning process. Specifically, student cohorts engaged in blended learning demonstrated superior creative thinking skills compared to those not utilizing blended learning approaches. The positive effects of blended learning-based learning shown by a fairly high average measure of effect in several studies provide philosophical reinforcement that active student involvement, lecturer

readiness, and availability of teaching materials are important factors for the success of these learnings. In addition, this meta-analysis also provides an important picture for lecturers how to apply good and creative technology to learning, so that lecturers are able to innovate well. In conclusion, blended learning emerges as a more effective approach compared to conventional bias-free learning. The analysis results unequivocally underscore the imperative of integrating blended learning to bolster the learning process effectively.

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