The Influence of STEM-Based Blended Learning Model Assisted by Schoology on Critical Thinking Skills

Oki Dermawan[1, a)], Defriyanto[1], Junaidah[1], Sovia Mas Ayu[1], Busmayaril[1], Jayusman[1], Senja Shaldy Gemilang[1]

[1]*Universitas Islam Negeri Raden Intan Lampung, Lampung, Indonesia*

[a)] Corresponding author: okidermawan@radenintan.ac.id

Abstract. Critical thinking is required to face industrial revolution 4.0 since industrial revolution 4.0 focuses on mastering the 4C skills, where critical thinking is one of them. The influence of the STEM-Blended learning model can improve students' critical thinking skills. This research aimed to determine the STEM-based Blended Learning model assisted by Schoology on critical thinking skills. The method applied was quasi-experimental research with a non-equivalent control group design. The results showed that the STEM-Blended learning model influenced student's critical thinking skills. Furthermore, since this research was conducted before the COVID-19 pandemic, the researchers recommend that other researchers find out the technique to implement this model on virtual learning.

INTRODUCTION

All students must possess critical thinking skills. Critical thinking skills need to be cultivated to train students in studying, researching, and reviewing necessary things [1-2]. Someone who can think critically will have the ability to analyze problems and can find appropriate, logical, and useful solutions. Critical thinking is also the basis for understanding complex problems through experiential sustainability learning in making and drawing logical conclusions about what actions to take and what to believe [3]. Bensley and Murtagh argue that critical thinking involves skills, dispositions, and metacognition. By training the critical thinking skills, students can conduct self-assessment, interpretation, analysis, evaluation, and conclusions on their learning outcomes.

Furthermore, critical thinking is included in the category of skills needed to face the industrial revolution 4.0 that emphasizes the 4Cs, namely critical thinking skills, creative thinking skills, communication skills, and collaboration skills [4]. Therefore, critical thinking skills become essential skills that must be possessed by every graduate at every level of education. However, the quality of graduates is still low and does not meet the criteria for several jobs or careers, making it difficult to compete at a global level [5-8].

The researchers conducted a pre-research test on eleventh-grade students' critical thinking skills at SMA N 2 Bandar Lampung. The researchers distributed a ten description questions test with critical thinking skills indicators. The results showed that the average physics problem-solving ability was 60% (low category). Low critical thinking skills are usually caused by students' unfamiliarity with the problems presented during the physics learning process. Therefore, the students could not solve the problems. Thus, an appropriate learning model is needed. The blended learning model combines face-to-face and online learning methods. It is considered suitable because it is supported by ICT facilities that already exist in schools.

Additionally, the blended learning in this research was assisted by Schoology as the Learning Management System (LMS) or a tool in online learning. Schoology is a learning platform that meets the learning needs in overcoming the schools' limited learning time [9].

Moreover, the previous research carried out by some researchers includes the Blended Teaching and Learning model being able to increase the effectiveness of learning [10]. The Blended Learning model was able to increase learning independence and attractiveness in lectures. The application of Blended Learning was approachable to improve the ability accounting and generic skills. Blended Learning tools based on the learning management system (LMS) can improve learning outcomes in dynamic electrical materials. Web-based Blended Teaching and Learning can improve learning outcomes and learning motivation [11]. Blended Learning based on a learning management system (LMS) with an inquiry learning model can improve learning outcomes on static electricity material. Blended Teaching and Learning can improve motivation and learning outcomes.

However, the learning model is not enough. Several studies say that the learning approach is also very important. The learning approach is a way for teachers to seek the interaction between students and their environment. One of the popular learning approaches is the STEM approach. The STEM approach is also becoming a trend in the world of education to overcome real-world situations. STEM has been developed in developed countries and developing countries. The linkages between science and technology and other sciences cannot be separated in science learning. STEM is an interrelated discipline. Mathematics as a science tool is required for managing data, while engineering and technology are the applications of science. The STEM approach in teaching and learning produces a meaningful learning process [12]. Many benefits of the STEM approach will make students more active, can solve their problems much better, be innovative, inventive, independent, and critical [13].

Other researchers have researched STEM-based learning, including STEM-based learning (Science, Technology, Engineering, Mathematics), which can improve students' concepts in causal reasoning. STEM-based science learning can increase motivation. Integrated STEM-Based teaching and learning can improve science literacy in gender terms. Project-based learning and STEM integrated project-based learning can improve learning outcomes and creativity. Based on local wisdom, STEM-A (Science, Technology, Engineering, Mathematics, and Animation) can improve physics learning outcomes.

There are many separate studies on blended learning [14,15]and the STEM approach [16-18]. Therefore, the renewal of this research is to examine blended learning based on the STEM approach (Science, Technology, Engineering, Mathematics) on students' critical thinking skills, specifically on sound waves material.

Based on the data and description, the researchers aimed to determine the influence of blended learning assisted by Schoology on critical thinking skills.

RESEARCH METHODS

This research employed quasi-experimental research with a non-equivalent control group design. This design involved the control class and the experimental class. The research design is shown in Figure 1.

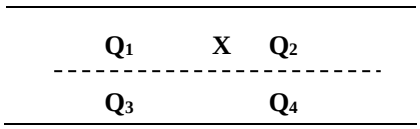

FIGURE 1. Research Design None Equivalent Control Group Design

Information:
Q1 : Pretest in the experimental class
Q3 : Pretest in the control class
X : Treatment using the Blended Learning
learning model
Q2 : Posttest in the experimental class
Q4 : Posttest in the control class. (Sugiyono, 2016)

Furthermore, the eleventh-grade students of SMAN 2 Bandar Lampung served as the population. Seventy-two samples had been determined using the purposive sampling technique. The researchers applied the blended learning model based on the STEM approach in the experimental class. On the other hand, the researchers applied the discovery learning model in the control class. The instrument used in this study was a description test. The researchers administered a pretest before applying the treatment.

The research hypothesis was tested using the t-test assisted by the SPSS 18 program with a significant level of 5%. Also, the researchers performed prerequisite tests (the normality test and the homogeneity of variance test).

RESULTS AND DISCUSSION

The data of this research were obtained from the experimental class with 36 students who applied the STEM-based Blended Learning and the control class with 36 students who applied the discovery learning model. The stages of STEM-based Blended Learning could be seen in Figure 2

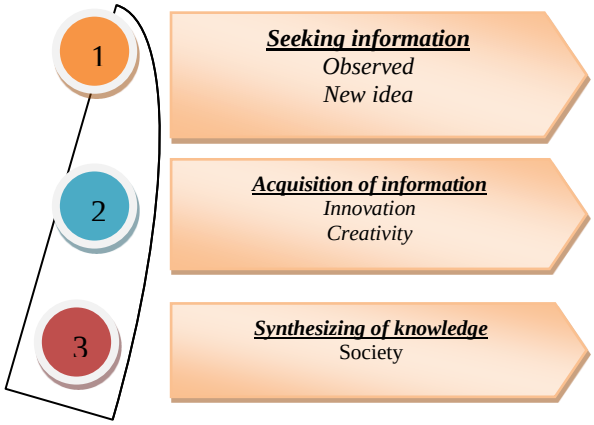

Figure 2. STEM-based Blended Learning Stages

The researchers applied three stages of STEM-based Blended Learning during the learning process. The first stage was seeking information assisted by the STEM approach at the observation stage.

The critical thinking skills data of the experimental class and the control class after treatments could be seen in Table 1.

TABLE 1. Data on Acquired Critical ThinkingAbility in Physics

Class	Amount of Data	Max Value	Min Value	Average	Std.Dev
Experiment	*36*	*97.5*	*65*	*81,94*	*6.998*
Control	*36*	*85*	*60*	*75.833*	*6.395*

Table 1 shows the average score of the experimental class was higher than the control class. Judging from the score and the standard deviation, the distribution was more uniform.

The students' critical thinking skills' percentages for each indicator are presented in Figure 3.

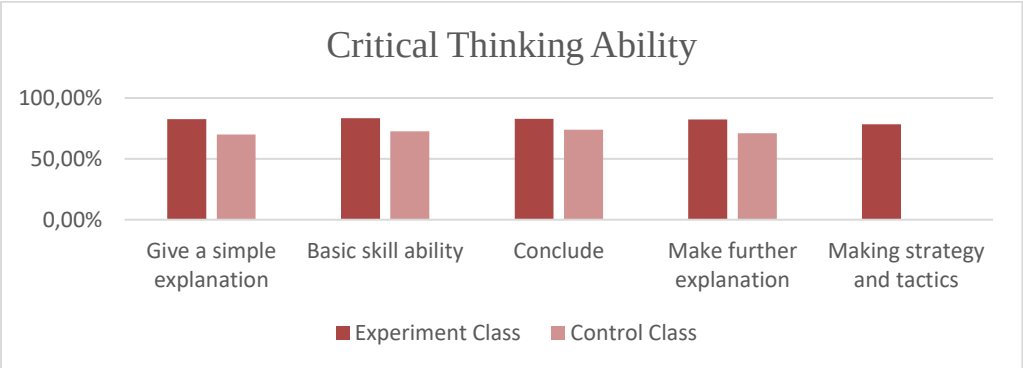

FIGURE 3. The Percentage Critical Thinking Skills on Each Indicator

Table 2 shows that the highest scores were obtained by the concluding aspect and making further explanations aspects in the experimental and control classes.

The students' improvement in critical thinking skills and the influence of the STEM-based Blended Learning model can be seen in Table 2.

TABLE 2. About Results of Gain Test Analysis

Class	Respondent	Gain Max	Gain Min	Gain Score	Category
Experimental	*36*	*0,96*	*0,52*	*0,72*	*High*
Control	*36*	*0,79*	*0,30*	*0,58*	*Moderate*

Table 2 shows an increase and difference between the control class and the experimental class has differences. The experimental class obtained a value of 0.72 (high category), and the control class obtained 0.58 (moderate category). From the difference of N-gain score, the STEM-based Blended Learning produced a better result.

Prerequisite Tests Analysis

The hypothesis of this research was tested using the t-test. The probability would be accepted if (sig) is higher than 0.05, which means no effect. If the probability (sig) is lower than 0.05, Ho is rejected, and there is an influence. The requirements that must be met before testing the hypothesis were the normality and homogeneity of variance tests. If the data were distributed normally, then this research can use parametric statistical techniques. However, if the data are not distributed normally, then the statistical technique that must be used is non-parametric statistics.

Normality

The one-sample Kolmogorov-Smirnov test was used to measure the normality test assisted by the SPSS 18.00 program with a significant level of 5% or 0.05. The normality test was performed on the control class and the experimental class's pretest and posttest data. If the significant value is higher than 0.05, then the data is distributed normally. At the same time, if the significant value is lower than 0.05, then the data is not normally distributed. The results of the normality test could be seen in Table 3.

TABLE 3 Normality Test Results of Problem Solving Ability

Group		Significant	Summary
Exsperimental	*Pretest*	0,200	Normal
	Posttest	0,087	Normal
Group		**Significant**	**Summary**
Control	*Pretest*	0,200	Normal
	Posttest	0,069	Normal

Table 3 shows that the significant value obtained by the control and experimental classes was lower than 0.05. Therefore, the data were distributed normally.

Homogeneity Test

A homogeneity test was conducted to determine whether the control class and the experimental class had a similar variance or not. In this research, the homogeneity of variances test was assisted by the SPSS 18.00 program with a significant level of 5% or 0.05. If the significant value is higher than 0.05, then the data are homogeneous. On the other hand, if the significant value is lower than 0.05, the data is not homogeneous. The results of the homogeneity test could be seen in Table 4.

TABLE 4. Result of Homogeneity Test of Problem Solving Ability

Data	Significance	Criteria
Pretest	*0,683*	*Homogen*
Posttest	*0,843*	*Homogen*

Table 4 shows that the significant value was higher than 0.05. Therefore, both classes had the same variance or homogeneous.

T-Test

The t-test was conducted after it was known that the data were normally distributed and homogeneous (parametric statistics). If the significance value is higher than 0.05, then H_0 is accepted, meaning there is no difference or effect. However, if the significant value is lower than 0.05, then H_0 is rejected, which means an effect. The summary of the results of the t-test is presented in Table 5.

TABLE 5. Hypothesis test results Independent Sample T-Test critical thinking skills

Data	T	Significance	Conclusion
Critical Thinking	*3.733*	*0,000*	*Related*

Table 5 shows an effect presented by the applied model with a significant value of 0.000. The significant value was lower than 5%, which means that H_a is accepted. Therefore, it can be concluded that STEM-based Blended Learning influenced students' critical thinking skills [19].

The results are in line with research conducted by Wayan Suana, which states that WhatsApp-assisted Blended Learning can improve critical thinking skills and problem-solving abilities [20]. Anggian Anggraeni et al. revealed that Blended Learning could improve the critical thinking skills of high school students on the temperature and heat material [21]. Ignatius Alexandro et al. developed a Blended learning device based on the Learning Management System (LMS) with inquiry learning on static electricity material [22]. Also, Nailul Khoiriah et al. discovered that the STEM learning approach could improve students' critical thinking skills in the experimental class [23,24]. Ani ismayani revealed that the STEM (Science, Technology, Engineering, and Mathematics) learning approach can improve creative thinking [25]. Then, Mellya Dewi stated that the STEM learning approach could improve students' problem-solving abilities on dynamic electrical material [26].

Furthermore, previous research supports the finding of this research that the Blended Learning model and the STEM learning approach (Science, Technology, Engineering, and Mathematics) can improve students' critical thinking skills [10]. However, the previous research applied the blended learning and the STEM approach separately, unlike this research that integrated the blended learning and the STEM approach into the STEM-based Blended Learning on sound wave material [27].

Blended learning is learning that combines face-to-face learning and online learning. Schoology assisted online learning as the Learning Management System. Blended learning can help students learn independently without direct teacher guidance [28, 29]. Although blended learning presents many advantages, the researchers felt the need to integrate it into the STEM approach. Through the STEM approach, students can relate a scientific process in everyday life so that physics learning can be more interesting because it is directly related to science and technology [30].

Also, one of the higher-order thinking skills is critical thinking skills. Students need critical thinking skills to understand various things, including the concepts of scientific disciplines [31]. One of the learning models that can be used to hone students' critical thinking skills is STEM-based Blended Learning because it emphasizes aspects of thinking effectively. The research hypothesis was accepted. Therefore, STEM-based blended learning influenced students' critical thinking skills.

CONCLUSIONS AND SUGGESTIONS

Based on the data analysis and discussion, the STEM-based blended learning assisted by Schoology influenced students' critical thinking skills. The STEM-based Blended Learning learning model also improves students' communication skills, self-confidence, and cooperation in group learning. However, this research was conducted before the pandemic. Then, the researchers recommend further researchers implement this model on virtual teaching and learning during the pandemic.

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