Effectiveness of Blended Learning to Improve Critical Thinking Skills and Student Science Learning Outcomes

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Abstract. This study was based on the limited accessibility and connectivity of student learning during the COVID-19 pandemic. The purpose of this study was to determine effectiveness of Blended Learning in improving students’ critical thinking skills and science learning outcomes. This study used a quasi-experimental design in the form of Nonequivalent control group design. Meanwhile, data collection used questionnaires and performance tests in SD Dabin II, Tlogowungu District. The data analysis in this study used the prerequisite test including the normality test and the homogeneity test, while the research hypothesis was tested using the T test and statistic descriptive test. The results in this study indicate that the Blended Learning model is effective in significantly improving students' critical thinking skills and science learning outcomes. This research is expected to become a foothold in further research as a further development on the use of blended learning.

1. Introduction

21st century skills provide challenges for all aspects of life, including education. ICT-based education is one of the characteristics that is identical to learning patterns in the 21st century. The 21st century school standard for teachers and students is to use their knowledge in online learning activities [1]. The learning system in the 21st century focuses on creative learning, critical thinking skills, and problem solving. One of the important aspects needed in the 21st century is the ability to think critically [2].

Critical thinking is an intellectual process in making scientific concepts and allows students to analyze their thoughts in making choices and draw conclusions intelligently [3]. Furthermore, Critical thinking makes students able to interpret, analyze and provide alternative solutions to problems. Focus in this study is on science subjects [4]. Critical thinking is part of the thinking skills listed in one of the Graduate Competency Standards (SKL) in Science subjects, namely that students have the ability to think logically, analytically, systematically, critically and creatively.

Based on the description above, the science learning process is able to facilitate students in developing critical thinking. However, in practice it tends to be less than optimal, including teachers who do not understand its application. Pre-research observations in grade V SDN Sambirejo 02 revealed that learning was dominant in lecture activities, activities to record material in books, and continued assignment by the teacher.

During the COVID-19 pandemic, new problems were found in teaching and learning activities. Activities carried out must be based on the concept of online and virtual communication. The problem is that online learning tools and facilities are not supported, especially for students, the majority of whom do not have a device and lack network accessibility and connectivity in rural schools.
Blended learning provides solutions to the challenges of adapting learning and development to the needs of individuals during a pandemic. Blended Learning is an e-learning innovation to obtain better learning output [5]. Blended learning is a new learning strategy that provides many benefits, as well as a form of support for information and communication technology towards new learning modes [6].

There is an effectiveness in design of the Blended Learning. The results show that Blended Learning will be effective when it is designed with planning and uses a variety of media that makes learning more innovative[7]. Blended learning provides good final semester evaluation results. The results showed that several student characteristics experienced good changes and were followed by a significant increase in learning outcomes after being taught using the blended learning model [8].

The purpose of this study was to determine the effectiveness of the blended learning model in improving students' critical thinking skills and science learning outcomes. The innovation in this research is that students use gadgets as an efficient learning tool and are able to manipulate teaching materials from the teacher so that they are able to generate critical thoughts from students.

2. Method
This research is a quantitative study with an experimental design. This study used a quasi-experimental design in the form of a Nonequivalent control group design. The model in this study is effective if there is an increase in the score of critical thinking skills and student learning outcomes. There are two class groups. The experimental class was given treatment using the Blended Learning model, while the control group was given the conventional model. See Figure 1. to know the quasi-experimental design in the form of a Nonequivalent control group design. in this technique the experimental group and the control group were not randomly selected.

![Figure 1. Nonequivalent control group design](image)

The population in this study were students of grade V SD in Tlogowungu sub-district, Pati regency. Data collection used questionnaires and performance tests in Public Elementary School Area II, Tlogowungu District.

The variables in this study are the Blended Learning Model, Critical Thinking Skills, and Student Learning Outcomes. The data analysis in this study used the prerequisite test which included the normality test and the homogeneity test, while the research hypothesis was tested using the T test and statistic descriptive test.

3. Results and discussion
The results of the normality test in this study were conducted in the experimental class and the control class. Analysis of normality using the Kolmogorov-Smirnov test. Based on the SPPSS output in Table 1, the normality test is normally distributed because the significance value is more than 0.05. The significance value in the experimental class is 0.089 and the control class is 0.200. The data in Table 1 shows the results of the normality test in the experimental class and the control class.

| Table 1. Test for normality in the experimental and control class |
|-------------------------------------------------------------|
| Variation | Experimental Class | Control Group |
| N         | 30                | 59            |
| Most extreme differences | 0.18              | 0.10          |
| Test statistic | 0.18              | 0.10          |
Homogeneity test results on the variables of critical thinking skills and student learning outcomes in science. Based on the SPSS output, the significance value of the homogeneity test is 0.771 and 0.559, more than the significance of 0.05, and the assumption of normality be met. In conclusion, the data tested has a homogeneous variance in the aspects of assessment, and the questionnaire items given to each element in the sample apply proportionally.

To determine the effectiveness of the blended learning model on students' critical thinking skills, data processing used the T test. The results are summarized in Table 2 in the experimental and control classes.

| Table 2. T-test of critical thinking skills on experimental and control classes |
|-----------------|-----------------|-----------------|
| Variation       | Experimental    | Control         |
| Class           | Class           | Class           |
| Mean            | 84.59           | 73.67           |
| N               | 30              | 30              |
| Std. Deviation  | 6.915           | 6.392           |
| Std. Error Mean | 1.284           | 1.167           |

Figure 2 shows the acquisition of the average score in the experimental and control classes in the blended learning model on students' critical thinking skills.

Based on the visualization from Table 1 and Figure 2, the mean value in the experimental class is higher than in the control class. The average value of the experimental class reached 84.59 and the average value in the control class was 73.67. In Figure 2, the relationship between the two bars shows an increase in the average shown on the X-axis and Y-axis. This shows that blended learning has an influence on students' critical thinking skills.

The concept of blended learning is learning in 2 ways, namely by meeting virtually and face to face. Processing in blended learning syntax allows students to be able to process their knowledge in a context that is able to influence their critical thoughts and ideas.

Blended learning tool developed is able to improve students' critical thinking skills with a high category. Learning tools can facilitate students to think critically because blended learning makes students think holistically and raises questions and critical answers [9]. In line with this, critical thinking skills
develop after treatment from 8.4% to 42.2% in the first cycle. In conclusion, blended learning is effective in developing students' critical thinking skills [10].

To determine the effectiveness of the blended learning model on science learning outcomes, data processing used descriptive statistical tests. Analysis of the data programming used SPSS 22. The results are summarized in Table 3 for the control and experimental classes.

| Tabel 3. Descriptive statistics on student learning outcomes |
|-----------------------------------------------------------|
| Experimental Class | Control Class |
| N | 30 | 30 |
| Range | 16 | 15 |
| Min | 73 | 66 |
| Max | 89 | 80 |
| Mean | 86.50 | 71.64 |

Figure 3 shows the acquisition of the average score in the experimental and control classes in the blended learning model on student science learning outcomes.

Based on Table 3 and Figure 3, it is known that the average value of student learning outcomes in the experimental class is higher, namely 86.50 than the control class (71.64). In Figure 3, the relationship between the two bars shows an increase in the average shown on the X-axis and Y-axis. This shows that blended learning has an influence on student science learning outcomes.

Blended learning is a learning environment designed to integrate face-to-face (F2F) learning with online learning that aims to improve student learning outcomes [11]. Blended Learning can be applied to anyone, especially those who have high mobility and find it difficult to continue to meet face to face with the teacher [13]. The COVID-19 pandemic, learning space and time are limited. The Blended Learning model can be an alternative solution for teachers and students so that it can increase the meaning of the learning process.

There is an increase in student learning outcomes with sig. 0.000, average increase 38.23 [12]. Meanwhile, student learning outcomes after the application of Blended Learning have increased, [14], [15]. Furthermore, showed that the learning outcomes of students taught with the Blended Learning model were higher than students taught with ordinary learning both as a whole and based on their initial
Meanwhile, critical thinking skills can be improved activity-based learning where students actively discuss and find concepts [17], [18].

4. Conclusion
Based on the results of research in this study that Blended Learning is effective in improving students' critical thinking skills and science learning outcomes. The average score of students' critical thinking ability in the experimental class was 84.59 higher than the control class 73.67. Student learning outcomes also increased from an average score of 86.50 in the experimental class from an average score of 71.64 in the control class.

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