

## The Enhancement of Students' Critical Thinking Skill on Heat and Temperature through Blended Learning

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**Abstract.** Blended learning is one of the learning techniques that combines face-to-face learning with online learning. The use of blended learning is expected to achieve physics learning goals, which is students' critical thinking skills. The purpose of this research is to determine the increase of students' critical thinking skills in heat and temperature through *blended learning* techniques. The sample of the research based on purposive sampling. The subjects of this research were students of SMA Negeri 5 Malang class XI G-3 consisting of 34 students. The research design is one group *pretest - posttest* design with descriptive and quantitative analysis. The results of the research showed that there is an increase in the ability of students with critical thinking skills between the *pretest* and *posttest* scores. The increase in the ability of critical students is also supporting the analysis of the N-Gain value of 0.38 with the moderate category.

**Keywords:** Critical Thinking Skill, Blended Learning, Heat and Temperature

### 1. Introduction

Nowadays, using Information and Communication Technology (ICT) in learning process is a learning done by teachers and students in the classroom during face-to-face learning process so that paper use can be as minimal as possible [35]. The use of ICT in the world of education in addition not only the use of technology but also occurs in the development of online networks when the learning process occurs so that students can receive information from the teacher such as learning material and quizzes [40, 43]. Based on previous research, it has been produced that the use of ICT in the learning process have a positive impact on the achievement of student learning outcomes and also improve students' conceptual understanding of the material [2, 37].

The development of current technology, forcing teachers to be able to follow the development of these technologies in the learning process. In addition to the use of ICT, teachers and students can also use the internet in the learning process to get information through online [26]. The purpose of using the internet are being able to provide material, discussion section, or questions for understanding the material that students have received in face-to-face learning process in classroom [28]. The learning process that uses the internet can also help students who have misconceptions about a material [16]. The combination of face-to-face learning process in classes with online learning is called blended learning [1, 5, 29, 30, 41, 43]. The research conducted by Aslam (2015) said that blended learning

techniques can be done by the teacher as an alternative learning process. This is because blended learning techniques can change learning that was previously only done in the classroom into learning that can be done by teachers and students anywhere and anytime [3]. In the face-to-face learning process, the role of the teacher is surely very important, but the use of blended learning can increase students' knowledge of a material [14].

The blended learning technique applied by the teacher has several advantages. The advantages such as online learning can help students to learn independently without teacher guidance directly, helping conventional learning that is often done by teachers so that can help students gain information without having to meet face to face with teachers [5], increasing students' curiosity of the information, flexible learning, and can also reduce the costs used in face-to-face learning process [15, 20]. In addition, students can learn according to their learning speed without being influenced by their friends [43]. Several previous studies have shown that blended learning techniques can influence student learning achievement [41], give positive results on students' conceptual understanding and problem solving in a material [31, 38], improve student learning outcomes [13]. Blended learning is also proven to increase student independence in learning and students' critical thinking skills [36] and can train students' critical thinking skills [19].

The ability to receive material owned by students is different from each other because these abilities are determined by the thinking ability of each student [11]. Critical thinking is one of the things that are considered very important skills in the learning process [24], so that students use their thinking critically to solve a given problem [32]. At present, students have difficulty in developing their critical thinking skills because the learning done by the teacher is still using conventional methods or lectures [18], besides that the learning done is more focused on memorization and only reading the material [23]. Someone's critical thinking skills can be seen from the way he gives opinions with confidence and how he act by giving reasons [32].

Learning activities will run smoothly and in accordance with the learning objectives if the teacher can determine suitable learning strategies so that learning process can run optimally [17, 27]. Besides that, teachers can combine learning material with phenomena that occur in everyday life [27]. The problem is whether the blended learning technique can improve students' critical thinking skills. Therefore, the purpose of the research is to find out the magnitude of the increase in students' critical thinking skills in the material that is temperature and heat through the bended learning technique.

## 2. Method

The design of the research was one group pretest - posttest design. This research design consists of only one class given a treatment. The research class was given a pretest and posttest. Pretest is used to find out the students' critical thinking skills before students are given a treatment by using blended learning techniques. While posttest is used to find out students' critical thinking skills after being given a treatment by using blended learning techniques. Then, the pretest and posttest were used to determine the increases of students' critical thinking skills in heat and temperature material.

The population of this research was all class XI SMA Negeri 5 Malang consist of 11 classes of XI grade. The sampling technique is cluster random sampling. The sample of this research was the XI H-3 class which consisting of 34 students with details of 20 female students and 14 male students.

The instrument of this research was an essay question with the number of questions as many as 5 items which have represented each the indicator of critical thinking skills. The instrument is used to measure students' critical thinking skills in heat and temperature material. Before the instrument for critical thinking skills was used in the research, previously the instrument was validated by 2 expert lecturers and tested on 84 students. The results of the validation show that the value of Cronbach Alpha reliability is 0.828 which indicates the reliability of the item is high [7]. The students' critical thinking skills in physics concepts were limited to 5 indicators of critical thinking skills by Tiruneh et al. (2017). Indicators of students' critical thinking skills in heat and temperatures are shown in Table 1.

**Table 1. The Indicator of Critical Thinking Skills**

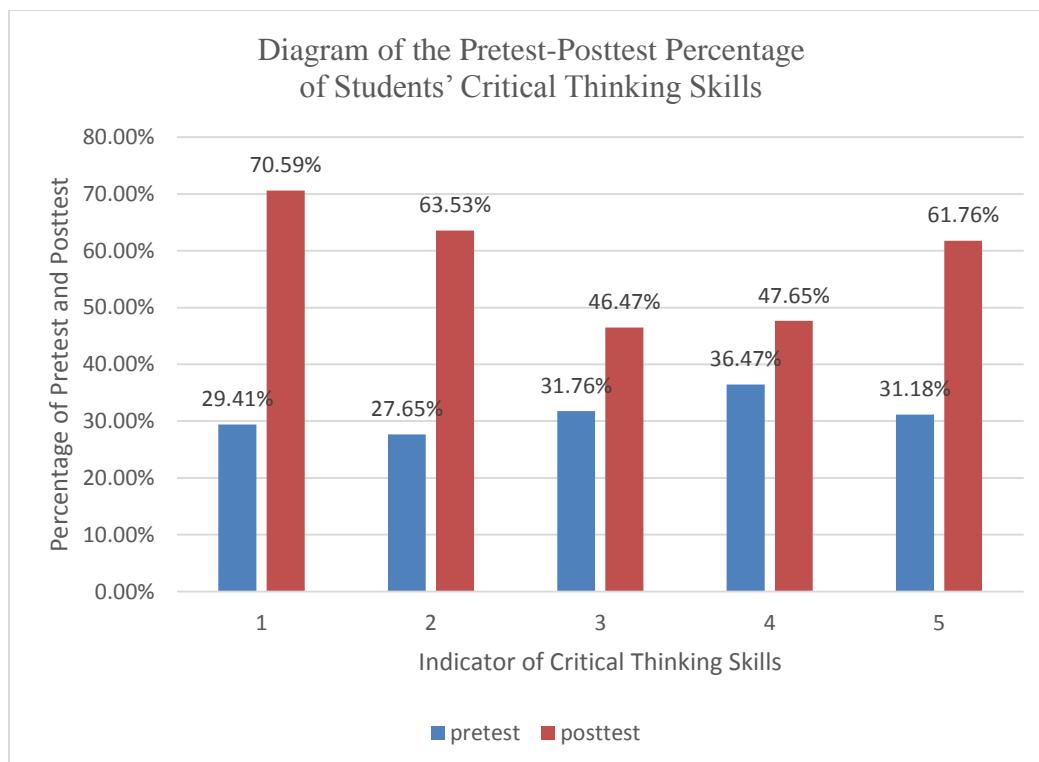
No	The Indicator of Students' Critical Thinking Skills	Questions Number
1	<i>Reasoning</i>	1
2	<i>Hypothesis Testing</i>	2
3	<i>Argument Analysis</i>	3
4	<i>Likelihood and Uncertainty Analysis</i>	4
5	<i>Problem Solving and Decision Making</i>	5

The research data was then analyzed statistically to determine the improvement of students' critical thinking skills in heat and temperature material. Statistical tests performed include normality tests, different tests using the T test, and the N-Gain test.

### 3. Results

The percentage of students' correct answers from the pretest and posttest on each indicator are shown in Figure 1. The percentage results obtained from the number of correct answer on each indicator to the number of students who took the pretest and posttest.

Figure 1. Diagram of the Pretest-Posttest Percentage of Students' Critical Thinking Skills



The percentage value in Figure 1 was obtained from each student who answered the items of critical thinking skills to the number of students who followed the learning process using blended learning techniques. The pretest and posttest data obtained from the research are analyzed statistically which includes the normality test as the initial prerequisite test, the different test using the T test, and the N-Gain test. The tests are conducted to determine the increase in the critical thinking skill about heat and temperature material. Table 2 shows a data analysis.

**Table 2. The Analysis of Research Data**

Parameter	Pretest	Posttest
N	34	34
$\bar{X}$	31,76	69,76
$X_{\min}$	4	36
$X_{\max}$	60	88
Sd	14,166	11,481
Normality of Kolmogorov-Smirnov	0,672	0,810
Normality Significance	0,756	0,528
T Test		19,546
T Test Significance		0,000

The results of the normality significance at the pretest and posttest values were 0.756 and 0.528 respectively which indicated that the pretest and posttest data are normally distributed. Then a different test using T Test is carried out which shows the significance of the T test is 0,000. These results indicate that there are differences in students' critical thinking skills between pretest and posttest data. Then the pretest and posttest data are tested using the N-Gain test to determine the increase of students' critical thinking skills by using blended learning techniques. The results of the analysis using the N-Gain test show that the value of the increase in critical thinking skills shown by the pretest and posttest is 0.38 which is in the Medium category [21].

#### 4. Discussion

The percentage value in Figure 1 was obtained from each student who answered the item about the ability of critical thinking to the students who followed the learning process using blended learning techniques. In Figure 1, it is known that the percentage of students' critical thinking skills in the heat and temperature material in each indicator has increased. But on indicators 3 and 4 represent the percentage of critical thinking skills' indicators that have a small difference compared to indicators 1, 2, and 5. The difference in the percentage of pretest and posttest on the two indicators are not more than 15%. These percentage showed that the ability of students' critical thinking still need to be developed.

In the first indicator, it is shown that students' critical thinking skills are increase based on the percentage of pretest and posttest. The increase or difference in the percentage of students' critical thinking skills is 41.18%. The posttest results of students on this indicator represent the largest percentage (70.59%) compared to the other indicators. There are still 29.41% of students not yet maximal in showing their critical thinking skills in the first indicator. In this indicator students are required to be able to explain the differences of heat and temperature. Based on student answers, there are still students who think that temperature can move from one object to another object. In reality heat can move due to heat is energy, while temperature is only the degree of heat or coldness of an object. This causes the results of the percentage of students' critical thinking skills in the first indicator is still not maximal (100%). Less than optimal results of student posttest is because of the students cannot distinguish the differences between heat and temperature. It is also seen in previous research that students still find the difficulties to distinguish the differences between heat and temperature [4, 10, 12, 34].

Furthermore, the second indicator of students' critical thinking skills has increased. The increase from the difference in the value of the pretest and posttest are shown in Figure 1. The difference of the pretest and posttest in second indicator is 35.88%. This second percentage of difference value is the highest value compared to the other critical thinking skills indicators. In this indicator, students are asked to explain the use of carpet will make the feet warmer than without the use of carpets where the feet interact directly with the floor. Student answers to the questions given by the teacher indicate that students only answer because there is a distance between the floor and feet from the carpet so that the temperature cannot move from the floor to the feet. The student's answer is because students assume that the temperature can flow from one object to another object. This is what causes the results of the percentage of student posttest still not reach the maximum value (100%).

In indicator number 3, students' critical thinking skills showed an increase in the percentage of the pretest and posttest. The difference in the percentage of students' pretest and posttest are only 14.71%. The difference on third percentage is one of the lowest difference compared to other indicators (46.47%). It shows that there are still 53.53% of students who do not show the ability to think critically about a problem presented by the teacher. In this indicator students are required to be able to determine the correct statement from several statements given by the teacher regarding heat and temperature material. Almost all student answers have been able to determine the correct statement but students tend to explain the statements that are correct compared to explaining the wrong statement. There are several students who have tried to explain a statement that is wrong with the actual concept. This causes the student's critical thinking skills to be less than optimal on the third indicator. Students are not accustomed to explaining the incorrect statements of the statements given. Students are also poorly trained in developing their critical thinking skills in everyday life.

In indicator number 4, students' critical thinking skills has increased as indicated by the value of the pretest and posttest percentage. The difference in this indicator is one of the lowest difference compared to other indicators (11.18%). Figure 1 shows that there are still more than 50% of students still having difficulty in showing their critical thinking skills. In this indicator, students are asked to be able to provide solutions to a given problem about Black Principle concept. But many of students cannot explain the solution based on Black Principle concept. Many students give an explanation that high temperatures in hot water will move to cold water so that the temperature of the mixed water are warms up. This shows that students still have difficulty to determine the heat and temperature differences as well as the Black Principle concept that causes critical thinking skills in the 4th indicator of students is still not reach the maximal value. This is supported by previous research conducted by several researchers who show that students still have a misconception of the Black Principle concept [10, 12, 42], so that the increase in learning outcomes in the Black Principle is still low [25]. In the other hand, students are still not trained in generating critical thinking skills. So, it takes time to be able to hone the student's skills.

In the last indicator, the increase in critical thinking skills in the 5th indicator is only 30.58%. Students are asked to make decisions in the use of dry cloth or wet cloth in taking very hot objects. Students are also asked to explain why we prefer to hold the handle of a cup when filled with hot water compared to holding the entire surface of the cup. Students do not explain the fact by using the concept of heat transfer that when holding a hot object using a dry cloth there will be an air space between the fabric of the hot object and the hand. The student's answer also does not explain that holding around the cup will expand the surface and will cause greater heat transfer. This is what causes the results of students' posttest still not reach the maximum value (100%). Less than optimal students show that students still feel difficulty in understanding heat transfer.

Figure 1 also shows that students' critical thinking skills shown in the posttest values are still low. There is no percentage in each indicator that reaches the maximum value (100%). The average difference in the percentage of pretest and posttest in the overall critical thinking skills are 31.29% and 58.00%. This percentage shows the increase in students' critical thinking skills by 26.71%. This increase is a little value because the increase that occurs is not more than 30%. Therefore, it can be said that the critical thinking skills of students who have been taught through blended learning

techniques are still not optimal. The reason for the students' lack of critical thinking skills not only students still do not master the material concepts of heat and temperature but also students lack practice in improving their critical thinking skills so students feel difficulty in demonstrating their critical thinking skills in the questions given by the teacher. Besides that, students still need time to develop each indicator of students' critical thinking skills. Some research also showed that there are difficulties faced by students in showing their critical thinking skills. The difficulty is that students still feel difficulties in showing a critical attitude in facing a given problem by the teacher [22].

The results of the research obtained are reinforced by the results of previous research that blended learning influence the critical thinking skills of physics material [6, 33, 44]. Based on the exposure of the students' difficulties, it is shown that the critical thinking skills in students who are taught using blended learning techniques are not optimal. There are several factors that cause students' critical thinking skills to be low. The students' difficulty factors in this research are also supported in previous research which showed that students were still weak in connecting problems with solutions that had been obtained [8].

However, based on Table 2, the results of statistical test show that the average pretest and posttest on the question of students' critical thinking skills has increased from 31.76 to 69.76. The results of the N-Gain test are 0.38 with the medium category [21]. So, it can be concluded that blended learning techniques that have been applied in the classroom can improve students' critical thinking skills.

## 5. Conclusion

The enhancement students' critical thinking skills are shown from the average value of the students' pretest and posttest. The average results of the pretest and posttest indicate that there is an increase in students' critical thinking skills after taught by blended learning. Students learnt heat and temperature form the teacher in school and students learnt anywhere or anytime in the online learning. The blended learning made students thinking more critically to the problem given. However, if analyzed on each indicator, students' critical thinking skills are still said to be not optimal. The results of the research show that indicator 3 (argument analysis) and 4 (likelihood and uncertainty analysis) have a small difference of more than 15%. The low of pretest and posttest are because students who have not been trained in demonstrating their critical thinking skills. Based on the results of the overall analysis showed that the use of blended learning techniques in the learning process proved to be able to improve students' critical thinking skills in the heat and temperature material.

## 6. References

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