

The Influence of the PBL Model on Students' Critical Thinking Ability in Wave Topic

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Abstract: The Problem-Based Learning (PBL) model is an educational innovation that improves students' thinking ability through organized team or group work. This research aims to determine the influence of the PBL model on students' critical thinking ability in wave topics. The research method used was quantitative experimental or descriptive methods. This research was carried out by collecting numerical data, which was then processed and analyzed to extract the scientific information behind it. There are two variables: X is the independent variable, and Y is the dependent variable. The sample source of the study sample was 27 students at SMP Negeri 1 Bulawa, in class VIII. The results of this research show that the calculated value of the t-test shows that the value of t-count = 57.062 at a significance level of 0.05 and t-table = 2.055. So this result shows t-count \geq t-table. Therefore, the researcher concluded that the PBL model influenced students' critical thinking skills in wave topics.

Keywords: Critical Thinking Ability; PBL Model; Wave

Introduction

Education is the right of all children. In the preamble to the Constitution, education receives special attention and is stated explicitly in the fourth paragraph. A human right that all children must freely develop their potential through the learning process they gain [1], [2], [3], [4], [5]. It can give birth to the nation's next generation with intelligent and qualified individuals. This generation can make the best use of existing progress and a high level of nationalism. Without education, progress will be impossible [6], [7]. The development and improvement of a country are determined by the quality of its human resources so that it can compete with other countries. Indonesia's education quality is at the lowest level, lagging behind other countries. If we examine it as a whole, there are many reasons for Indonesia's low education quality [8], [9], [10], [11].

Education has a role because education, which is essential in life, is a method to improve human resource standards [12]. Through education, students will become intelligent, virtuous people who can help others and the surrounding community. The National Education System in Indonesia has been used since Law 2003 number 20. The government runs a centralized or centralized learning system in this particular country. One of the elements of the learning model is essential in learning [12], [13], [14], [15]. The government regulates all aspects of education, including learning objectives, materials, and techniques. The use of learning models is an essential element of education. However, to develop, select, and apply a learning model, instructors, lecturers, or investigators must process measuring, evaluating, and evaluating weighing [16], [17]. One learning model often used in the learning process is the Problem-Based Learning (PBL) model. The

PBL model allows schools to be independent, increase self-confidence, improve their skills and interests, and organize their knowledge [18], [19], [20].

The PBL model is an educational innovation that improves students' thinking ability through organized team or group work. This allows students to consistently improve their thinking skills, face challenges, and test their abilities [21], [22], [23], [24]. In junior high school subjects, especially science subjects, the PBL model is often used. Middle school students still consider science subjects a product, namely a set of ideas that must be remembered. As a result, they are less capable in cognitive aspects. As a result, students must understand the concepts taught in science learning so that they can remember them and use them in everyday life. This differs from remembering ideas without knowing them [25], [26], [27]. However, cognitive elements such as processing problems, assessing, and creating are still poorly introduced to students. In addition, students do not usually solve problems that start with investigative activities. By applying, students can learn and gain the ability to think critically independently by applying principles to solve their learning problems. Critical thinking skills teach students to make decisions carefully, thoroughly, and logically from various points of view. They can also consider their own opinions [28], [29], [30]. As a result, learning in schools must teach students how to search for, process, and evaluate data critically. This is relevant to the consideration by Saputra (2020) that the ability to think critically is an expected ability and a necessary tool for constructing knowledge [31].

It is hoped that new technology in learning models will produce a more active learning atmosphere, material that is easier to master, students who are more creative and critical in solving problems, improve their social skills, and improve their learning outcomes. The teacher's learning model can help in analyzing students. Compared with PBL

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models, it is anticipated that PBL models influence students' critical thinking abilities [32]. Utilizing the PBL model in science learning, it is hoped that students will have the ability to develop and use the ability to solve problems by thinking critically through investigation and inquiry into the issues they experience. Apart from that, it is hoped that they will participate more in understanding and thinking about the material in the group [33]. Based on the explanation above, researchers are interested in examining the influence of the PBL model on students' ability to think critically about The Influence of the PBL model on students' critical thinking ability in wave topics.

Research Methods

The research method used was experimental or quantitative descriptive. Quantitative-based methods related to numbers or nominal values are often used [34]. This research was carried out by collecting numerical data, which was then processed and analyzed to extract the scientific information behind it. There are two variables, where X is the independent variable, and Y is the dependent variable, namely, variable X for the PBL model and variable Y for the critical thinking ability.

Population can be defined as the entire research that includes objects and subjects using specific attributes and qualities determined to be studied by researchers and then used to make results about them [35]. The sample source of the study sample was 27 students at SMP Negeri 1 Bulawa, in class VIII.

This study collected data through analytical thinking tests. Critical thinking is the systematic way students think to obtain information. The data is analyzed by grouping responses, tabulating the data based on the variables and types of respondents from all the people who answered, displaying the data about each variable studied, and explaining the information analysis techniques used for this analysis.

The hypothesis proposed for Ho: There is no effect of using the PBL model on students' critical thinking skills in wave topic in class VIII SMP Negeri 1 Bulawa. Ha: The PBL model influences students' critical thinking abilities in class VIII of SMP Negeri 1 Bulawa. The test criteria are

that Ho is accepted if $t\text{-count} \leq t\text{-table}$ and Ha is accepted if $t\text{-count} \geq t\text{-table}$ at the significance level $\alpha = 0.05$.

Before testing the research hypothesis, it is necessary to look for improvements in students' critical thinking abilities. This can be sought through data analysis of test results that have been carried out to measure students' critical thinking abilities after participating in learning using the PBL model. After obtaining the results of students' critical thinking abilities, the researcher determined the category of students' critical thinking abilities. The aim of assigning categories is to determine the percentage of student's critical thinking abilities that qualify in Table 1 [36].

Table 1. Criteria for Students' Critical Thinking Ability

Category	Range
Very critical	81-100
Critical	66-80
Enough critical	56-65
Less critical	41-55
Not critical	0-40

This research used analysis of the course average normalized gain for single students. After the calculations are carried out, the results are interpreted as in Table 2 [37].

Table 2. N-Gain Criteria

Gain Index	Criteria
$g > 0.70$	High
$0.30 < g < 0.70$	Medium
$g < 0.30$	Low

According to the N-gain category in Table 2, if the Gain index value g is > 0.70 , then the n-gain criteria is the same as high. For n-gain values of $0.30 < g < 0.70$, the n-gain criteria are the same as medium, while for n-gain values $g < 0.30$, the n-gain criteria are the same as Low.

Results and Discussion

Students' critical thinking ability can be assessed by applying the PBL model to wave topics using four indicators, as seen in Table 3.

Table 3. Results of students' critical thinking abilities using the application of the PBL model in wave topic

Code	Indicator	Pre-test	Category	Post-test	Category
AA	Provide a simple explanation (elements clarification)	8.30	Not Critical	75	Critical
AB	Provide further explanation (advance clarification)	8.90	Not Critical	78	Critical
AC	Concluding (inference) from things that are deductive (specific to general) and (general to specific)	9.60	Not Critical	77	Critical
AD	Determining strategy and tactics (strategy and tactics)	9.10	Not Critical	79	Critical

The average student learning outcomes are shown in Table 3, showing the difference between the average pre-test and post-test scores. It is known that the average score on indicator 1 provides a simple explanation (clarification element). The average pre-test score is 8.3, while the average post-test score is 75. Based on the pre-test average score, students' critical thinking abilities were classified in

the Non-Critical category. In contrast, the post-test scores obtained by students after implementing the PBL model showed an increase in the average score, so they are included in the Critical category. The average value of indicator 2 provides a further explanation (advance clarification). The average pre-test value is 8.9, while the average post-test is 78. Based on the average pre-test value,

students' critical thinking abilities are classified as non-critical.

Meanwhile, the average post-test score is included in the Critical category. The average score on indicator 3 concludes (inference) that the average pre-test score is 9.6 while the average post-test score is 77. Based on the average pre-test score, students' critical thinking abilities are classified as not critical. Meanwhile, the average post-test score is included in the Critical category. The average score on indicator 4 determines strategy and tactics (strategy and tactics). The average pre-test score is 9.1, while the average post-test score is 79. Based on the average pre-test score for students' critical thinking abilities classified in the Not Critical category.

Meanwhile, the average post-test score is included in the Critical category. The goal of the PBL model is for students to acquire new knowledge while exploring and integrating it independently. The technique starts with identifying workplace challenges. The striking disparity in

several pre-test and post-test variables is because students' perspectives on the implementation model vary regarding wave topics using the PBL model. Meanwhile, student learning motivation is greatly influenced by the infrastructure, supporting facilities and comfort used during the learning process. Students' enthusiasm for learning will increase their thinking, along with the availability of good learning facilities and infrastructure.

The average post-test score for each indicator has increased based on the table of indicators for the ability to think critically. This proves that the PBL can improve students' critical intelligence [38]. PBL is a model that can support students' understanding and accountability for what they learn, making learning more fun and stimulating them to discover more knowledge. This model can also help students grow and take responsibility for what they know, make additional learning enjoyable, and improve their thinking analytically [39]. Next, pre-test and post-test scores for students' critical thinking abilities are in Figure 1.

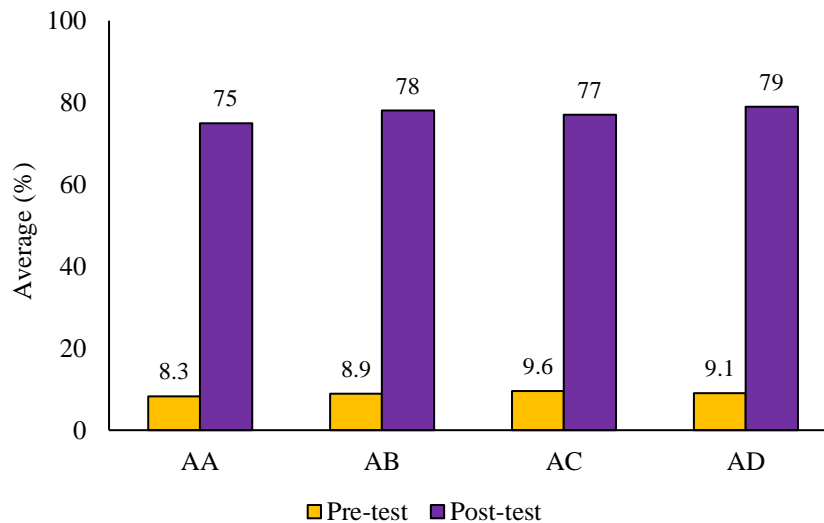


Figure 1. Comparison graph of the average pre-test and post-test scores for students' critical thinking abilities

The average calculation results for each indicator in Figure 1 have increased from the pre-test and post-test. Indicator 1 provides a simple explanation (clarification element). The average pre-test value is 8.3, increasing the post-test value to 75. Indicator 2 provides a further explanation (advance clarification): the average pre-test value is 8, 9 increases the Post-test score to 78, indicator 3 concludes (inference) that the average Pre-test score is 9.6, increases the Post-test score to 77, indicator 4 determines

strategy and tactics (strategy and tactics) average value Pre-test was 9.1 increasing Post-test score to 79.

Significant t-test

In addition, data from both pre-trial and post-test concepts were evaluated using a trial with a significance level of 0.05. The t-test evaluation using the SPSS statistical sequential sample test is at a significance level 0.05, as shown below in Table 4.

Table 4. Analysis of Critical Thinking Ability Data Using T-test

Value	Average	N-Gain	df	Significant Level	t-count	t-table
Pre-test						
Post-test	9.111	0.751	26	0.05	57.062	2.055

Based on Table 4, the t-test, according to the t-count = 57.062 table at the significance level t-table = 2.055, so Ho is rejected. The researcher then concluded that the use was equivalent to a significance level of 0.05. the PBL model analyzed students' ability to think critically at SMP Negeri 1 Bulawa class VIII, and Ha was accepted.

The hypothesis Test

The purpose of hypothesis testing is to ascertain whether the application of the PBL Model influences how students achieve in class VIII SMP Negeri 1 Bulawa to think critically. The t-test results, obtained using the formula for t-count, are at a significant level of 0.05, so the

result is $t = 57.062$. The following table shows the results of hypothesis research in the following experimental class in Table 5.

Table 5. Hypothesis test results

Class	t-count	t-table	Status
Experimental	57.062	2.055	Ha Accepted

According to Table 5, the hypothesis states that the t-count is greater than the t-table, namely $57.062 \geq 2.055$. Therefore, H_a is accepted because the PBL model influences students' critical thinking abilities in Wave topic in class VIII SMP Negeri 1 Bulawa. This proves that this research influences students' critical thinking skills.

N-gain analysis

N-gain analysis of test results using the course average normalized gain in the experimental class as shown in the following in Table 6.

Table 6. N-gain test results

Class	N-gain	Criteria
Experimental	0.751	High

Table 6 is proof that the experimental class is included in the high criteria because the Gain index value is $g > 0.70$, so the n-gain criteria are the same as high, as shown by the average pre-test score of 9.111, the average post-test score of 77.41, the average score of post-pretest 68.3, S-Ideal-Pretest 90.89. From the day the average value was obtained, the N-Gain score was 0.751 22 students obtained the high criteria, and five students received the medium N-Gain criteria.

Based on these results, researchers can conclude that using the PBL model influences students' critical thinking abilities in wave topics in class VIII of SMP Negeri 1 Bulawa. These results mean that applying the PBL model can improve the critical thinking abilities of class VIII students at SMP Negeri 1 Bulawa in the 2024/2025 academic year wave topic. With the results of this research, the researcher concluded that the PBL model is very suitable to be applied because this learning provides opportunities for students to be directly involved in problem-solving (actively), so it ultimately has an impact on increasing students' critical thinking abilities.

The findings above align with previous researchers who explained how the PBL model learning paradigm can increase student learning motivation. Teachers must pay close attention to their students' learning interests when carrying out learning activities. Developing an interest in learning is crucial because it makes learning more dynamic and engaging [40]. Students who use the PBL model method are much more interested in learning than those who use the traditional learning model. This is because the PBL model fosters student-centred and PBL that arouses student enthusiasm and curiosity. Studies show that applying the PBL paradigm significantly affects student learning motivation [41].

The PBL model can increase students' self-confidence and motivation in learning. Students gain confidence in their skills through problem-solving and

presentation of results, which increases their desire to participate in the learning process [42]. Students believe that learning becomes better and more relevant when they actively participate in solving contextual problems. Research shows that the PBL model approach increases students' learning motivation. Students are expected to participate actively in the inquiry process and problem-solve using this method. Teachers can use this strategy to help students become more interested in learning, especially in subjects or topics they find less interesting. Implementing this approach can increase student engagement and interest in education, making learning more relevant.

Conclusion

Based on the results of research that has been conducted, the influence of the PBL model on students' ability to think critically on wave topics in class VIII SMP Negeri 1 Bulawa. The results of this research show that the calculated value of the t-test shows that the value of t-count = 57.062 at a significance level of 0.05 and t-table = 2.055. So this result shows $t\text{-count} \geq t\text{-table}$. Therefore, the researcher concluded that the PBL model influenced students' critical thinking skills in wave topics in class VIII SMP Negeri 1 Bulawa. Thus, this research was declared successful (H_a was accepted).

Author's Contributions

Indriani Sa'aban: Conceptualization, writing-original draft preparation, methodology; Masrid Pikoli: Methodology; Tirtawaty Abdjul: Curation, writing-original draft preparation; Mursalin: Writing-review and editing; Muhammad Yusuf: Formal analysis, methodology; Nurhayati: Validation.

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