



The Influence of the Problem Based Learning Model on Students' Critical Thinking Ability in Mechanical Wave Material

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Abstract: The learning process is still teacher-centered, resulting in students being less active during learning. This research aims to increase the influence of the Problem-Based Learning model on students' critical thinking abilities in mechanical wave material. This quasi-experimental research uses a non-equivalent control group design. The research population included all students in class XI MIPA at one of the State High Schools in East Praya. Sampling used a purposive sampling technique so that 2 groups were obtained, namely 30 experimental class students and 30 control class students. The experimental class was given treatment in the form of using the Problem-Based Learning model, while the control class used the conventional model. Students' critical thinking abilities are obtained from the description questions they work on. Data from the pretest results of experimental class students obtained an average score of 25 and control class students obtained an average score of 23. The posttest scores showed that the critical thinking abilities of experimental class students were in the good category with an average score of 78.6 and the students in the control class were in the good category with an average score of 74.3. The research hypothesis was tested using the pooled variance t-test at a significance level of 5%. Data analysis shows that the t_{count} value, namely 3.384, is greater than t_{table} , namely 2.002, which means that H_0 is rejected and H_a is accepted, so it can be concluded that there is an influence of the Problem-Based Learning model on students' critical thinking abilities in mechanical wave material.

Keywords: Critical Thinking Ability; Problem Based Learning; Wave Mechanics.

Introduction

The world of education cannot be separated from the knowledge, skills, and habits carried out by students from generation to generation through teaching, research, and training. As time goes by, to achieve national education goals, the government continues to carry out curriculum development efforts. The curriculum is one of the elements that contribute to realizing the development of the potential quality of students (Sahidu, 2018).

One of the branches of science that must be studied at school is physics. Physics learning is learning where students should be able to be confronted directly with the object being studied, learning to connect the

knowledge that students have actively and creatively (Aulia et al., 2022).

According to Gunawan (2015), the essence of science consists of 3 parts, namely attitudes, processes, and products. Science as an attitude places greater emphasis on efforts to equip, train, or discover positive values in students. Science as a process prioritizes how to obtain knowledge, especially the process of discovering concepts involving basic skills through scientific experiments which can be carried out and improved through laboratory activities. Science as a product emphasizes the results obtained in scientific activities themselves, both in the form of concepts and equations.

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Learning is at least able to provide direct experience by implementing a learning model that actively involves students in the learning process (Hartawati et al., 2020). One learning model that can be applied is the Problem-Based Learning model. The Problem-Based Learning model encourages students to actively explore information related to a problem posed by the teacher through the instructions given to find a solution by conducting experiments. The Problem-Based Learning model is a learning model that provides authentic experiences that encourage students to learn actively, construct knowledge, and integrate learning contexts at school and learning in real life scientifically (Azmi et al., 2016). The Problem-Based Learning model is a learning model that requires full student activity to solve every problem faced by students independently by constructing the knowledge and experience they have (Suminar & Rini, 2016). The Problem-Based Learning model provides conditions for improving critical thinking and analysis skills as well as solving complex problems in real life so that it will create a culture of critical thinking in students. This learning model requires students to play an active role in learning activities that are not only centered on the teacher by also it can help students think critically (Robiyanto, 2021).

Hardianto, et al (2015) stated that the Problem-Based Learning model is a learning model that provides authentic experiences to encourage students to learn actively, construct knowledge, and integrate learning contexts at school and learning in real life naturally. According to Lismayana (2019), the Problem-Based Learning model is a learning model that can be used to improve a system that occurs in the surrounding environment, from events in a family or social event. The Problem-Based Learning model is a learning model that encourages students to know how to learn and work together in groups to find solutions to problems (Vebrianto et al., 2021). Furthermore, according to Nurhadi & Sanduk (2004), the Problem-Based Learning model is a learning model that uses real-world problems as a context for students to learn problem-solving and critical thinking skills as well as to acquire essential knowledge and concepts from the subject matter.

Thinking is a mental activity that cannot be separated from human life. The critical thinking ability of each individual is different from one another so it needs to be honed from an early age. Thinking occurs in every human mental activity that functions to formulate or solve problems, make decisions, and find reasons. Critical thinking is a cognitive strategy for solving more complex problems, students can use higher knowledge and thought patterns (Surya, 2015). Critical thinking ability is an ability that students must have as basic capital to understand science. Training and developing students' critical thinking skills in learning is very

important so that students can understand what they are learning because students do not just gain knowledge but discover the knowledge themselves. According to Lie & Siti (2020), critical thinking ability is the ability to use and process thought processes based on facts. Someone who has critical thinking skills not only knows certain facts but also uses the knowledge gained to develop that knowledge themselves. It can be concluded that critical thinking skills are a thinking process for analyzing or evaluating information obtained from observation, experience, and common sense or communication. According to Facione (2011), critical thinking is thinking that has a goal that proves something, and interprets what a problem means.

When working on practice questions, students more often use mathematical equations without analyzing them first, guess the formulas used, and memorize examples of questions that have been worked on previously to work on other practice questions. The impact of this is that students are more likely to have difficulty when faced with more complex problems.

There are several problems in learning physics, namely that students consider physics lessons to be difficult and boring lessons that contain concepts, theories, and several mathematical equations. The learning process is still teacher-centered, resulting in students being less active during learning. Students tend to be required to sharpen memory aspects, without being allowed to train students to develop their reasoning power in applying physics concepts that have been studied in real life so that students' critical thinking abilities cannot develop well, students also tend to memorize the material they have learned. given by the teacher without understanding the meaning of the material. Therefore, students' critical thinking abilities are still relatively low. The relevant learning model is the Problem-Based Learning model. Where the Problem-Based Learning learning model is a learning model that is characterized by the existence of a real problem as a context for students to learn critical thinking and skills in solving problems or gaining knowledge. According to Pitriah et al., (2018), teachers must have the ability to use effective learning models and methods to improve students' critical thinking abilities.

In physics learning, several learning models are used, one of which is Problem-Based Learning. Problem-based learning is a learner-centered approach (Zulkarnaen et al., 2022). Agraw et al., (2017) in their research stated that the Problem-Based Learning (PBL) model allows students to understand science well. Meanwhile, according to Intandari et al., (2018) learning physics using the Problem Based Learning model makes students in the classroom more active and think critically when facing problems in physics lessons. The Problem-Based Learning Model is a problem-based

learning model in everyday life that is related to learning material.

According to Mulyasa (2009), Problem-Based Learning is contextual learning that links learning material to the real-world context of students. The main focus of Problem-Based Learning is on what students think. The Problem-Based Learning model sharpens students' thinking skills so that it can improve students' critical thinking skills in physics learning, especially in mechanical wave material. The problems used are real problems that are closely related to everyday life. The subject of mechanical waves is one of the many concepts in physics lessons whose application is often found in everyday life. Therefore, mechanical wave material is suitable to be applied according to the Problem-Based Learning model.

Method

This quasi-experimental research uses a non-equivalent control group design. A population is an object or subject that has certain requirements related to research (Riduan, 2015). The population of this study was all students in class control. The sample is a small group studied which is part of the population (Sukmadinata, 2010).

The variables in this research consist of independent variables, namely factors that are measured, manipulated, or selected by the researcher to determine the relationship between the phenomena being observed or observed (Setyosari, 2013). In this research, the independent variable is the Problem-Based Learning model. The dependent variable is a factor that appears or does not appear or changes according to what is introduced by the researcher (Setyosari, 2013). In this research, the dependent variable is students' critical thinking abilities. Control variables are variables used to control independent variables (Setyosari, 2013). The control variables in this research are material, learning objectives, teachers, and research instruments (syllabus, RPP, LKPD, LDPD, critical thinking test question grid, and description test questions). The data collection technique is a written test in the form of essay questions totaling 10 questions. The critical thinking indicators used in this test consist of five indicators, namely interpretation, analysis, evaluation, inference, and explanation.

Critical thinking ability test instruments before being used in research must meet several requirements, namely validity, reliability, level of difficulty, and differentiability of questions. The data analysis test used in this research is the t-test with a significance level of 5% and degrees of freedom $(n_1+n_2)-2$ and the N-Gain test is used to determine the increase in critical thinking skills per indicator in the experimental and control

classes. This research was carried out by providing treatment in the experimental class in the form of using the Problem-Based Learning model and treatment in the control class in the form of a conventional model.

Result and Discussion

This research aims to analyze the influence of the Problem-Based Learning model on students' critical thinking abilities in mechanical wave material. This quasi-experimental research was conducted by providing treatment in the form of a Problem-Based Learning model in class XI MIPA 3 as an experimental class with a total of 30 students and treatment in the form of conventional learning in class XI MIPA 2 as a control class with a total of 30 students.

The results of research conducted based on the pretest of students' critical thinking abilities in the experimental and control classes were still low. This can be seen from the average critical thinking ability test in each class. The low average pretest score is because students have not been given treatment and students have not received mechanical wave material. Data from the pretest results on critical thinking skills for both classes were analyzed to determine homogeneity and normality. After conducting a pretest in both classes, treatment was carried out in the experimental class using the Problem-Based Learning model and in the control class using the conventional model. As pictures 1 and 2 show.



Figure 1. Giving Treatment to the Experimental Class



Figure 2. Giving Treatment to the Control Class

To measure the effect of the treatment that had been given, both classes were given a posttest, the experimental class obtained a higher average score of 78.6 compared to the control class's average score of 74.2.

The pretest and posttest results of critical thinking skills for the experimental class and control class can be seen in Table 1 and Table 2.

Table 1. Pretest Results Data for Experimental and Control Classes

Test	Class	(N)	F_{count}	F_{table}	Variance
Pre	Experimental	30	1.534	1.868	Homogeneous
	Control				
Post	Experimental	30	1.306	1.868	Homogeneous
	Control				

Table 2. Experimental and Control Class Posttest Results Data

Test	Class	(N)	χ^2_{count}	χ^2_{table}	Data
Pre	Experimental	30	9.031	12.592	Normally Distributed
	Control		6.334		
Post	Experimental	30	10.76	12.592	Normally Distributed
	Control		3.241		

Table 1 and Table 2 show that the experimental class and control class had the same abilities before being given treatment. These results show that the increase in the average value in the experimental class is higher than the increase in the average value in the control class. To prove further statistically, a hypothesis test was carried out using the t-test. As for the results of the hypothesis test, the t_{count} value was greater than the t_{table} , namely $3.384 > 2.002$. These results indicate that the Problem-Based Learning model affects students' critical thinking abilities in mechanical wave material.

Increased critical thinking skills can be seen from the N-Gain results per indicator. The results of the N-

Gain test in the experimental class showed a higher value compared to the control class as a whole. The results of this research are also in line with research conducted by Islamiah et al. (2018) also revealed that applying the PBL model in science learning can improve students' critical thinking abilities. Apart from that, Putri et al., (2022) one learning model that can improve students' critical thinking skills is the PBL model. Furthermore, Agustina (2022) stated that the class where the PBL model was applied was better than the direct learning model, this was proven by the difference in the average post-test scores in the two classes.

Table 3. Data on KBK N-Gain Test Results for Experimental and Control Classes

Class	N-Gain per KBK Indicator					$N-Gain$ Total (%)	Criteria
	1	2	3	4	5		
Experimental	80	73	81	73	60	73.4	high
Control	76	63	73	72	58	68.4	medium

The N-Gain values for the experimental class and control class for each indicator are in Table 3. Based on Table 3, it can be seen that the percentage increase in critical thinking skills was better in the experimental class for each indicator. This increase is due to differences in treatment, where the problem or problem is solved independently.

Four indicators of critical thinking abilities have increased in the high category in this research, namely interpretation, analysis, evaluation, and inference. The highest increase occurred in the third critical thinking indicator, namely evaluation, because in this indicator students were able to use the right strategy in solving problems in each question. Further improvement occurs in the first indicator, namely interpretation, where in this indicator students can have the ability to understand, explain, and give meaning to problems clearly and

precisely. Further improvement in the second indicator, namely analysis of this indicator, students can identify relationships between information used to express students' thoughts or opinions. The fourth improvement, namely inference on this indicator, students can identify and draw conclusions based on the questions asked logically.

Conclusion

Based on the results of the research and discussion, it can be concluded that there is an influence of the Problem-Based Learning model on students' critical thinking abilities in mechanical wave material. The N-Gain test per KBK indicator carried out showed that the experimental class experienced an increase in the evaluation indicator with an N-Gain value of 0.81, while

the control class experienced an increase in the interpretation indicator with an N-Gain value of 0.76, resulting in a difference of 0.05. The N-Gain test per KBK indicator in the experimental class with an N-Gain value of 0.60 and the control class of 0.58 experienced a decrease in the explanatory indicator by a difference of 0.02. Thus, the experimental class had a higher increase compared to the control class.

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