THE EFFECT OF THE PROBLEM-BASED LEARNING MODEL ON STUDENTS' CRITICAL THINKING ABILITY IN THE TEMPERATURE AND HEAT CHAPTER

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ABSTRACT: This research aims to examine the effect of problem-based learning models on students' critical thinking ability in the temperature and heat chapter. The type of research used was quasi-experimental with a pretest-posttest control group design. The population of this research was all students of class XI MIPA at SMAN 2 Praya. sampling in this research uses probability sampling with a random sampling technique so that students in class XI MIPA 3 were selected as the experimental class and students in class XI MIPA 4 as the control class. The instrument used to measure students' critical thinking skills is an essay test. The average score of the student's critical thinking skills in the experimental class was 63,50 and that of the control class was 57,74. The results of the prerequisite test showed that the post-test data were normally distributed and homogeneous, so the statistical test used was the parametric statistic t-test polled variant and obtained t_{count} 2.998 and t_{table} 1.995 at a significant level of 5%. The value of t_{count} is greater than t_{table}, then H_0 is rejected and H_1 is accepted, so it can be concluded that there is an effect of the problem-based learning model on students' critical thinking ability in the temperature and heat chapter.

Keywords: *Problem Based Learning* Model, Critical Thinking Ability.

I. INTRODUCTION

Education is a means to improve the quality of Human Resources. Education in Indonesia is part of efforts to educate the nation's life and improve the quality of human resources [1]. Therefore, the quality of education at all levels, both public and private, must be improved, one of which is to improve the quality of learning.

Learning is a process of transferring knowledge from teachers to students. According to Permendikbud no 81 A of 2013 attachment IV, the learning process consists of five main learning experiences namely observing, asking, gathering information, associating, and communicating. The learning process using the 2013 curriculum requires educators to involve students actively in class, and students are required to participate actively in class. According to Farisi [2] based on the basic views of the 2013 curriculum, an educator acts as a facilitator who guides and directs students so that students themselves find concepts about learning material through a thought process. The thinking process carried out by students is expected to provide a way of understanding independently to students through experiences or events that are experienced in everyday life related to learning. Student learning outcomes are obtained through learning achievement tests that show student achievement or progress in learning. This requires students to have higher-order thinking skills. One of them is 21st-century skills, namely critical thinking skills [3].

Critical thinking in 21st-century education is one of the needs that must be possessed by students to compete in the era of globalization [4]. According to Rizaldi et al. [5] critical thinking is an embodiment of higher-order thinking because critical thinking skills are seen as students' thinking abilities to compare two or more of information they have. According to Men [6], students who have critical thinking skills can study problems systematically, face challenges in an organized way, formulate questions, be innovative, and design solutions that are seen as relatively new. The development of student's critical thinking skills will certainly make it easier for students to understand a concept so that it will produce learning outcomes in the cognitive domain as well. Because based on the opinion of Oktaviani [7] states that there is a significant relationship between critical thinking and learning outcomes. If students have high critical thinking skills, their learning outcomes will also be high.

The student's critical thinking skills continue to be improved and are still a concern because phenomena in schools show that teachers are still constrained in improving students' critical thinking skills. This was disclosed by a physics subject teacher at SMAN 2 Praya that students were less active in class and tended not to pay attention to the material presented by the teacher. One of the reasons is that the learning process applied by the teacher does not provide access for students to develop independently and compile their knowledge so it will have an impact on the critical thinking skills of students who are not trained. Learning carried out by teachers still tends to use the lecture method, and the learning media used is also only blackboards. As a result, students assume that physics lessons are not fun even though physics lessons are in everyday life.

The way that can be done to improve student's critical thinking skills in learning physics is by applying an interactive and interesting learning model that is associated with physical phenomena that exist in everyday life. According to Zamroni and Mahfudz's research [8], there are four ways to improve critical thinking skills,

namely: (a) certain learning models, (b) giving assignments to criticize books, (c) using stories, and (d) using the Socratic question model. One solution that can be done to improve student's critical thinking skills is to use the Problem-Based Learning (PBL) model.

The problem-based learning model is a learning model that emphasizes students being active in class and the teacher presenting problems at the beginning of learning. According to Ibrahim and Nur in Sahidu [9] problem-based learning is not designed to help teachers provide as much information as possible to students but is developed to help students develop thinking skills, problem-solving and intellectual skills, learning various adult roles through their involvement in real experience. The PBL model is also intended for students to construct their knowledge, develop higher-order thinking skills, and develop independence and self-confidence.

The teacher's role is very important in providing learning experiences to students by designing interactive and exciting learning processes. Teachers can design learning by providing problems that involve students' critical thinking skills and involve analyzing processes based on actual problems. According to Tan in Nafiah [10], the Problem-Based Learning model can lead students to solve life's problems through discovering, learning, and independent thinking. The Problem-Based Learning model also emphasizes learning as a process that involves problem-solving and critical thinking in the actual context.

Based on the problems described above, the researcher is interested in researching the effect of the problem-based learning model on students' critical thinking skills in the subject matter of temperature and heat. So the problem-based learning model used is expected to improve students' critical thinking skills.

II. METHODS

The type of research used is quasi-experimental. Quasi-experimental is a way to look for causal relationships between two or more variables [11], in which in practice there are treatments given to research subjects to find out whether the treatment given affects certain outcome variables or factors. The research design used was a pretest-posttest control group design. The research design was carried out by selecting students from two classes as samples, namely one class as the experimental class and the other class as the control class. Students who are in these two classes will be given a pre-test to determine the level of students' initial critical thinking skills. Students in the experimental class were given treatment using the problem-based learning model and control class students were given treatment using conventional learning models. At the end of the research activity, students will be given a final test to determine their level of critical thinking skills after being given treatment. The research design can be seen in table 1 below.

Table 1 Research Design

Class	Pre-test	Treatment	Post-test
Eksperiment	O_{11}	X_1	O_{12}
Control	O_{21}	X_2	O_{22}

(Adapted from Setyosari [12])

The population in this study were all students of class XI MIPA at SMAN 2 Praya which was divided into 4 classes. The sample of this study were students in class XI MIPA 3 as the experimental class and students in class XI MIPA 4 as the control class. Samples were selected using probability sampling with random sampling techniques. To measure students' critical thinking skills, a description test was used with a total of 10 questions that had been previously tested with the following criteria.

Table 2 Criteria for Level of Critical Thinking Ability

Gain Score	**Critical Thinking Ability Level**
$81{,}25 < x \leq 100$	very critical
$62{,}50 < x \leq 81{,}25$	critical
$43{,}75 < x \leq 62{,}50$	less critical
$25{,}00 < x \leq 43{,}75$	very less critical

(Yuliati [13])

The hypothesis test used in this study is the t-test with the polled variants equation with a significance level of 5%. Before the t-test is carried out, a normality test is first carried out which is used to find out whether the data is normally distributed or not, and the F test is used to determine the homogeneity of the data. If the data is normally distributed and homogeneous, then the next stage can be carried out, namely the t-test with the polled variants equation to find out whether there is an influence of the independent variable on the dependent variable.

III. RESULTS AND DISCUSSION

This research was conducted in five meetings in each class, the first meeting was used for the pretest, the second, third and fourth meetings were used for delivering material and the fifth meeting was used for the posttest, where all activities in this study are conducted face-to-face (outside network). Students in the experimental class and control class were given a pretest first to find out the initial abilities of students in each

class before being given treatment (treatment), and the posttest aimed to determine the effect of learning after being given treatment on students' critical thinking abilities. The learning model used in this study for the experimental class is a problem-based learning model and the control class uses a conventional learning model. The test instrument being tested is a test of critical thinking skills which totals 10 questions. Test instruments were given to students before receiving treatment (pretest) and after receiving treatment (posttest). This research required five meetings, the first meeting was carried out with a pretest on the level of students' initial critical thinking skills, the second, third, and fourth meetings were filled with the delivery of material and the fifth meeting was filled with a posttest. The results of the analysis of the pretest and posttest critical thinking skills of students in the experimental and control classes are as follows.

Table 3 Pretest and Posttest Results of Critical Thinking Ability

Ability	Class	Average Value	Critical Thinking Ability Level
Pretest	Eksperiment	46,10	less critical
	Control	38,64	very less critical
Posttest	Eksperiment	63,50	critical
	Control	57,74	less critical

Based on the table above, the results of the pretest critical thinking skills test for experimental class students showed a less critical category with an average of 46,10 and the results of the control class test showed very less critical results with an average of 38,64. While the results of the post-test critical thinking skills test for experimental class students showed a critical category with an average of 63,50 and control class students showed a less critical category with an average of 57,74. The facts obtained from the posttest results are that the experimental class experienced a significant increase with the application of the problem-based learning model compared to the control class which applied the conventional learning model. The increase in scores from the pretest to the posttest indicates that the problem-based learning model can be applied to temperature and heat material because, with the application of this model, the experimental class experiences a better improvement in critical thinking skills compared to the control. This is in line with the opinion of Yuliana et al. [4] that one solution to solving problems related to critical thinking skills is to apply to learn related to how to find out and emphasize learning experiences, obtained through a process by training students' critical thinking abilities. The results of the analysis of students' critical thinking skills for each indicator can be seen in table 4 below.

Table 4 Level of Students' Critical Thinking Ability for Each Indicator

Class	Critical Thinking Ability Indicator					Average	Category
	A	B	C	D	E		
Eksperiment	76,39	54,17	79,51	53,82	57,99	64,38	critical
Control	64,24	40,51	70,49	83,33	30,56	57,82	less critical

Keterangan: A: Elementary clarification; B: Basic support; C: Inference; D: Advance clarification; E: Reasoning and integrate.

From the results of the analysis of critical thinking skills for each indicator, it was found that the highest score for the experimental class students on the inference indicator is 79.51, and the lowest on the further explanation indicator is 53.83. While the highest score for the control class is the further explanation indicator is 80.33 and the lowest score is the reasoning and integrating indicator is 30.56. Based on table 4 above, it can be seen that there are differences in the results between the experimental class and the control class, this indicates that the delivery of material using the problem-based learning model and conventional learning models with the lecture method gives different. Before testing the hypothesis, the normality test and homogeneity test are first carried out. The results of the analysis of the pretest and posttest data normality test for the critical thinking skills of students in the experimental class and control class are as follows.

Table 5 Pretest and Posttest Normality Test Results

Ability	Class	χ^2_{count}	χ^2_{table}	Criteria
Pretest	Eksperiment	4,557	12,592	Normally distributed
	Control	1,240		
Posttest	Eksperiment	6,4543		
	Control	11,2378		

Table 5 shows that the results of the analysis of the pretest and posttest normality tests for students in the experimental class and control class show that the data is normally distributed with $\chi^2_{count} < \chi^2_{table}$, that is, if the value of χ^2_{count} is smaller from χ^2_{table} it can be concluded that the data is normally distributed. Meanwhile, the results of the pretest and posttest data homogeneity tests for students' critical thinking skills in the experimental class and control class can be seen in the following table.

Table 6 Pretest and Posttest Homogeneity Test Results

Ability	Class	N	$\bar{X}$	S^2	F_{count}	F_{table}	Criteria
Pretest	Eksperiment	36	46,10	48,16	1,310		Homogeneous

	Control	35	38,64	36,72		1,767
Posttest	Eksperiment	36	63,50	76,26	1,143	
	Control	35	57,74	66,73		

Table 6 above shows that $F_{count} < F_{table}$, namely F_{count} pretest and posttest students in the experimental class and control class are smaller than F_{table}, so it can be said that the pretest and posttest results data of students in the experimental class and control class are homogeneous.

Furthermore, the hypothesis testing of the experimental class and control class data was carried out. The hypothesis test aims to determine the influence of problem-based learning models on students' critical thinking abilities. The determination of hypothesis testing is based on the results of the prerequisite test, namely the results of the normality test and the homogeneity of the data in the experimental class and the control class. The results of hypothesis testing can be seen in the following table.

Table 7 Hypothesis Test Result Data

Class	N	t_{count}	df (n_1+n_2-2)	Significance	t_{table}
Eksperiment	36	2,998	69	0,05	1,995
Control	35				

Based on the table above, it can be seen that $t_{count} > t_{table}$ is 2.998 > 1.995 at a significance level of 0.05 and degrees of freedom df = $n_1 + n_2 - 2 = 36 + 35 - 2 = 69$, the value of t_{table} is 1.995. The result of calculating t_{count} using the t-polled variance test formula is 2.998. Because $t_{count} > t_{table}$, it can be concluded that H_0 is rejected and H_1 is accepted, meaning that there is an influence of the problem-based learning model on students' thinking abilities in the matter of temperature and heat. Because the problem-based learning model supports the activeness of students in the classroom this model can improve students' critical thinking skills. This is in line with the opinion of Apriani et al. [14] who states that the problem-based learning model can activate students through problem-solving activities. This is following research conducted by Hasanah et al. [15] that the use of the PBL model influences students' critical thinking abilities. In addition, Pharisee's research [2] states that there is an influence of the problem-based learning (PBL) model on students' critical thinking skills regarding the concepts of temperature and heat. Likewise, research conducted by Iskandar et al. [16] states that the problem-based learning model has a high influence on students' critical thinking skills.

IV. KESIMPULAN

Based on the results of data analysis and discussion, the posttest data of students in the experimental class and control class are normally distributed and show a homogeneous variant, so that the results of the hypothesis test are obtained $t_{count} > t_{table}$, namely 2.998 > 1.995. Thus it can be concluded that there is an influence of the problem-based learning model on students' critical thinking skills.

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