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The Effect of PjBL Model based on Skill Approach Process to Physics Critical Thinking Ability of High School Student

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Abstract: This study was aimed at describing and determining the level of critical thinking skills of students using learning tools with a project based learning model based on material process skills approach to momentum and impulse in class X.4 (Modeling) and X.2 (Implementation) SMAN 1 Kalasang, Indonesia. This research was a *Pre-Experiment Design* research using the *One-Shot Case Study Design* research design. Research subjects were 48 students which obtained based on purposive sampling by looking at certain criteria and reasons. The results of the research data were obtained through critical thinking ability test instruments, learning device planning instruments, student worksheet instruments, and valid product assessment instruments, and instrument validation. Data collection techniques consisted of the preparation stage, implementation phase, and data collection stage. Data analysis techniques used were descriptive analysis and inferential analysis. The results showed that students' critical thinking skills using learning tools with a *project based learning* model based on material process skills approach to the momentum and impulse of SMAN 1 Kalasang were in the good category (Modeling class with an average value of 75.20 and an Implementation class with an average value of 77.39). And there was increase in critical thinking skills after using learning tools with a *project based learning* model based on the process skills approach to material momentum and impulse of SMAN 1 Kalasang in the Modeling class as well as in the Implementation class.

Keyword: Model PjBL; Process skill approach; Critical thinking ability; Physics.

1. Introduction

Education is the basis for every effort, protection, assistance and influence given to children who are focused on the maturity of the child (learners), or rather help students in being capable enough to carry out their own lives [1]. Without education, one will find it difficult to participate in the development of knowledge and technology. To produce good education, good learning is needed in every learning activity. Learning is said to be ideal when it is student oriented (student centered). According to Minister of Education Regulation No. 22 of 2006, with student centered learning, students will try to construct their knowledge and can be actively involved in finding problems or information [2]. But as a matter of fact, physics learning is sometimes not according to plan, students have difficulty in developing conceptual knowledge [3] such as determining understanding of the concepts of physics, operations, and the relationship between momentum and impulses [4].

The main goal for learning physics [5] leads to cognitive knowledge [6, 7], that is conceptual knowledge that can be useful in the skills of students [8,9] so that students have been directed to higher level knowledge [10] which is developing critical thinking skills in accordance with the

curriculum [7] as a basis for continuously evaluating and proposing hypotheses and models used [11]. With increasing critical thinking skills, students will understand the concepts taught.

Critical thinking is the ability and habits naturally based on the power of reason, logic, and analysis, which really need to be trained as often as possible [12]. Critical thinking is part of the ability to think clearly and rationally [13] where critical thinking describes an ability to explore problems, questions, or situations [14] based on concepts, real circumstances, and principles [15,16]. We begin by planning taxonomy that has been developed for teaching critical thinking in physics [17]. With the increasing ability to think critically, it can indirectly improve the cognitive abilities of students in accordance with the taxonomy that has been developed.

But the desired thing is not in accordance with reality. Based on previous research, it was found that the correlation between the two classes of critical thinking ability was not due to a joint connection with cognitive abilities, because half of the cognitive abilities had come out [18]. Based on student interviews conducted at the school of SMAN 1 Kalasang there are still many students who are confused with the ability to think critically, because the learning process is not in accordance with the indicators of critical thinking skills.

One of the efforts for the learning process which is predicted to be able to overcome these problems is through learning tools with the *Project Based Learning* (PjBL) model combined with the process skills approach. The basis of science process skills includes experimental skills, observing, measuring, and processing data [19] calculate, classify, find a space / time relationship, make hypotheses, control variables, interpret, compile temporary conclusions, predict, implement, and communicate [20]. so this approach can support the implementation of the *project based learning* model.

The project based learning model is a learning model that focuses on the activeness of students; teachers learn together with students [21,22]. The phases of the project based learning model consist of the phase of preparing project questions or assignments, designing project planning, arranging schedules, monitoring project activities and developments, testing results, and evaluating activities and experiences [23].

Project based learning model is a good model for students who do not like sitting and reading for learning and can develop critical thinking skills. With the project based learning model, they become independent and creative, and make them able to be active in critical thinking, based on project making, practicum through the created projects, statements and pictures as supporting material discussed at the beginning of the lesson. Moreover, the *project based learning* model is integrated with the process-oriented approach [24], so as to provide convenience in the implementation of learning using a project based learning model both in the making of projects and trials of the projects created, as well as the implementation of phases of the project based learning model.

Based on the above problems, the purpose of this study is to describe students' critical thinking abilities using learning tools with *project based learning* models based on material momentum process skills and impulses in class X.4 (Modeling) and X.2 (Implementation) SMAN 1 Kalasang, and find out the level of critical thinking skills after using learning tools with *project based learning* models based on material process skills approach to momentum and impulses in class X.4 (Modeling) and X.2 (Implementation) SMAN 1 Kalasang.

The rest of this paper is organized as follow: Section 2 describes the proposed research method. Section 3 presents the obtained results and following by discussion. Finally Section 4 concludes this work.

2. Proposed Methods

The type of research used was the *Pre-Design Design* using a research design namely the *One-Shot Case Study Design*, with a design according to [25].

X	O

Where:

X = Treatment / treatment namely learning physics by using Project Based Learning (PjBL) model based on the process skill approach given to the class which is used as the subject of research namely class X MIA 4 (modeling) and class X MIA 2 (implementation) SMAN 1 Kalasang

O = The measurement of students' critical thinking skills after being taught using the Project Based Learning (PjBL) model based on the process skills approach in the class which is used as the subject of learning, namely class X MIA 4 (modeling) and class X MIA 2 (implementation) of SMAN 1 Kalasang

This research was conducted at SMAN 1 Kalasang Yogyakarta on Wednesday, 2 May 2018. The population of this study was 125 students, while the research subjects amounted to 48 students consisting of 25 students in class X MIA 4 (Modeling) and 23 students in class X MIA 2 (Implementation). The research object was obtained based on purposive sampling by looking at certain criteria and reasons. The reason for the subject was because the supervising teacher taught in both classes that were not being used as research subjects, and the criteria of the research subject could represent the entire population in class X MIA SMAN 1 Kalasang, where classes were used as research subjects, namely classes that were between high-ability classes and low-ability classes that were observed based on observations.

2.1. Research Procedure

The steps taken in this study begain with the initial hypothesis about learning conducted in SMAN 1 Kalasan Yogyakarta, whether or not a project based learning model based on process skills approach was needed, then made observations relating to students' critical thinking skills during the learning process in the classroom. From these results it was found that students were less active in learning and did not utilize the skills of students. Then analysis of the material was based on facts, concepts, principles, laws and theories of momentum and impulses.

The next step in the research was to make Learning Implementation Plans (RPP) and Student Worksheets (LKPD) in accordance with the project based learning model based on the process skills approach and the test instrument for critical thinking skills and product assessment. Furthermore, a review and validation sheet were made relating to the Learning Implementation Plan (RPP), Student Worksheet (LKPD), and critical thinking ability test instruments, as well as product assessment sheets, then validated through the validator. If there were suggestions and input, revision was immediately made.

After all was validated by the validator / lecturer, we are ready to do research in looking at the ability to think critically through the implementation plan of learning and student worksheets that contained a *project based learning* model based on the process skills approach.

2.2. Data and Instruments

Data were obtained through critical thinking ability test, Lesson Plan (RPP) instruments, Student Worksheet (LKPD) instruments, and instrument of validaty to determine whether or not an instrument was used. The instrument was said to be valid if the validator gave an average value of 3 and 4 in each aspect. In addition to validity relevance, instrument reliability was also determined, it is said to be reliable if r count> 0.75.

2.2.1. *Gregory test* (See [26])

This test is used to see whether the instrument used is valid or invalid.

$$\text{Validation Coefficient} = \frac{D}{A+B+C+D} \tag{1}$$

2.2.2. *Percent Of Agreement test* (See [26])

This test is used to see the reliability of the instrument used.

$$PA = \left(\frac{|A-B|}{|A+B|}\right) X100\% \quad (2)$$

2.3. Data Analysis Techniques

2.3.1. Descriptive analysis

In descriptive data analysis consisted of data after being given a *Project Based Learning* Model based on a process skills approach, where this analysis described the critical thinking ability score with the steps, namely: making the frequency distribution table, determining the average score, standard deviation, variance, and the category of critical thinking skills in physics.

2.3.2. Inferential analysis

This analysis was used in proving the basic assumption test and hypothesis testing.

- Normality test (See [27])

$$D_{count} = maksimun|F_O(X) - S_N\ (X)| \quad (3)$$

- Hypothesis test
  - Statistical hypothesis

    H_o: $\mu \geq 75$

    H_1: $\mu < 75$

    Information:

    H_0 : There is an increase in critical thinking skills after using learning tools with project based learning models based on material process skills approach to momentum and impulse in class X MIA 4 (modeling) and class X MIA 2 (implementation) SMAN 1 Kalasang.

    H_a : There is no increase in critical thinking skills after using learning tools with project based learning models based on material process skills approach to momentum and impulse in class X MIA 4 (modeling) and class X MIA 2 (implementation) SMAN 1 Kalasang
  - Determining the value of the degree of freedom (*df*)
  - Determining the value of t_{tabel} pada $\alpha = 0{,}05$
  - Calculating correlation values (See [26])

$$r = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{[n(\sum X^2) - (\sum X)^2][n(\sum Y^2) - (\sum Y)^2]}} \quad (4)$$

  - Determining the value of t_{count}(See [27])

$$t_{count} = \frac{\overline{X} - \overline{Y}}{\sqrt{\left(\frac{S_X^2}{n_1} + \frac{S_Y^2}{n_2}\right) - 2r\left(\frac{S_X}{\sqrt{n_1}}\right)\left(\frac{S_Y}{\sqrt{n_2}}\right)}} \quad (5)$$

3. Results and Discussion

This section describes the obtained result dan following by discussion.

3.1. Validation Analysis

The instruments validated in this study were the instruments of critical thinking skills in physics, Learning Implementation Plans (RPP) and Student Learning Worksheets (LKPD), as well as product assessment sheets both in the modeling class and in the implementation class.

a. Validation of critical thinking skills test instrument, this test instrument was in the form of multiple choice descriptions consisting of five choices, namely a, b, c, d, and e which were validated by expert experts, where each aspect consisted of values 3 and 4 for each item based on the Gregory test, so that the ability to think critically was said to be valid. Based on the *percent of*

agreement test, it was found that reliability was 1.00 so that the instrument was declared reliable and could be used because r_{count}> 0.75.

b. Validating instruments of learning implementation plan, based on the Gregory test this instrument consisted of guidance aspects, coverage aspects of model elements and aspects of language where the three aspects got an average value of 4 from the validator, so that the instrument was said to be good or valid in the modeling and implementation classes. Besides that, based on the *percent of agreement* test, the reliability value was 1.00, so the instrument was said to be reliable, because r_{count}> 0.75 and the instrument could be used.
c. Validation of students' worksheets, this instrument consisted of guidance aspects, coverage aspects and aspects of language, where each aspect is tested by Gregory test, by obtaining an average value of 4 of the validators, so that the instrument was said to be valid. In addition, based on the results of the analysis with the *percent of agreement* test, the reliability value was 1.00 so the instrument was declared reliable because the r_{count}> 0.75 and the instrument could be used.
d. Validation of product assessment instruments, this instrument consisted of guidance aspects, coverage aspects and aspects of language, where each aspect got an average value of 3 and 4 based on the Gregory test of the validator, so that the instrument was said to be valid. Whereas based on the results of the analysis with the *percent of agreement* test, the reliability value of 1.00 was obtained so that the instrument was declared reliable, where r_{count}> 0.75 and the instrument could be used.

3.2. Descriptive Analysis

From the research, the results of descriptive analysis were used to describe students' critical thinking skills, which can be observed in Table 1.

Table 1. Statistics Model Implementation

		Modelling	Implementation
N	Valid	25	23
	Missing	0	2
Mean		75.20	77.39
Std. Deviation		18.956	17.377
Variance		359.333	301.976
Minimum		40	40
Maximum		100	100
Sum		1880	1780

Table 1 above illustrates that students' critical thinking skills in the modeling class and implementation class are better than the KKM scores in SMAN 1 Kalasang, where the average value (mean) in the modeling class is 77.39, while the average value (mean) in the implementation class is 75.20. The modeling class and implementation class had the same maximum value as well as the minimum value. With the number of 25 students in the modeling class and the implementation class there were 23 students.

Critical thinking skills score category after being given a *project-based learning* model assisted by the process skills approach can be shown in Figure 1. From Figure 1 illustrates that the value of students is dominated by good categories in the modeling class, while the implementation class is dominated by good and very good categories. For the frequency of the values of students in the modeling class and implementation class, there were at least or no one who got the score in the category, namely the category was very lacking, so the students both in the modeling class and the implementation class were in the less, moderate, and very good.

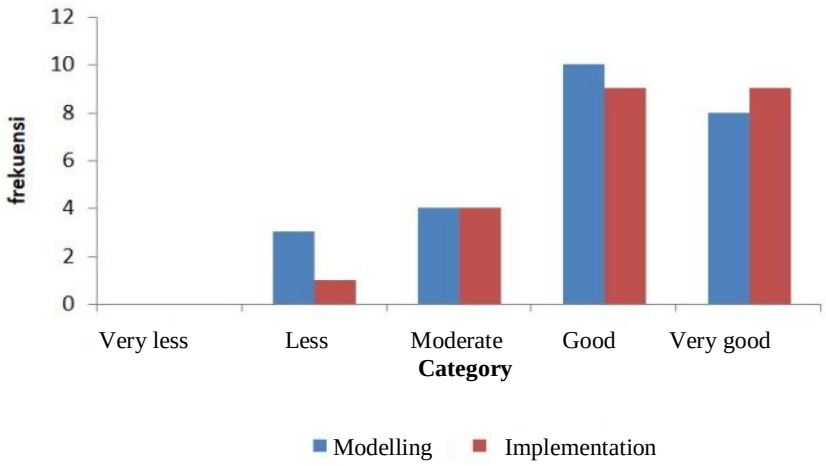

Figure 1. Categories of critical thinking skills in modeling and implementation classes

From the two results above it showed that students' critical thinking skills was better after being taught with a *project based learning* model based on process skills approach in class X MIA 4 (modeling) and class X MIA 2 (implementation). The results obtained were supported by studies related to research conducted. Based on the research, it was found that the *project-based learning* model and *problem-based learning* influenced the creativity and critical thinking skills of students. There were differences in the effect between *project-based learning* and *problem-based learning* on students' creativity, and there was no difference in influence between *projects based learning* and *problem-based learning* on students' critical thinking [28].

In another study, the mean value (mean) obtained at posttest (81.44) was higher than the pretest (61.41), so it can be concluded that students' critical thinking skills were better after being given a model of *project based learning* assisted by learning micro hydro power plants [29]. Furthermore, the results of the research were carried out with descriptive research and found that with the four pillars of education set by UNESCO namely learning to know, learning to do, learning to live together and learning to be, the *project based learning* model was deemed appropriate to develop students' critical thinking skills, based on the four pillars of education [30]. The latest research related to the research of this article, the average value of critical thinking ability was 2.82. Critical thinking skills were categorized better through the STEM education *model based learning* [31].

Based on the explanation above, it can be concluded that the *project based learning* model combined with critical thinking skills has been successfully applied. It can be seen from the general description of students' critical thinking skills after being taught with a *project based learning* model combined with process skills better than the KKM values (*Criteria Minimal Completeness*).

3.3. Inferential Analysis

This was the testing of the effectiveness of the *project based learning* model assisted by the process skills approach in improving students' critical thinking skills according to the Minimum Completeness Criteria (KKM = 75) in the modeling and implementation classes. This effectiveness analysis used*one-sample t-test* technique. The decision criteria used were H0 accepted if the significance level was > 0.05, which indicated that the average critical thinking ability of students was greater or equal to the KKM value. Likewise, vice versa if the significance level was <0.05, then H0 was rejected and Ha was accepted, so that the average critical thinking ability of students was below the KKM value. But before entering the t test analysis what we needed to do was the normality test so that the data obtained from the research subject could be normally distributed. The results of normality test data can be seen in Table 2.

Table 2. Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Modelling	.127	23	.200	.925	23	.087
Implementation	.157	23	.146	.932	23	.123

Table 2 explains that the data is normally distributed using the Kolmogorov-Smirnov method and the Shapiro-Wilk method. The Kolmogorov-Smirnov method obtained a significant value of 0.127 whichwas greater than 0.05 (sig.>0.05) in the modeling class and 0.157 which was bigger than 0.05 (sig.> 0.05) in the implementation class. Likewise, the Shapiro-Wilk method obtained a significant value of 0.087 greater than 0.05 (sig.> 0.05) in the modeling class and 0.123 greater than 0.05 (sig.> 0.05) in the implementation class. From the results obtained, it can be concluded that the data was normally distributed. To reinforce this conclusion, data on critical thinking ability test results were made in the form of QQ diagram Plots for modeling classes and implementation classes. This result can be seen in Figure 2.

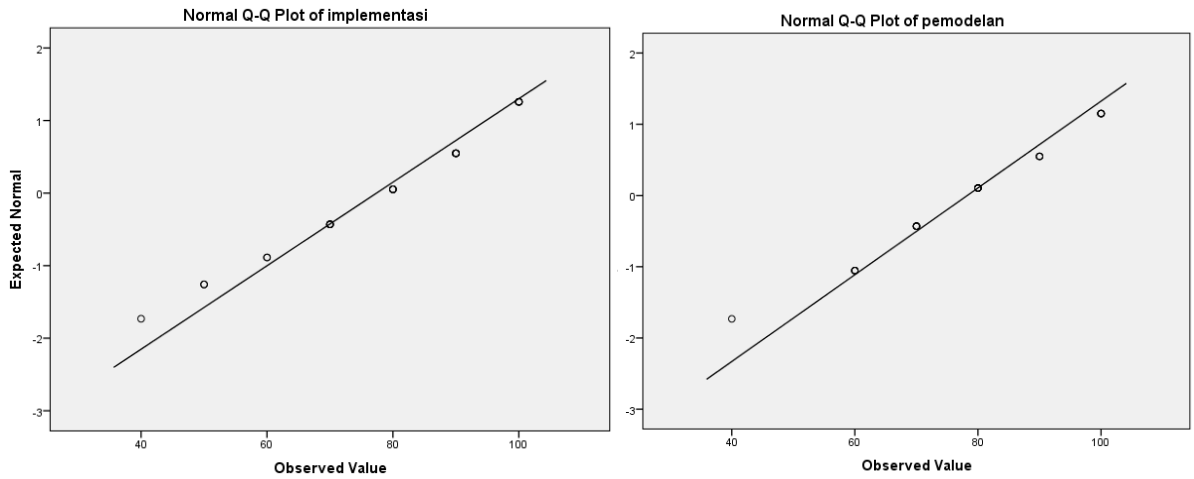

Figure 2. Normal QQ Plot critical thinking skills in modeling classes and implementation classes

To reinforce the above conclusions, critical skill ability test data was made in the form of a normal QQ plot plot, both in the modeling class and implementation class which can be seen in the bland below. The point shown in Figure 2 is a point that represents the research data. That point represents the score of critical thinking skills in the modeling class and implementation class. The number of points shows the number of variations in research data. Straight lines are normal curve lines which form the basis of normal determination or not the data obtained in the study. The closer the points on a linear line, the more normal the research data is. Figure 2 shows the points that represent students' critical thinking skills data, both in the modeling class and in the implementation class, gathered (approached) a linear straight line. These results indicated that students' critical thinking skills scores both in the modeling class and in the implementation class are normally distributed. After using the normality and data tests with normal distribution, then we analyzed using the hypothesis test to see if there was an increase after being taught with a *project based learning* model based on the process skills approach using the *t* test 1 sample at the level = 0.05. The results of the t test analysis can be seen in Table 3.

Table 3. One-Sample Test

	Test Value = 75					
					95% Confidence Interval of the Difference	
	T	Df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Modelling	.053	24	.958	.200	-7.62	8.02
Implementation	.660	22	.516	2.391	-5.12	9.91

Table 3 shows that the sig value is 0.958 in the modeling class and 0.516 in the implementation class where the sig value is 0.958> 0.05 in the modeling class, as well as 0.516> 0.05 in the implementation class. This result indicated that H0 was accepted and Ha was rejected, so there was an increase in students' critical thinking skills after being given a project based learning model based on process skills approach in class X MIA 4 (modeling) and class X MIA 2 (implementation).

The increase in this study was influenced by several factors, one of which was the renewal in the learning process that was adapted to the character of the students and the 2013 curriculum by using a *project based learning* model combined with the process skills approach, said to be appropriate for the students' character, because the model used could make students were more active and provided opportunities for students to think more critically in the worksheets of students given, in accordance with the phase of the project based learning model that was integrated with indicators of the process skills approach. The process skills approach made it easy for students to support the implementation of a *project based learning* model so that the indicators of critical thinking skills could be achieved by students in accordance with the 2013 curriculum.

Based on the circumstances that occurred during the study, students were able to adapt well to the *project based learning* model combined with the process skills approach. This could be seen from the enthusiastic attitude of students when learning took place, which was aimed at working together to think about the project completion, asking questions, and discussing the tasks contained in the students' worksheets given according to their respective groups. So that the *project based learning* model combined with the process skills approach made it easier for students to complete the test of physics critical thinking skills on material momentum and impulses. The above results were also supported by research using t test. Based on data with t test (t test) it showed that there were differences in the ability of students before and after being given learning with a *project based learning* model based on the learning media of micro hydro power plants [29].

In another study using t-test, students' critical thinking skills were more effective using *Thinkquest-assisted project-based learning* models compared to classes that do not use *Thinkquest-assisted project-based learning* models, so it could be concluded that critical thinking skills could be increased by using a *project based learning*model assisted by *Thinkquest* [32]. Subsequent research related to this article shows that students with high science process skills had high critical thinking skills, students with science process skills had moderate critical thinking skills and students who had low science process skills had low critical thinking skills based on the PBL model used in learning [33].

Based on the results and discussion it can be concluded that the research used a *project based learning* model combined with a process skills approach improved students' critical thinking skills in the modeling class and implementation class, which was seen from the H0 received while Ha rejected with the sig value in modeling class was > 0.05 and sig value in implementation class was > 0.05.

4. Conclusion

The effect of PjBL model based on skill approach process to physics critical thinking ability of state high school student. The conclusion of the research results is based on the formulation of the problem, as follow: (1) Physical critical thinking ability of students using learning tools with *project based learning* models based on process skills approach material of momentum and impulse of SMAN 1 Kalasang in class X.4 (Modeling) were in good category with an average value of 75.20 and in class

X.2 (Implementation) werealso in good category with an average value of 77.39; (2) There was an increase in students' critical thinking skills after using learning tools with a *project based learning* model based on the process skills approach to material of momentum and impulse of SMAN 1Kalasang in class X.4 (Modeling) and X.2 (Implementation).

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