The effect of physics-based scientific learning on the improvement of the student’s critical thinking skills

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Abstract. This study aimed to determine the influence of a physics-based scientific learning to increase student’s critical thinking skill. This type of this research was quantitative research with taking the conclusion through statistical analysis. This research was carried out in MA (Senior High School) Mu’allimat NW Pancor in the second semester in the academic year of 2016/2017 with all students of XI class. The sampling is done by using technique purposive sampling where the class was taken from XI 6 class. Based on the result of descriptive analysis, it was obtained an average pre-test score of 49.17 and an average post-test score of 82.43. Also, the results showed that the average score was gained of 0.67 with a medium category. Based on the inferential analysis showed the value of t= 22.559 while the \( \text{table} \) in significance level of 5% was 2.04. Thus, \( t > \text{table} \) from \( Ha \) is accepted. Therefore, the pre-test and post-test were different significantly when the students used scientific-based learning. The result showed that a physics-based scientific learning has influenced to increase the student’s critical thinking skill.

1. Introduction

Based on the research of the United Nations Development Program (UNDP) [1], the position of Indonesia in development index of human resource (HDI= Human Development Index) in 2014 was in 108 of 187 countries in the world. Meanwhile, in the field of education was researched by the OECD in the study of the Program for International Student Assessment (PISA) in 2009, showed that Indonesia has the capability of education counting, reading and science in rank 60 of 65 countries, but in 2012, it decreased to rank 64 of the 65 countries [2]. Based on the data can be concluded, Indonesia has decreased in human resources, especially in the education of science. Based on the data can be concluded, Indonesia has decreased in human resources, especially in the education of science. Based on the data can be concluded, Indonesia has decreased in human resources, especially in the education of science. Based on the assessment indication “The Program for International Student Assessment (PISA) 2015” United state science reached 496 while Indonesia only achieved a gain 403 [3]. Meanwhile, the education must be managed properly, so that can be produced more qualified graduation and ready to face the world in the future that completed with the problems and challenges.

There have been many ideas about the appropriate of education system for this nation that applied in various curriculums. And the last curriculum that used until now was the curriculum of 2013, as the refinement of the previous curriculum. The Curriculum of 2013 was followed up of the competency based curriculum that tested in 2004. Based on the Education minister regulation of the number 64 in 2013, Curriculum in 2013 on content standard, the curriculum of 2013 was the thematic-integrative that was aimed to encourage the student better in observing, asking, trying, reasoning and communicating that they get after learning to create a better generation for future [4]. It showed that the important of learning process was guided by the principles of scientific approach. Scientific learning is a learning on the ground of a scientific approach in oriented learning to foster student’s ability to solve problems through a series of inquiry activities that demand critical thinking skills, creative thinking and communicating as an effort to improve student’s understanding [5]. Scientific approach in learning process was the hallmark the curriculum of 2013. Scientific approach in learning was said by Kemendikbud [6] as scientific assumption and axioma underlying the learning process designed to provide balance, train and strengthen students’ competence in attitude, knowledge and skills intact. Daryanto [7] revealed that the advantages and scientific approach is the students must be active and creative, the obtaining the score of student not only obtained from the score of examination.
but also obtained from the all aspects such as: attitude value, religion, practice and the others, the scientific approach was the one approach that centered on the students’ so in learning process the students were active answering the questions correctly that given by the teacher with using the critical thinking skills.

Critical thinking is logical and reasonable that focused on taking the decision about what the people believe and do [8]. While Hendra Surya [9] stated the critical thinking as an active process and the way of thinking regularly or systematically to understand in-depth information, so it built the correctness of information and the opinion delivered. Critical thinking is required to check the correctness of the information, so it can be decided that worthy information rejected or accepted [10]. The advantage of critical thinking skill is the student able to answer the question in the real situation or the actual situation so that is not only becomes the opinion [11]. Critical thinking skill becomes the capability is needed to make the students able to face the alteration of the situation or challenges in the learning process [12].

The importance of critical thinking skill that believed by researchers and supported by many studies that discussed about the critical thinking skills. The Previous researches studied about the ability of critical thinking are: the research of Svecova, Rumanova, and Pavlovicova [13] and Chukwuyenum [14] that explained in the learning process, we would apply and clarify the ability of critical thinking. The next research, the study conducted by Duron, Limbach and Waugh [15], in their research was explained that in learning should be emphasized the ability of the students’ critical thinking skills, it aimed to produce the experience of learning more enjoyable and reward for the students and the teachers. The next research, the study conducted by Gueldenzoph and Snyder [16] which stated that the critical thinking was important because the critical thinking was automatically a person would be able to solve the simple problem or complex in daily life.

The Critical thinking is not easy, but the ability of critical thinking can be learned and practiced [17]. The indicator of critical thinking that used in this study as the indicator of critical thinking from Hendra Surya [9], such as: the thinking skill of analysis, the thinking skill of synthesis, the thinking skill of solving problem, the skill of concluding and evaluating. The Researchers referred to the indicator of critical thinking skill Hendra Surya in consideration of many studies that used the indicator Hendra Surya in measuring the critical thinking skill. The Description of the background explained was underlined to conduct the research about “The Effect of Scientific-Based Learning toward the improvement of the students' critical thinking skills”.

2. Research method
The type of this research was quantitative research with taking the conclusion through statistical analysis. The population in this research was all the students of XI class of MA Mu'allimat NW Pancor. The Sample selection was held by using purposive sampling. In the sample determination was recommended directly by the headmaster of MA Mu'allimat NW Pancor by the principal of the class XI IPA, is a class that was given special treatment from the beginning in compare the other XI class. The design of this researches was pre-experimental one group pretest-postest design. Because in this study there were still outside variables that participate in the effect and the sample was not selected by random [18]. The Data of the students' critical thinking skills collected with test instrument that shaped of the description amounted of 10. Before used in the study, the research instrument must be held the trial. The trial or the instrument validity was made to obtain the feasibility from the instrument that used in research. There were several steps of validation toward the instrument that explained by the physic expert included: The test item analysis, the analysis of the difficulty level, the analysis of distinguishing feature and the analysis of reliability with using software Quest. The data that collected must be analyzed using descriptive statistical analysis. In addition the data of the research result also analyzed using inferential analysis with t test to test the hypothesis of the study. Before the testing of the hypothesis was held, the first, the test of normality and homogeneity were held using SPSS18 for windows. And the analysis to know the effectiveness in scientific-based learning used gain score normalized for pretest and posttest.
3. The result and discussion

This research analyzed the data with using the descriptive statistical analysis, and hypothesis testing with using t test. The data in this study was the data that consisted of critical thinking skill score before and after using scientific approach. The result of the data test of the critical thinking skill and the descriptive analysis were presented in the following table.

| Test       | Number of Students | Mean  | Standard Deviation | Minimum Value | Maximum Value |
|------------|--------------------|-------|--------------------|---------------|---------------|
| Pretest    | 30                 | 49.17 | 2.160              | 32            | 70            |
| Posttest   | 30                 | 82.43 | 1.712              | 62            | 98            |

Based on the Table 1, it can be seen the results of descriptive analysis about the pretest and posttest of the student’s critical thinking skills. The averages of the students' critical thinking skills were 49.17 with the deviation standard of 2.160, the minimum score of 32 and the maximum score was 70. After used the scientific-based learning, the averages of students' critical thinking skills was 82.43 with the deviation standard of 1.712 the minimum score of 62 and the maximum score of 98. The average score of posttest was higher than the average score of pretest in Table 1. It can be seen that the scientific-based learning can improve the students' critical thinking skills.

| Test           | The Value of Critical Thinking Skills in Every aspect |
|----------------|------------------------------------------------------|
| Posttest average | Analysis    | Synthesis   | Problem Solving | Concluding | Scoring |
|                | 2.90        | 3.33        | 3.43            | 3.63       | 3.43    |

Based on the Table 2, it can be seen the result of the students' critical thinking skill in every aspect. The aspect of analysis with the averages score of 2.90, the aspect of synthesis of 3.33, the aspect of problem solving of 3.43, the concluding aspect of 3.63 and the scoring aspect of 3.43. Seeing the averages score of every aspect of the students' critical thinking skills, the concluding aspect has given the highest contribution and the analysis aspect has given the smallest contribution. This was caused of the concluding student activity more easy to make the statement and deciding the event object based on the fact of observation result. The concluding stage was a skill to identify and select elements that maybe necessary to form a reasonable conclusion or to form a hypothesis by taking into account relevant information and recuding the consequences of data, question, principles, evidences, judgments, beliefs, opinion, concepts, description, question or other representation. Student who had skill inferring more experienced or competent in drawing, making conclusion, forming allegation or hypothesis according to reality, principle, evidence, judgments, belief, concept, description, question, or other form of representation [19]. And the analysis activity, the students were still difficulty in processing the information that has been collected, the difficulty in link the phenomena and related information, in this case the difficulty in recognizing the variable, recognizing the formulation of hypothesis and the other activities. Students’ who have more competent analytical competencies and are able identify inferential, actual, relationship between statements, question, concept, description, in expressing beliefs, judgments, experiences, reason and information [19].

Before held the test of hypothesis, the first the researcher held the requirement test. The first requirement test was the test of normality. The test of normality was done to determine whether the data obtained normal distribution or not. In this case the data of normal distribution acquired, if the value of \( \alpha < \text{sig} \) with \( \alpha = 0.05 \) (5%). Based on the calculation using SPSS 18 for Windows, the result of the data analysis was required the result of normality test for the data pretest as followed: the significance was 0.180> 0.05, so it can be concluded that the pretest score of the students was normal distribution. The
test result of normality to the posttest data as followed: the significance was 0.090 > 0.05, so it can be concluded the score of the students’ posttest was normal distribution. The next, doing the variance of the homogeneity test of critical thinking skills. The homogeneity test was done to determine whether the data obtained from the variance that was homogeneous or not. In this case the data with the homogeneous variance was obtained, if the score of α < sig with α = 0.05 (5%). Based on the calculation using SPSS 18 for Windows, the analysis result was obtained the homogeneity test result of pretest and posttest as followed: 0.069 > 0.05, it can be concluded the score of pretest and posttest was the homogeneous variance and the summary of analysis result of data with SPSS18 for Windows was presented in the following table.

**Table 3. Paired samples test.**

| Pair  | Paired Differences | 95% Confidence Interval of the Difference | Sig. 2-tailed |
|-------|--------------------|------------------------------------------|--------------|
|       | Mean | Std. Deviation | Mean | Lower | Upper | T     | df  |
| 1     | -33,267 | 8,077 | 1,475 | -36,283 | -30,251 | -22,559 | 29   | .000 |

Based on the Table 3, Based on the test result above obtained the significance amounted of 0.000. Because the significant score of 0.000 <0.05 so \( H_0 \) was rejected, so it can be taken the conclusion that there was the significant difference between the pretest and posttest score of the student that using scientific-based learning. Based on the test result above was obtained | \( t_{\text{table}} \) at the significance level of 5% and 1% for df = 30, was \( t_{0.05} = 2.04 \) and \( t_{0.01} = 2.75 \). Based on these scores can be seen that:

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2.04 < | - 22.559 | > 2.75 \text{ or } 2.04 < |22.559| > 2.75
\]

Therefore the score of \( t_{\text{C}} \) was higher than \( t_{\text{table}} \) so, \( H_0 \) was rejected, so it can be taken the conclusion that there was the difference of very significance between the students’ pretest and posttest after applied using scientific approach. This showed that the physics-based scientific learning was affected toward the improvement of the students’ critical thinking skill. The Analysis to determine the effectiveness in scientific-based learning using gain score normalized for pretest and posttest. Based on the calculation of gains core, included the medium category that was mounted of 0.67 [20].

**4. Conclusion**

Based on the problem formulation and the result of the study, it can be interpreted that the result showed the difference of the students’ critical thinking skills before and after applied using scientific approach. Thus, it can be concluded that the scientific approach influenced toward the improvement of the students’ critical thinking skills, and scientific-based learning was effective to use in learning process. As for the test result of critical thinking skills of every aspect, based on the average result of each aspect of critical thinking skills, the aspects that given the greatest contribution was a conclude aspect and aspect of critical thinking which contributed least to the aspect of the analysis.

Based on the result of the study it can be presented some suggestions such as: (1) it was recommended to the teachers of physics to deliberate the application of scientific approach as one of approach alternative in learning that is innovative, so that the study became fun, effective, not monotonous, and can improve the result of the student learning. (2) For the other researcher that interested to organize the further research about the scientific approach in broader scope, this study can be used as the comparison and consideration for repairing and the completing toward the study that will be held.
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