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The Analysis of Scientific Approach on Student Physics Learning Outcomes

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Abstract. This research aimed to analyze the effect of scientific approach in physics learning outcomes at SMA/SMK. This research was conducted in SMA 105 Jakarta. The research type was quasi-experiment and the sampling technique was Purposive Sampling. The samples of this research were students in class X MIA B as an experimental class with 32 students and X MIA A as a control class with 34 students. The instrument consists of 25 multiple choices in Temperature and Heat topic. Based on the findings, Scientific Approach had the potentials to improve the process of creating (C6 cognitive domain).

1. Introduction

In the globalization era, all countries are competing to improve the quality of education. Education is largely a methodical approach to a body of knowledge agreed by relevant experts and then delivered to willing and unwilling learners alike [1]. The important role of School is as the producers of qualified human resources. In addition to that, one of the subjects which can increase the quality of human resources is Science. Science has a pervasive but often subtle, impact on a virtually every aspect of modern life-both from the technology that flows from it and the profound philosophical implications arising from its ideas [2].

Based on the statistics of *The Program for International Student Assessment* (PISA) 2015, Indonesia placed 62nd from 70 countries, where Indonesia achieved an average score of 403 from the highest score of 556, and an overall average score of 493 in Science. [3].

There are several factors affects the student learning outcome in physics, one of them is the way the teacher determine their learning approach. A research on student learning has identified the learning approach as a crucial factor in determining the quality of the outcome, as the approach describes the way a student relates to a learning task [4].

Now, the innovation of learning approach has developed. Curriculum 2013 introduced Scientific Approach. Scientific Approach is the mainstay approach of the Curriculum 2013. In essence, Scientific Approach is an approach to learning activities that prioritizes creativity and student's findings [5]. Learning steps on the scientific approach are observing, asking, trying/gathering information, reasoning/associating, and networking (make a communication). With this approach, in addition, to improve students' learning outcomes, students are expected to develop the competence of attitudes, skills, and knowledge that much better. Principles of learning can be generalized, learning outcome identified five categories of learning outcomes: (a) intellectual skills, (b) verbal information, (c) cognitive strategies, (d) attitudes, and (e) motor skills [6].

There is several research which shows that scientific approach is able to improve the students' learning outcomes, where this proven by the improvement of average learning outcome of the students from 61,35 before the implementation to 79,65 (after implementation). 80,77% students stated that they are more interested with the materials, 81,72% thought that they understand easily to

the materials with a scientific approach, 75,96% students felt that the class is more conducive and 91,35% students are more confident to conduct an experiment at the workshop [7].

This article focuses on the analysis of the scientific approach to the students' learning outcomes in physics.

2. Literature Review

2.1 Learning outcomes

The American Heritage Dictionary defines learning as follows: "To gain knowledge, comprehension, or mastery through experience or study. Kimble (1961) defines learning as a relatively permanent change in behavioral potentially that occurs as a result of reinforced practice. Learning refers to a change in behavior potentiality, and performance refers to the translation of this potentiality into behavior [8].

Structure of the cognitive process dimension of the revised taxonomy [9]:

1. Remember: Retrieving relevant knowledge from long-term memory.
2. Understand: Determining the meaning of instructional messages, including oral, written, and graphic communication.
3. Apply: Carrying out or using a procedure in a given situation.
4. Analyze: Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose.
5. Evaluate: Making judgments based on criteria and standards.
6. Create: Putting elements together to form a novel, coherent whole or make an original product.

Learning outcomes not only about cognitive, but there is three evaluation. The first category of learning outcomes is cognitive, cognitive refers to a class of variables related to the quantity and type of knowledge and the relationships among knowledge elements, then the second category of learning outcomes concerns the development of technical or motor skills, and the third category of learning outcomes include motivational and affective outcomes [10].

2.2 Learning with Scientific Approach

Curriculum 2013 encourage the implementation of scientific approach to learning activities. The scientific approach is believed to be the golden ways of development in attitude, capability, and knowledge of students. According to the Regulation of the Ministry of Education and Culture (Permendikbud) No. 81 A of 2013 addendum IV, scientific learning process consists of five basic learning experiences, namely observing, asking, reasoning, associating and communicating [11]. The details of the five basic learning experiences are as follows.

1. Observing: The first step of scientific learning is observing. Observation is to use the five senses to obtain information. This activity aims to obtain the general description of a material object with respect to the basic competencies studied.
2. Asking: Asking means 'to ask questions'. In a scientific approach, the student will ask the question. The question which arises is expected to be related to the objects that have been observed. This learning activity is very important to increase curiosity in students and develop their ability to learn throughout their lives.
3. Reasoning or Experiment: the activity to answer the question is called reasoning. The reasoning is done by performing activity similar to the initial observation. The difference is that the process is more intensive with expectations that the facts collected by the students are sufficient to answer the questions.

4. Associating: Association are linked in memory to other people or goods; the establishment of a relationship or relations between ideas, memories or sensory activities. In scientific approach, associating means to implement (developing, deepen) the understanding of a concept to another concept.
5. Communication: Communicating means to deliver the results of previous activities to others, either spoken or written. Working together in a group is one of the abilities of students to be able to build networks and to communicate.

The benefits of Scientific Approach, including:
(1) To improve intellectual ability, especially high-level thinking skills, (2) To establish the students' ability in resolving issues systematically, (3) to create a learning condition where the students considered that learning is a necessity, (4) to obtain high learning outcome, (5) to train the students to communicate ideas, especially in writing scientific articles, (6) to develop the students' characteristic [12].

3. Methodology

The method used in this research is an experimental method. Moreover, the research design used is Quasi-Experimental Design with the design form of Nonequivalent Control Group Design, in which the control group and experimental group are not selected randomly, but with the Purposive Sampling, the technique of determining sampling with certain considerations.
To know hypothesis test, this research uses equation [13]:

$$t = \frac{\bar{X}_A - \bar{X}_B}{s_{gab}\sqrt{\frac{1}{n_A}+\frac{1}{n_B}}} \quad (1)$$

Annotation :
$\bar{X}_A$: experimental group's score on average
$\bar{X}_B$: control group's score on average
s_{gab}: join standard deviation
n_A: the amount of experimental group's sample
n_B: the amount of control group's sample

4. Result and Discussion

The data obtained in this research is the result of student learning on temperature and heat topic that obtained from 66 students divided into 32 students of experimental class (X MIA B) and 34 students of control class (X MIA A). In the learning process, the experimental class uses the Scientific Approach in accordance with the applicable curriculum (Curriculum 2013). Completed data on the result of experiment class and control class will be described as follows:

Table 1. Descriptive Statistic of Control and Experimental Class Students' Learning Outcomes

Statistic	Experimental Class	Control Class
n (Student Amount)	32	34
Maximum Score	88	88
Minimum Score	40	28
Score Range	8	10
Average	64,375	65,412

There are several ways to acknowledge the requirement testing analysis, which are the normality test and homogeneity test. Normality test is conducted to determine the sample of the students' learning outcome has taken the normal distribution or abnormal. The normality test is performed using Chi-Square test. From the experimental class learning outcome, the calculated value obtained χ^2_{count} = 8,126 and χ^2_{table} = 12,592 at a significant level of α = 0,05 and dk = 6. From the control class learning outcome, the calculated value obtained χ^2_{count} = 7,197 and χ^2_{table} = 12,592 at a significant level of α = 0,05 and dk = 6. Since the arithmetic price of χ^2_{count} obtained by both classes is less than the χ^2_{table} price, then it can be concluded that both classes come from a normally distributed populations. Then, homogeneity test is conducted by using F Test. From the test, it is obtained that F_{count} = 1,36. F_{table} is between 1,78 and 1,72 at a significant level of α = 0,05. Since the price of F_{count} obtained is less than the $F_{table,}$ price, it can be concluded that the learning outcome of both classes comes from a homogeneous class.

Next, the hypothesis test is conducted to determine whether there is any scientific approach influence to the students' learning outcome in physics. From the research data, the average learning outcome on experiment class is 64,375, variant of 233,661, and standard deviation combined of 15,5281, while the average learning outcome of control class is 65,412, variant of 248,128. From the calculation, the results obtained that the value of t_{count} is 0,271. With significant level of α = 0,05 and dk = 64 then the t_{table} is equal to 1,998. This means that there is no significant influence of Scientific approach to the learning outcome of Freshmen students in SMA/SMK.

From the data of the students' learning outcome, the cognitive ability of each class is visible. The details on the cognitive aspects of both experimental and control classes will be described as follows:

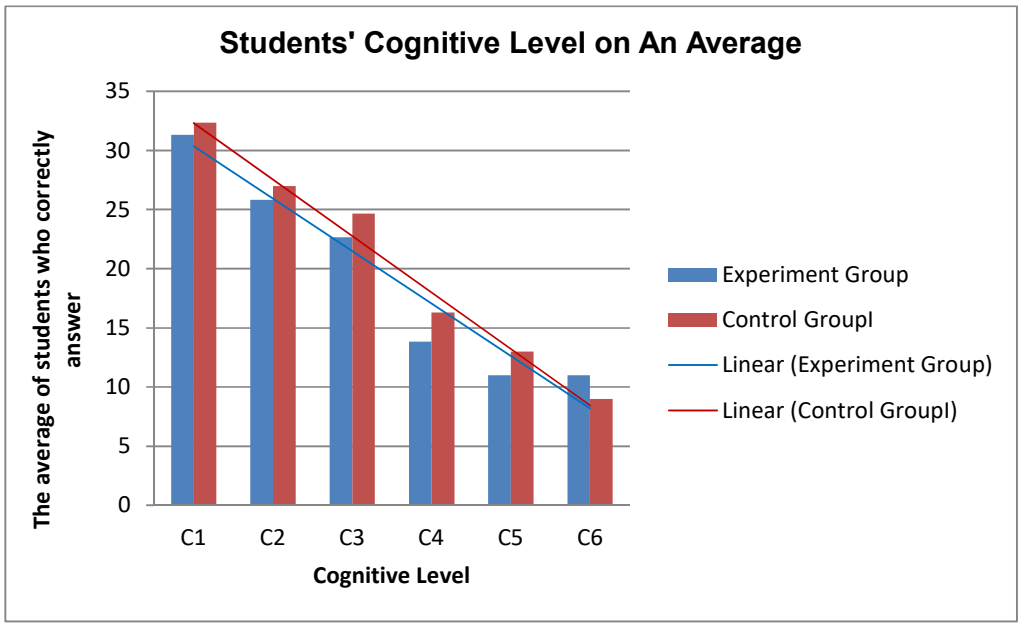

Fig 1. Bar Diagram of Experimental and Control Class Students' Cognitive Level on An Average

Based on the bar chart above, it is clear that the students' ability in each cognitive domain fluctuates in both classes. In the experimental class on C6 cognitive domain, which is the process of creating, the goal of the taxonomy is to classify educational objectives to be achieved, thus the final purpose of education is that the student is able to create work or products by utilizing the ways or concepts of knowledge obtained during the learning process. With the achievement of the highest

cognitive domain which is creating or working, students are able to implement the knowledge which they obtain in a form or real object. This will affect the outcome of education, among others, better human resources, because knowledge is not just about learning, but internalized in everyday life. The model creation of a new work or project creation can further encourage the students to think critically and integrally by utilizing the knowledge obtained during the learning process compared to the ability to assess a situation without seeking solutions of the errors.

5. Conclusion

Based on the result, it can be concluded that: a) There is no significant influence of *Scientific Approach* to the learning outcome of the class X students' in physics on temperature and heat topic, b) Scientific Approach steps of observing, asking, reasoning or experiment, association and communicating is making students be more active, creative, and think critically during the learning process in the classroom, c) The Government may review on the flagship approach of 2013 curriculum, namely Scientific Approach, and the teachers are required to be creative in using learning approaches to make learning process enjoyable so as to improve the learning outcome of students in physics, d) Scientific Approach has the potentials to improve the process of creating (C6 cognitive domain).

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