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The Effect of Experimental Methods with an Inductive Approach on the Students' Physics Scientific Performance

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Abstract – Science is concerned with how to understand nature systematically so that it is not only limited to mastering a collection of knowledge in the form of facts or concepts, but also as a process of discovery. An inductive approach can help students gather information and test it thoroughly, process information into concepts, and learn to manipulate these concepts. The aim of this study were 1) to describe the scientific performance of class VIII students of one of the schools in Bulukumba who were taught by using the experimental method with the Inductive Approach, 2) to describe the scientific performance of class VIII students of one of the schools in Bulukumba who were taught using conventional learning methods, 3) analyzing the scientific performance of class VIII students of one of the schools in Bulukumba which was higher. This research is a type of experimental research, with posttest design only control group design. The population in this study were all students of class VIII of one of the schools in Bulukumba which were divided into six classes. The sample in this study were students of class VIII_1 as the experiment class and class VIII_2 as the control class who were selected by class randomization technique. The instrument used in this study was the scientific performance test. The results showed that 1)the scientific performance of class VIII students of one of the schools in Bulukumba who were taught using the experimental method with the inductive approach was in the very high category, 2)the scientific performance of class VIII students of one of the schools in Bulukumba who were taught using conventional methods were in the medium category, and 3) the physics scientific performance of class VIII students of one of The schools in Bulukumba who were taught using the experimental method with an Inductive Approach was higher than those taught using the conventional method. The recommendation of this research is that inductive learning should be carried out on a broader scale, namely in other schools, especially in physics learning.

Keywords: experimental methods, inductive approach, physics learning, scientific performance

I. INTRODUCTION

Physics is a science lesson with various natural events and problem solving both qualitatively and quantitatively (Susilowati, 2012). Physics is an empirical science, and has abstract concepts that are difficult to imagine (Marisda et al., 2010). Therefore physics is made one of the compulsory subjects taught at the secondary school level (Marisda et al., 2020; Ismayanti et al., 2010). Physics is one of the science lessons that plays an important role in creating quality young generations,

because the content of physics learning consists of logical concepts that are able to shape human thought patterns (Riskawati & Marisda, 2020). It was further explained that in learning physics, students must be the learning subject, not the learning object (Siahaan & Suyana, 2010). Therefore, the task of a teacher is not only limited to conveying information, but also to directing students to discover their own physics concepts. However, the reality in the field is that teachers do not apply learning methods that are able to develop the ability to think and examine physics problems through scientific performance (Marisda et al., 2020). In fact in Indonesia, in teaching, teachers more often use conventional approaches that only pay attention to the development of knowledge. This has not been able to prepare students to face the challenges of this increasingly developing area (Ma'ruf et al., 2020; Ma'ruf et al., 2019).

Based on the characteristics and content of physics learning, physics lessons as one of the sciences must be taught with a science learning approach that balances knowledge development and scientific performance (Marisda et al., 2020). To be able to balance the acquisition of knowledge achievement and performance in students, a teacher must be creative in presenting learning so that learning becomes fun for students (Marisda et al., 2020).

Based on observations in one of the junior high schools in Bulukumba, it can be seen that physics learning is carried out using the lecture and discussion method. The teacher does not consider the suitability of the subject matter with the methods and approaches used. This causes the low quality of student learning (Marisda et al., 2016), especially in terms of experiments.

One of the effective methods to improve the scientific performance of students' physics is by applying the experimental method with an inductive approach (Warsyidah et al., 2016). The experimental method is in the form of experimental activities which are the most important activities of science lessons, especially science. Through inductive learning, students draw conclusions based on concrete facts. Whether or not this inductive conclusion is drawn is determined by the objectivity of the observer (Suparmin, 2017) .

Referring to the background description and to instill the scientific performance of physics in students, a research was conducted with the title "The influence of experimental methods with an inductive approach to the scientific performance of students physics."

II. THEORETICAL BASIS

A. *Learning and learning activities*

The term learning is commonly used to indicate that we have discovered something new about something, someone, or we have taken a new stand. Vernon and Donal in Ahmadi et al. (2011) suggested the occurrence of learning by linking learning and changes in observed behavior. According to them,

learning is a change in behavior, while behavior is an action that can be observed. Learning according to Gredler is the process of people acquiring various skills, skills and attitudes. Thus, it can be concluded that learning is a process of activity that causes new behavior or changes old behavior so that a person is better able to solve problems and adapt to situations faced in his life (Ahmadi et al., 2011) .

Learning is an everyday event at school. Learning is a complex thing. The complexity of learning can be seen from two subjects and teachers. In term of learners, learning is experienced as an internal process. What is involved in this internal process is the whole mental which includes the cognitive, affective and psychomotor domains. Students experience mental processes in dealing with learning materials. From the teacher's point of view, the learning process appears as learning behavior about something.

Teachers can arrange learning programs based on Skinner's view. The learning steps based on Skinner's theory are as follows: (1) studying the state of the classroom, the teacher looks for and finds positive and negative student behavior, positive behavior will be strengthened and negative behavior reduced, (2) making list of positive reinforcers, the teacher looks for behaviors that are positive and negative. More preferred by students, behavior that is subject to punishment and activities outside of school that can be used as reinforcement, (3) selecting and determining the order of behavior learned and the type of reinforcement, (4) creating a learning program, this learning program contains a sequence of desired behaviors, reinforcement, time studying behavior, and evaluation (Dimyati & Mudjiono, 2009) .

B. *Learning with an inductive approach*

The inductive approach was originally put forward by the English philosopher, French Bacon, who wanted to draw conclusions based on concrete facts as much as possible. This system was seen as the best system of thinking in medieval times. Inductive thinking is a process of thinking that goes from specific to general. People look for certain characteristics or characteristics of various phenomena, then draw the conclusion that those characteristics or traits exist in all types of phenomena (Ahmadi et al., 2011).

The inductive approach is developed on the basis of the following postulates:
 1. The ability to think can be taught.
 2. Thinking is an active transaction between individuals and data.

This means that in a classroom setting, teaching materials are a means for students to develop certain cognitive operations.

The thought process is an orderly (lawful) sequence of stages that is, in order to master certain thinking skills, certain prerequisites must be mastered first, and the order of these stages cannot be reversed.
According to Hilda Taba, inductive thinking involves three stages and thus she developed

three strategies for how to teach it. The first strategy is concept formation as a basic strategy, second, data interpretation, and third, the application of principles (Uno, 2011).

C. Scientific performance

Performance is something that is achieved or an achievement is shown. Kane explained that performance is a record of work results obtained by certain employees through activities within a certain period of time. Furthermore, Casio argued, performance is a guarantee that a worker or group knows what he expects and focuses on effective performance.

Maier provided performance limits or work performance as a person's success in carrying out a job. From these limitations it can be concluded that, performance is the results achieved by a person according to the size applicable to the job concerned (Sugiyarto, 2005).

The word scientific is defined as an activity based on scientific characteristics, namely rational, empirical, and systematic. Rational means that research activities are carried out in ways that make sense, so that human reasoning can reach them. Empirical means that the ways in which it can be observed by the human senses. From this explanation, it can be formulated that scientific performance is the ability or success of a person in completing tasks or jobs according to certain sizes (quality and quantity) based on scientific characteristics,

namely rational, empirical, and systematic (Sugiyono, 2017).

In science, problems related to natural phenomena and various problems in people's life are studied. Natural phenomena in science can be viewed from the object, problem, theme, and place of occurrence.

Science learning requires investigative activities, either through observation or experiment, as part of scientific work that involves process skills based on scientific attitudes. Through scientific work, students are trained to make use of facts, build concepts, principles, theories as a basis for creative, critical, analytical, and divergent thinking. Science learning is expected to shape students' attitude in everyday life and increase their belief in God Almighty (Hamid, 2011).

Process skills in science include basic skills and integrated skills. Basic skills include the skills of observing, classifying, communication, measuring metrics, predicting, concluding, and interpreting. Integrated skills include identifying variables, determining operational variables, explaining relationships between variables, developing hypotheses, designing procedures and carrying out investigations/experiments for data collection, processing/analyzing data, presenting the results of investigations/ experiments in tables/graphs, and discussing, concluding, and communicate in writing and orally (Warsyidah et al., 2016).

III. METHODS

This research is a type of experimental research. To find out scientific performance using the Inductive approach, the posttest only control group design design is used (Sugiyono, 2017).
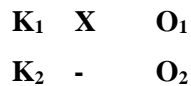
$$K_1 \quad X \quad O_1$$
$$K_2 \quad - \quad O_2$$

Figure 1. Posttest (only) control group design

The population in this study were all students of class VIII of one of the schools in Bulukumba who were registered in the academic year of 2019/2020 totaling 154 people who were divided into six classes. The sample in this study were students of class VIII of one of school in Bulukumba, namely class $VIII_1$ consisting of 25 people as the experimental class and class $VIII_2$ consisting 25 people as the control class selected through class taking, with the assumption that all classes were considered homogeneous.

Inferential analysis is used to test the correctness of the proposed research hypothesis

A. Prerequisite testing

The prerequisite test consists of two, namely the normality test and the homogeneity test:

a. Normality test

The normality test is carried out to find out whether the data obtained comes from a normally distributed population. Testing the normality of student physics scientific and homogeneous, the t-test formula used is as follows.

performance data using the Lilliefors normality test.

b. Homogeneity test

Homogeneity test is carried out to determine whether the two samples taken are homogeneous or not. Homogeneity test of students' physics scientific performance data was calculated using the homogeneity test of two sample variants.

B. Hypothesis test

Hypothesis test is intended to test the hypotheses that have been proposed, namely: "the scientific performance of class viii students of one of the schools in Bulukumba who was taught using the experimental method with an inductive approach was higher than those taught using conventional methods."

Based on this hypothesis, the test is carried out using the right-side test with Independent-sample t test analysis. The statistical hypothesis, namely:

$$H_o: \mu_1 \leq \mu_2$$
$$H_a: \mu_1 > \mu_2$$

Where,

μ_1: The average score of the scientific performance of students who are taught using the experimental method with an inductive approach.
μ_2: The average score of the scientific performance of students' physics taught by conventional methods.

Because the number of sample members is $n_1 = n_2$ and the variance is not homogeneous

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

(Sugiyono, 2017)

Where:

$\overline{X_1}$ = average score in the experimental class
$\overline{X_2}$ = average score in the control class
n_1 = number of samples for the experimental class
n_2 = number of samples for the control class
s_1^2 = variance in the experimental class
s_2^2 = variance in the control class

Testing criteria: Ho is rejected if $t_{count} > t_{table}$ and significance $< \alpha = 0.05$. To find out the t_{table}, dk = n_1 + n_2 - 2 is used with probability = 1- α.

IV. RESULTS AND DISCUSSION

A. Research result

The results of descriptive statistical analysis were the presentation of data to describe or provide an overview of the scientific performance of students' physics who were taught using the experimental method with an inductive approach (experimental class) and those taught through conventional methods (control class).

a. Description of the scientific performance of students' physics

For the results of descriptive analysis of the scientific performance of students in the experimental and control classes could be seen in the table 1.

Table 1. Scientific performance of experiment and control class

Score of scientific performance in physics	Experiment class	control class
Average	49	32
Variant	55.71	68.47
Standar deviation	7.07	7.89
Maximum score	60	50
Minimum score	32	15
Reach	28	35

Table 2. Interval category scientific performance score category of students in experiment class and control class (processed primary data, 2020)

Interval	Category	Frequency		Percentage (%)	
		Experiment	Control	Experiment	Control
0-12	Very low	0	0	0	0
13-24	Low	0	4	0	16
25-36	Moderate	1	14	4	56
37-48	High	10	6	40	24
49-60	Very high	14	1	56	4
Amount		25	25	100	100

The category interval for the scientific performance of students in the experimental and control class could be seen in Figure 2
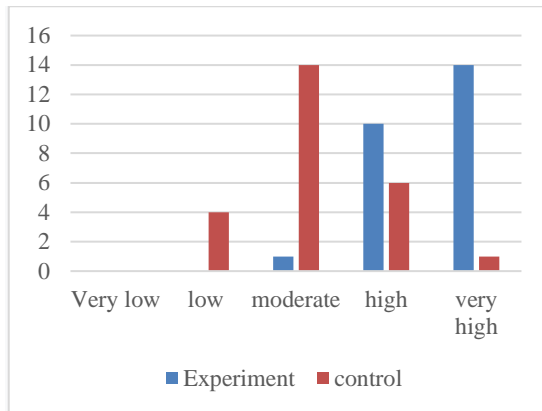
Figure 2. Categories of scientific physics performance scores of students in experiment and control class.

Overall from Figure 1, the category of the average score of the physics scientific performance of students in the experimental class was in the very high category with an average score of 49 while the control class was in the medium category with an average score of 32.56.

b. *Result of inferential statistical analysis*

1) *Prerequisite test*

The requirements that must be met before testing the hypothesis were testing for normality and homogeneity. The normality test was carried out on the scientific performance score data of students in the experimental and control classes with the Liliefors Method Normality Test with a significance level of > 0.05, while the homogeneity test was calculated using Excel with t-test analysis: two sample assuming unequal variances with a significance level > 0.05.

2) *Hypothesis Test*

The hypothesis in this study was tested by using the right-side test which was calculated manually or by computer with the test criteria H0 accepted if $t_{count} > t_{table}$.

Hypothesis:

The scientific performance of class viii students of one of the schools in Bulukumba who was taught using experimental methods with an inductive approach was higher than those taught using conventional methods

With statistical hypothesis

$$H_0: \mu_1 \leq \mu_2$$
$$H_1: \mu_1 > \mu_2$$

B. *Discussion*

The results obtained illustrate that the physics scientific performance of students in the experimental class is in the very high category, while in the control class, the physics scientific performance of students is in the medium category. It is proven that the Experimental Method with an inductive approach can be used to instill scientific performance in learning physics of students.

This is concluded from the results of descriptive statistical analysis in the experimental class and the control class, which shows that the average score of scientific physics performance of students in the experimental class is higher (X average = 49) compared to the control class (X average = 32). This difference is due to the fact that the experimental class was given treatment in the form of learning using the experimental

method with an inductive approach while the control class used conventional methods. Furthermore, the hypothesis testing is carried out by using the - t test, which is obtained t_{count} = 7.57, while the value of tt_{able} at the real level α = 0.05 is 2.01. Based on the test criteria, H0 is rejected, which means that the hypothesis is accepted.

Therefore, there is a significant difference between the scientific performance of students who are taught using the experimental method with the inductive approach and those taught using conventional methods in class VIII students of one of the schools in Bulukumba because learning physics using the experimental method with the Inductive approach can activate the participants. students in the learning process. This is due to several factors, including through the inductive approach, students are required to experience themselves, seek the truth, and try to draw conclusions on the process they are experiencing.

Research results that can support this research include the research of Subekti & Ariswan (2016) also shows a significant increase in learning outcomes in the cognitive aspects of physics and science process skills in terms of the initial abilities of physics in slass X students at SMA Negeri 9 Yogyakarta with guided inquiry learning models through experimental methods. In line with that research that applies inductive thinking

learning also gives positive results on student learning outcomes on the subject matter of geometric optics in class X semester II SMA Negeri 20 Medan (Sirait & Sihombing, 2017). In addition, a positive effect is also seen in research using the inductive thinking learning model on student learning outcomes on geometric optic material for class X in pure intelligent private high school Tembung (Arwira et al., 2017) .

V. CONCLUSION AND SUGGESTION

A. Conclusion

1. The scientific performance of class VIII students of one of the schools in Bulukumba who was taught using the experimental method with an inductive approach is in the very high category.
2. The scientific performance of class VIII students of one of the schools in Bulukumba who was taught using conventional methods was in the medium category.
3. The scientific performance of class VIII students of one of the schools in Bulukumba who was taught using the experimental method with an inductive approach was higher than those taught using conventional methods.

B. Suggestion

1. The experimental method with the inductive approach is tested or researched is limited to certain classes

2. In order that students can optimize the scientific performance of physics, especially simple aircraft material, the teacher should apply the experimental method with an inductive approach in the learning process

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