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The effect of interactive demonstration method on heat energy learning

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Abstract: The purpose of this study is to determine whether there is a significant influence in using the interactive demonstration methods on heat energy learning. The research method used was an experimental method, quasi-experimental design form, and Nonequivalent Control Group Design. The sample of the research was taken by using purposive sampling technique. After the researcher conducted teaching and learning activity on the subject of heat energy in the experimental class, the obtained mean of the cognitive learning outcomes in the experimental class was 81.60. With Chi-Square test and F test, it showed that the cognitive learning result data of the experimental class and control class were distributed normally and homogeneously. After the hypothesis was tested using t-test polled variance, then the $t_{arithmetic} > t_{table}$, which was 4.32 > 1.99 $t_{arithmetic}$ value lies in the rejection area of H_0 and the acceptance area of H_a with a 5% error rate and the degree of freedom was 74. Consequently, it can be concluded that there was a significant influence in using interactive demonstration methods on heat energy learning. If one plans using this method, it is recommended to use it for materials that are often encountered by students in everyday life.

1. Introduction

The effective learning process in education is needed because it is highly influential for the development of students' learning. On the other hand, students are expected to be able to master all the subject matter provided by the teacher. To achieve the learning objectives on each subject matter, students must achieve a minimum mastery of 75% of the whole material. All children should fully understand what is taught. [1].

Physics is one of the subjects within the science family, which is fundamentally a collection of knowledge, ways of thinking, and investigations. Physics as a collection of knowledge in the form of facts, concepts, principles, laws, theories and models discuss about the natural phenomena both macroscopic and microscopic. Physics is a form of science that has its product, attitudes and processes dimensions so that when we want to learn physics consequently we must know how to get the concept. This is consistent with the concept proposed by James Conant [2] stating that physics is a sequence of concepts and conceptual schemes related to each other and it grows as a result of experimentation and observation.

The lesson should help students to develop students' understanding by creating a supportive atmosphere for learning, motivating learning, and explaining concepts in which students cannot quickly learn by themselves, and helping students recognize and correct misconceptions. Furthermore, it needs to provide an opportunity to guide students in solving the problems. The nature of physics emerging and developed are through observation steps, problem formulation, hypothesis preparation, hypothesis testing, hypothesis testing through experiments, drawing conclusions, and the findings of theories and concepts. Aspects that need to be taught to learn physics are in the form of precision, accuracy, logical thinking, responsible, discipline, and faith.

The nature of physics has an important purpose in the teaching-learning activities. The purpose of learning to be achieved by teachers and students is the proper result of the learning. Students can achieve the three areas of learning objectives as proposed by Benjamin Bloom namely the cognitive, affective and psychomotor aspects [3]. Based on the results of observations during the teaching practicum program conducted in SMA Srijaya Negara grade X, the researcher found the fact that during the learning process, the method used by the teacher was the method of lectures and learning activities ,and the students had to sit still, listened and took notes from what was delivered by the teacher. The contribution of students during the learning process was very minimal. There was only few students who actively questioned and expressed the idea he or she obtained from the lesson. Then the data during the learning process was that students tend to be a passive learner.

Furthermore, based on the interviews conducted with the physics teacher at SMA Srijaya Negara, the result of physics daily assessment in one of the classes reached the average value of 43.3 with the value of minimum mastery 75 and it means that the average students' score was still low. Other data which was acquired by the researcher was the inability to use the physics laboratory because was still under reparation and the tools used to perform practicums were not sufficient to be used in interactive demonstration methods in the classroom. A more in-depth study was needed to improve the learning activities to be more well-planned, systematic and in line with the nature of physics, and to promote the use of innovative learning methods.

There are three components of learning innovation: students, teachers, and learning method. The interaction of these three components will result in the fourth component which is the physics learning process, and it reflects the quality of learning. The aim of the use of innovation introduction to all aspects of learning is in order to achieve the expected quality and improvement in learning. To prevent confusion in their learning activities, students should seek the truth, find problems and observe the phenomenon that applies to physics learning or *Inquiry*.

Four stages in the *inquiry* hierarchy that can be implemented in the learning activities are *discovery learning, Interactive demonstration, inquiry lesson,* and *lab inquiry*. In this study, *Interactive demonstration* is the variable to be applied [4]. *Level of Inquiry: Hierarchies of Pedagogical Practices and Inquiry Processes"* states that physics learning should develop and use *inquiry* of science during the learning process. An interactive demonstration generally consists of a teacher demonstrating the use of a tool and then asking questions about what will happen [5].

Interactive demonstrations are not only used as laboratory activities, but can be used as part of the inquiry process. Introduced the implementation of demonstrations into an inquiry-based activity which is currently being developed by Wenning [6]. State that students significantly understand a material better when traditional learning is combined with Interactive demonstrations [7]. Based on the problem mentioned by the researcher, the researcher wanted to solve the problem by applying demonstration interactive method in the students' physics learning.

2. Research Methods

This research I categorized as experimental research in which it was the research method used to find the effect of particular treatment in a controlled condition. There were two groups in the design of *quasi-experimental design (Non- equivalent Control Group Design),* namely the control group and experimental group. Those group were given a *pretest* to know the primary knowledge of the students before they were given the treatment [8]. The experimental class was exposed to interactive demonstration method, and the control class was exposed to the group discussion method. Then they were given a *post-test* in order to measure learning outcomes after the treatment.

The *post-test questions* were given to the class XI 3 IPA SMA Srijaya Negara in the academic year of 2012/2013, to determine the validity, reliability, the differentiating point, and the degree of the difficulty. The post-test consist of 40 questions. From the test, 21 questions were in the valid value.

The data of the questions were reliable. The results of the classification of the level of difficulty obtained: 12 questions are categorized as easy, 9 questions with medium difficulty and 4 questions were considered complex. For the differentiating point, there were 8 questions categorized as poor, 8 questions were in the medium criteria, and 9 questions were in good criteria. As the result, 25 questions will be used in the *post-test*.

The study was conducted on the subject of heat, with 6 meetings (8 hours of lessons), both in the experimental class and in the control class. In the experimental class. The learning activity in the classroom was conducted using interactive demonstration method for 5 meetings, and 1 meeting was used to conduct the *post-test*. For the control class, the process of teaching and learning was conducted using group discussion method for 5 meetings, and 1 meeting was used for the *post-test*.

3. Findings and Discussion

The primary data of this research was the student's cognitive learning result. It was obtained by conducting *post-tests* in the form of a written test, with multiple choice of five options, and there are 25 questions for the post-test. From the *pre-test* results, it can be seen in the experimental class the average score of students reached 4 2.63, and the pre-test grade control reached 39.71. The aggregate of the average of students' prior ability of students from class X plus 1 and X plus was 2 of 2.9. It was not too significant, so it can be said that they had the same initial ability.

The data of the *pre-test* and the *post-test* for experimental class and control class are shown in table 1 of research data.

Table 1. The Research Results

Calculation	Experimental class	Control class
1 x value of *pre-test*	42.63	39,71
2 x the value of *the post-test*	81.60	73.52
3 *N-Gain* Value	71%	55%

The description of the research data described earlier is a general description of the data of a sample, without any generalizable conclusions. To be able to conclude, it is necessary to test data statistically. The statistical test consists of the prerequisite test (normality test and homogeneity test) and hypothesis test. The data analysis of the research result that will be discussed is the statistical test analysis, by using excel, toward *post-test* data of students' cognitive learning result from experimental class and control class. The statistical test results are:

3.1. Normality test

In this research, to test the normality of the research result from both in experimental class and control class *Chi Square* formula will be employed [8]:

$$\chi^2 = \sum \left[\frac{(f_0 - f_h)^2}{f_h}\right]$$

If $\chi^2_{\text{arithmetic}} < \chi^2_{\text{table}}$, the data is distributed normally [4].

3.1.1. Post-test Data Normality Results in the Experiment Class

Based on the calculation obtained by using *Chi-Square* arithmetic value, experimental class got 8.42. The *Chi-Square* value of the table was 11,070 with the degree of freedom equal to 5 and 5% error rate. This means that the value of *Chi Square* count is much smaller than the price of *Chi Squares* listed in the table, which is: 8.42 <11.070. Thus the *post-test* data of the experimental class is distributed normally.

3.1.2. Normality Data Test of the Post-test result in the Control Class

Based on the calculation obtained by using *Chi Square* value, control class got 2.82. The *Chi Square* value of the table is 11,070 with degree of freedom equal to 5 and 5% error rate that means that the value of the *Chi Square* count is much smaller than the value of *Chi Squares* listed in the table, which is: 2.82<11.070. Thus the control class *post-test* data was distributed normally.

3.2. Homogeneity Test

The statistics used to test group homogeneity was variance. The formula of variance [9] is:

$$s^2 = \frac{\sum f_i(x_i - \bar{x})^2}{n-1}$$

Based on the calculation, the variance for the experimental class was 88.13, whereas the variance for the control class was 50.45. According to [9] to test the homogeneity between the experimental class and control class F test. If F arithmetic <F table, then the variance is homogeneous [3]. Thus, the value of F arithmetic in the experimental class and control class in this study were:

$$\mathrm{F} = \frac{88{,}13}{50{,}45} = 1{,}75$$

The value of F arithmetic was then compared with the value of F table, with the degree of freedom of the numerator = k - 1 = 6 - 1 = 5, and degree of freedom of the denominator = k - 1 = 6 - 1 = 5. Based on the degree of freedom of the numerator = 5 and the degree of freedom of the denominator = 5, with the error rate of 5%, the value of F table was 1.78. Thus, it was found that F arithmetic <F table, which is 1.75 < 1.78. Thus, the *post-test* data of the experimental class with the *post-test* of control class data is homogeneous.

3.3. Hypothesis Testing

Because the obtained data was normally distributed, homogeneous, n 1 = n 2, comparing the experimental class with the control class, for the hypothesis test t-test sample related was applied [9]:

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2} - 2r\left(\frac{s_1}{\sqrt{n_1}}\right)\left(\frac{s_2}{\sqrt{n_2}}\right)}}$$

Ho: There is no interaction between physics interactive learning methods on student learning outcomes.
Ha: There are interactions of interactive physics learning methods for student learning outcomes.
Or it can be written in the form:

$$\mathrm{H}_0 : (\mu_1 = \mu_2)$$

$$\mathrm{H}_a : (\mu_1 \neq \mu_2)$$

Because of the mentioned hypothesis, then the second phase of test were conducted [8]. The value of *t* arithmetic was compared to the value of *t* table, with error rate of 5%. If the value of $t_{\text{arithmetic}} > t_{\text{table}}$, or lies in the rejection region H_0, then H_a is accepted and H_0 was rejected, it can be generalized and it is significant (Sugiyono, 2011: 124). To find out the t_{table} degree of freedom is used with the value of = $n_1 + n_1$ - 2. From table 2 below:

Table 2. Hypothesis Test Results

Variables	Value	Criteria
$t_{arithmetic}$	4,32	Ha accepted: $t_{arithmetic} > t_{table}$
t_{table}	1.99	

The degree of freedom was determined by ne + nk - 2, which is 76 - 2 = 74 with the error rate (α) set at 5% while the value of the ttable was, 99. The researcher concludes that Ha is accepted. It means that there was an influence of interactive demonstration method of physics learning to students' learning result and reject Ho in which there was no influence of interactive demonstration method of physics learning to students' learning result.

First, the implementation of the interactive demonstration method should consider the aspects of the lesson planning and implementation. It should also prepare the concept of what to be shown in the demonstration. In that case, the researcher specifies the material presented by using interactive demonstration is the heat. It was done by proving that the heat energy is proportional to the mass of the substance, the type of substance and the rise in temperature, and changes in substance form. The students could describe that heat given to an object causes the temperature change to happen, as well as the changes in the substance forms, conduction to prove heat transfer. They also obtain the knowledge of heat conductivity in various substances, convection in heat transfer on the liquid and gaseous substances, and radiation to determine the absorption of heat.

Secondly, the teacher considered the most effective time to conduct a demonstration in the learning process. Third, the teacher investigated the background knowledge of the students so that they could discuss things related to the material before the demonstration. Fourth, the teacher prepared the steps to be followed in the demonstration. Fifth, the teacher asked questions that can motivate students and the mindset process of students before, during and after the demonstration. Sixth, the teacher provided higher commentary that can be used to improve students' understanding of the new concept.

The implementation of the learning method in the experimental class initially experienced little resistance. To do the treatment, electricity was needed at that time and the researcher had to deal with the school about the electricity, and for the demonstration, it took considerable time to adjust. The students were very rowdy at the time of grouping, and they needed sometimes to settle down. The constraints that were encountered could slowly be reduced when the researcher turned on the *projector* to display the *powerpoint* consisting the learning material. Students' attention started to be directed to the researcher. Thus, the teaching and learning activity started to run smoothly.

The data from the observation results showed the percentage of the accomplishment of the treatment in the classroom when discussing heat energy reached 87.5%. The second meeting discussing forms of substance reached 95.8%. The third meeting discussing conduction reached 95.8%. The fourth meeting discussing convention reached 98.6%. The fifth meeting discussing radiation reached 94.4% of the implementation percentage. With the percentage shown, it could be said that the influence of the interactive demonstration was considerable, although at the first meeting the percentage was small because the researcher was not well-prepared and could not manage the time well. After obtaining the data of the learning result, the data was analyzed using statistical normality test, homogeneity test, and hypothesis test. Normality test was done to determine whether the data being analyzed was normal or not by determining the ranges, multiple classes, class lengths, and variance in the experimental class and control class. From the analysis of the calculations of the data, the experimental class got 8.42 and control class got 2.85 with the table value of 11.070. Thus, it can be concluded that $X^2_{arithmetic} \geq X^2_{table}$ data was not distributed normally whereas the $X^2_{arithmetic} < X^2_{table}$ data was normally distributed.

The homogeneity test was conducted by using the equality test of two variances, which compares the largest variance with the smallest variance. It was said to be homogeneous or derived from the same population if $F_{arithmetic} < F_{table}$ with a real level $\alpha = 5\%$. The obtained the value of $F_{arithmetic}$ 1, 75 and F_{table} 1.78, thus it can be concluded that the obtained data was homogeneous.

Furthermore, after obtaining the data of the normality and homogeneity, the hypothesis was tested by using t-test. The result of the calculation obtained t *arithmetic* 4.32 and t *table* 1, 99 if compared to t *arithmetic* and t *table* then t *arithmetic* > t *table* or 4.32 > 1, 99 and it means that the researchers concluded that H a was accepted in which there is a significant influence of interactive demonstration methods of physics learning on student learning outcomes and rejects Ho which states there is no influence of interactive demonstration methods of physics learning on student learning outcomes.

4. Conclusion

Based on the results of research, it can be concluded that there is a significant influence of interactive demonstration method on the physics learning outcomes of students in SMA Srijaya Negara

Palembang, especially to the cognitive learning. The statement is proved by the data obtained after the study, as shown in table 1 of the test results from the experimental class and control class.

The median learning outcomes in the experimental class is greater than the control class. After the hypothesis test with t-test *polled variance* was conducted, there was obtained value of $t_{arithmetic}$ equal to 4.32 and the value of t_{table} equal to 1.99 with 5% of error rate, and degree of freedom 74 , then $t_{arithmetic} > t_{table}$, which means the value of $t_{arithmetic}$ is located in rejection area of H_0 and the acceptance H_a. Based on the conclusion, the researchers made the following suggestions: (1) in implementing the teaching with demonstration methods the teacher should prepare the questions well. (2) In teaching the material using the interactive demonstration methods, the teacher must master the material and prepare the tools well. (3) Subject matter (especially physics) must be that of what is often experienced and encountered by students in everyday life. (4) In the future research, it is expected to examine the learning outcomes in both affective and psychomotor.

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