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THE EFFECTIVENESS OF PHYSICS TEACHING AND LEARNING USING EXPERIMENTAL AND DEMONSTRATIONAL METHOD ON PROCESS SKILL AND COGNITIVE ASPECT ON YEAR TEN SMA NEGERI 1 ENDE STUDENTS

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Abstract

A research has been done to reveal the effectiveness of experimental method compared to demonstrational method in teaching Physics for year ten senior high school students at SMA Negeri I Ende, Nusa Tenggara Timur (NTT). The chosen subject was Heat and Temperature

The research was done on 60 year ten senior high school students of SMA Negeri I Ende, Nusa Tenggara Timur, Indonesia from February to April 2012. The 60 students were chosen using cluster sampling technique and separated into two different classes. The first class was treated with experimental method and the second one with demonstrational method. The student process skill data were taken using observation sheet and the student cognitive aspect achievement data were collected using a set of test. These data were then analyzed using SPSS Program.

The results showed that the experimental method was more effective for teaching process skill in physics on year ten senior high school students (SMA Negeri I Ende) compared to demonstrational method. This was shown by the t test result where the process skill was set as the dependent variable. The t value was found to be 3.726 and the significance was 0.156, which was greater than 0.05 significant level. In line with the above results, the experimental method was also found to be more effective compared to the demonstrational method for teaching physics on cognitive aspect on the same sample students. This was shown by the t value 2.552 and the significance value 0.103, which was greater than 0.05 significant level.

Keywords: **teaching physics, experimental method, demonstrational method, process skill, cognitive aspect**

A. INTRODUCTION

As part of science, physics covers a great deal of natural phenomena including material and energy. Martin (2006: 41) said that science rejects superstitious explanations as the main explanation of observed phenomena. The natural phenomena must be explained logically based on observation and experimentation. According to Muijs and Reynold (2011: 21) learning is something people do in response of external stimuli. Therefore, students studying physics should not only develop their thinking skill in response of teacher's speech, but also process skill.

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Student's achievement which is often referred to as student's cognitive skill is somewhat misleading. Since the affective and psychomotor aspect should also be included as the whole achievement. The process skill refers to psychomotor aspect of the student which can be observed during experiment.

According to Chiapetta and Koballa (2010: 71) the effectiveness of teaching depends on four factors, which are personal character of the teacher, teaching skill, instructional strategy, and learning techniques. The instructional strategy and learning technique should promote not only thinking skill, but also experimental and observational skill.

Teaching physics involves a great deal of mathematics, which requires a relatively intense thinking work. This cognitive aspect is often referred to as student's achievement in learning physics. However, teaching and learning physics does not only deal with cognitive aspect but also process skill. Collette and Chiappetta (1994: 30) said that science as a way of investigating includes hypothesis, observation, experiment, and mathematics. Teaching Physics, as part of science, by way of speaking and discussion do not develop observation and experimentation skill. In fact most senior high school teachers traditionally teach physics by speaking orally involving some discussion. This teacher centered learning system has been blamed to be the cause of the failure of Indonesian education system. This paradigm is now changing to student centered learning, where teacher's role is more like facilitator.(Slavin, 2009: 6)

What has happened in many senior high schools throughout Indonesia has also happened in SMA Negeri 1, Ende, Nusa Tenggara Timur (NTT). Most teachers teach Physics conventionally by speech, some discussion and question and answer method. Less experimental and demonstrational method applied for teaching Physics. This school is supposed to be the best in Ende regency. However, according to the results of 2011 National Evaluation in Physics it was ranked number four in Ende with the average Physics score 6.01.

The problem of relatively low student achievement in physics, especially on the cognitive aspect and process skill maybe solved by the introduction of experimental or demonstrational method in teaching and learning physics at senior high schools. The experiment itself may be classified into two categories, guided experiment and free experiment.(Paul Suparno; 2007: 78) Experimental method encourages students getting more involved in doing physical works related to many aspects of physics. This enables them to develop their own process skill. On the other side the demonstrational method enables students to observe by themselves how the demonstrated equipment works and how to operate related tools. This is in line with Rohandi's (2003: 120) statement that science teaching and learning is designed to develop student skill on observation, measurement, comparison, and drawing conclusion.

The introduction of experimental or in some cases demonstrational method does not neglect the oral explanation. Oral speech is still needed when it is necessary. Instead it enriches and varies student's

learning experience as what has been explained by William Burton as cited by Oemar Hamalik (2001: 28). Speech, discussion, demonstration, and experimentation should be unified in a proactive environment in order to achieve the best result.

A research was done to reveal the effectiveness of experimental method compared to demonstrational method in teaching Physics for year ten senior high school students at SMA Negeri I Ende, Nusa Tenggara Timur (NTT). The chosen subject was Heat and Temperature which is in line with what are students supposed to learn at the time of research, February to April 2012.

B. RESEARCH PREPARATION

Research samples were taken by cluster sampling technique, consisting of two classes with 30 students each. The population is all year 10 students distributed in 11 classes of SMA Negeri I Ende, Nusa Tenggara Timur, Indonesia. The subject was chosen in line with their curriculum. In this case Heat and Temperature.

Test of homogeneity of the sample was run on year 10 students SMA Negeri I Ende. As many as 332 students in 10 classes joined with the test excluding 1 class which is accelerated class. The result of homogeneity test of the sample is presented in Table 1. The results show that the *p Value* is 0.884 which is much greater than the significance level 0.05. This means that the sample is homogeneous.

Table 1. The results of homogeneity of the samples test

No.	Data	Score
1.	Highest Score	27
2.	Lowest Score	10
3.	Highest Value	67.5
4.	Lowest value	25.0
5.	*Mean Vakue*	46.79
6.	Deviation Standard	8.11
7.	*p Value*	0.884

The syllabus, lesson plan, student working sheet, test instruments and observation sheet were validated by some experts. Expert judgment decides whether the content and construct of the above instruments valid or not. The test instrument for the measurement of student's cognitive aspect and observation sheet for the measurement of process skill were put on try out on year 11 students of SMAN I Ende to determine their validity and reliability. The results were then analyzed using point biserial correlation with $p>0.05$ for the validity of each test item. The same program, ITEMAN version 3.00, was also used to analyze the reliability of each test item. Index of difficulty and discrimination were also

under consideration on this analysis. The results are presented in Table 2. This table shows that the degree of difficulty is 0.508 and the index of discrimination is 0.248 which are both fall into moderate level. Test of reliability results in alpha = 0.477 which is greater than 0.005. This means that the test instrument is reliable.

Table 2. The result of item analysis of based on the instrument try out on cognitive aspect.

No.	Data	Score
1.	The Highest Score	35
2.	The Lowest Score	16
3.	*Mean Score*	25.423
4.	Deviation Standard	4.134
5.	Reliability	0.477
6.	*Mean* P (degree of difficulty)	0.508
7.	*Mean biserial*	0.248

C. RESULTS AND DISCUSSION

The results of the research are presented in Table 3 and Table 4. Table 3 presents the score of the process skill test which was the average score of four set of observation sheets taken by four different teachers.

Table 3. The results on process skill test

No	Data	Exp. method	Demo. Method
1.	The highest score	89.29	85.71
2.	The lowest score	65.48	57.14
3.	*Mean*	77.30	72.22
4.	Deviation Standard	5.51	5.03

Table 4 shows the results of student achievement test on cognitive aspect. The test was done using instrument consisting of 40 validated and reliable items.

Table 4. The result of student achievement test (cognitive aspect)

No.	Data	Exp. Method	Demo. Method
1.	The highest score	85.0	82.5
2.	The lowest score	52.5	47.5
3.	*Mean*	67.67	62.33
4.	Deviation Standard	8.17	8.04

KOSMOGOROV-SMIRNOV NORMALITY TEST

The collected data were then analyzed using SPSS Program to observe their normality and homogeneity. Table 5 shows the analysis output on normality test Kolmogorov-Smirnov on the process skill. The hypothesis of normality test H_o is set to be: the data on process skill are normally distributed. This hypothesis is accepted if the significance if greater than 0.05.

Table 5 shows that the K-S (Kolmogorov-Smirnov) values of process skill using experimental and demonstrational methods were found to be 0.142 and 0.137 respectively. The significance values of both experimental and demonstrational methods are 0.124 and 0.154 respectively, These are all above 0.05 significance level, so that both hypothesis for experimental and demonstrational methods are accepted. This means that both experimental and demonstrational methods on process skill show normal distribution.

Table 5. The Kolmogorov-Smirnov normality test on process skill

No.	Data	Exp. Method	Demo. Method
1.	K-S Value	0.142	0.137
2.	Degree of freedom	30	30

3.	Significance	0.124	0.154

The analyzed data for cognitive aspect of student's achievement are given in Table 6. The hypothesis of normality test H_o is: the data on cognitive aspect of student's achievement are normally distributed. This hypothesis will be accepted if the significance if greater than 0.05.

Table 6 shows that the K-S value 0.126 and significance value 0.200. This significant value is greater than 0.05, so that the hypothesis is accepted, meaning that the data show normal distribution. The K-S value of demonstrational method is 0.181 and significant value is 0.103. Since the significant is greater than 0.05, the hypothesis is accepted and the data on cognitive aspect of student's achievement were normally distributed.

Table 6. The Kolmogorov-Smirnov normality test on cognitive aspect of student's achievement

No.	Data	Exp. Method	Demo. Method
1.	K-SValue	0.126	0.181
2.	Degree of freedom	30	30
3.	Significance	0.200	0.103

LAVENE'S TEST FOR HOMOGENEITY

The results of data analysis using SPSS Program on homogeneity are presented in Table 7 and Table 8. The hypothesis of homogeneity test H_o is: the variant of dependence variable, process skill is homogeneous. Table 7 shows the results of Lavene's test on homogeneity analysis on process skill. It can be seen that the F value on process skill is 0.361 and the significant value is 0.550, which is much greater than 0.05 significant level. Therefore, the hypothesis H_o is accepted, and the data for process skill are conclusively homogeneous.

Table 7. The results of *Lavene's test* for homogeneity on process skill

No.	Data	Value
1.	F Value	0.361
2.	Degree of Freedom	58
3.	Significance	0.550

The hypothesis of homogeneity test H_o is set to be: the variant of dependence variable (cognitive aspect of student's achievement) is the homogeneous. Table 8 shows that F value of the cognitive aspect of student's achievement is 0.030 and the significance is 0.864, which is greater than 0.05. Therefore, the hypothesis H_o is accepted, and the data for cognitive aspect of student's achievement are conclusively homogeneous.

Table 8. The results of *Lavene's test* for homogeneity on cognitive aspect of student's achievement

No.	Data	Nilai
1.	F Value	0.030
2.	Degree of Freedom	58
3.	Significance	0.864

T TEST ANALYSIS

The results of t test analysis using SPSS Program are given in Table 9 and Table 10. The hypothesis H_a: $\mu_1 > \mu_2$ on student process skill was set to be: Teaching and learning of Heat and Temperature for year ten student of SMA Negeri I Ende on process skill is more effective by using experimental method compared to demonstrational method.

Table 9. The results of *t* test analysis on process skill

No.	Parameter	Value
1.	t value	3.726
2.	Degree of freedom	58
3.	Significance	0.156

Table 9 shows that the t value for process skill is 3.726 with significance value 0.156, which is greater than 0.05, so that the Hypothesis H_a is accepted. This means that teaching and learning of Heat and Temperature for year ten student of SMA Negeri I Ende on process skill is more effective by using experimental method compared to demonstrational method.

Table 10 The results of *t* test analysis on cognitive aspect of student's achievement.

No.	Parameter	Value
1.	t value	2.552
2.	Degree of freedom	58
3.	Significance	0.103

The hypothesis H_a: $\mu_1 > \mu_2$ on cognitive aspect of student's achievement was: Teaching and learning of Heat and Temperature for year ten student of SMA Negeri I Ende on cognitive aspect of student's achievement is more effective by using experimental method compared to demonstrational method.

Table 10 shows that the t value for cognitive aspect of student's achievement is 2.552 and the significance value is 0.103 which is greater than 0.05, so that the Hypothesis H_a is accepted. This means that teaching and learning of Heat and Temperature for year ten student of SMA Negeri I Ende on cognitive aspect of student's achievement is more effective by using experimental method compared to demonstrational method.

D. CONCLUSION

Finally based on the above analysis, it can be concluded that:

1. Teaching and learning of Heat and Temperature for year ten student of SMA Negeri I Ende on process skill is more effective by using experimental method compared to demonstrational method.
2. Teaching and learning of Heat and Temperature for year ten student of SMA Negeri I Ende on cognitive aspect of student's achievement is more effective by using experimental method compared to demonstrational method.

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