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The Effect of Electronic Modules Based on Problem-Based Learning on Creative Thinking Ability

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ABSTRACT

Learning models proposed by an independent curriculum and student-centered tools have not been fully utilized. This observation is supported by the outcome of an initial assessment, which revealed a low level of creative thinking ability among students. This initial assessment forms the foundation for the research problem addressed in the context of electronic module-based problem learning in physics education. The study employs a quasi-experimental design utilizing a Randomized Control Group Only Design and posttest-only methodology. Data collection solely involves knowledge-related aspects. In this study, the experimental group underwent treatment through the utilization of problem-based learning electronic modules, while the control group did not receive this treatment. The research findings indicate notable variations in student creativity thinking abilities, discernible through the diverse average scores in each group's student responses. Assessments included tests for normality, homogeneity, and a two-sample similarity test. The analysis results indicate that the value of "t_h" falls within the range of H_0 resistance, leading to the acceptance of H_1 at a significance level of 0.05. Statistical analysis of the data demonstrates that $t_h > t_t$ is 2.6318 > 2.0181. Consequently, it can be inferred that disparities exist in student creativity thinking ability concerning knowledge acquisition when comparing the utilization of problem-based learning electronic modules to its non-utilization.

Keywords: *Electronic Module; Problem-Based Learning; Creativity Thinking Ability*

I. INTRODUCTION

Education is the most crucial procedure in shaping a person's character and making him a better person. According to Law No. 20 of 2003, education is a conscious and planned effort to create a learning environment and learning process in which students actively develop their potential to develop religious spiritual strength, self-control, personality, intelligence, noble character, and ability required by themselves, society, nation, and state [1]. Based on this, a person should pursue education in order to reach their full potential.

Modernization focuses on students to master soft skills rather than hard skills. Implementation of teaching and learning activities centered on learners not on educators anymore. So that students must have mature softskill abilities to follow the learner-centered learning [2].

One of the soft skills needed by learners is the 4C skills. 4C skills are collaboration, communication, critical thinking, and creativity [2]. In addition to 4C skills, learners must also master information and communication technology literacy, contextual learning, information and media literacy. All are important factors in the implementation of modern era learning going well [3].

One of the important thinking ability in learning physics is creative thinking ability. This is because physics is a branch of natural science or science that studies the nature and phenomena that occur in nature. The focus of problem solving and mastery of physics concepts is the most important thing in learning physics. Physics learning cannot be separated from mastering concepts, applying them in solving physics problems, and working scientifically [4]. In problem solving, students must have the ability to think creatively, so that students can solve problems with various alternative options.

In order to increase the thinking ability required in the current period, the government accommodates the growth of Indonesia's national education process by regularly upgrading the education curriculum. Indonesia is presently adopting an autonomous curriculum in accordance with Minister of Education, Culture, and Research

Decision Number 56 / 2022. The Merdeka Curriculum is a follow-up curriculum to the 2013 curriculum, and it is holistically oriented, competency-based, contextualized, and personalized in line with the cultural context, school mission, and local environment, as well as student requirements [5].

In Indonesia, the capacity to think is still quite poor. Education in Indonesia is placed 107th out of 117 nations reviewed by the UNDP (United Nations Development Program) in terms of the Human Development Index (HDI) [6]. According to the Martin Prosperity Institute's (MPI) Creativity and Prosperity: Global Creativity Index 2010, Indonesia is placed 81st out of 82 nations [7]. These findings suggest that in Indonesia, the capacity to think creatively is still relatively low.

Based on an initial exam administered to students in Class XI Physics 1th and Class XI Physics 2nd with four items including markers of creative thinking ability on the topic of measuring physical quantities. The average in Class XI Physics 1st is 45.68, while the average in Class XI Physics 2nd is 49.09, as shown in Table 1 below.

Table. 1 Preliminary Test Results Of Creative Thinking Ability

Indicators of Creative Thinking Ability	**XI Physic 1st (22 students)**	**XI Physic 2nd (22 Students)**
Fluent Thinking	40,90	49,09
Flexible Thinking	44,54	56,36
Original Thinking	52,72	33,63
Elaboration Thinking	44,54	57,27
Average Score Of Creative Thinking Ability	45,68	49,09

In order to fully execute an independent learning curriculum with a government-recommended learning model—in this case, the Problem Based Learning model—efforts to improve creative thinking ability that are rated as low must be made. Previous researchers have used the problem-based learning model that is being used. The electronic module is built on the Problem Based Learning concept, making it simpler for teachers and students to implement in the learning process. As was already mentioned, students today must also possess information and media literacy abilities. Another attempt to lessen educator-centered learning and increase student participation is the integration of the Problem Based Learning Model into the Electronic Modules [2].

Study aids (for students or educators) are crucial components of electronic programs. Material content, as well as the competences to be attained. Summary, exercises, implementation recommendations (which may take the form of worksheets), evaluation, and feedback on evaluation. The Problem-Based Learning paradigm has a grammar, which includes alerting students to the problem, organizing students, guiding individual and group investigations, generating and presenting work, and assessing and evaluating the problem-solving process [8].

The electronic module, which is based on the problem-based learning approach, will be tested to see how it affects creative thinking ability. With the support of student worksheets and assessments, this electronic module may make it easier for students to understand the topic. As a result, the title of this study is "The Effect of Electronic Modules Based on Problem-Based Learning on Creative Thinking Ability."

II. METHOD

The research methodology utilized in this investigation is experimental, falling under the quantitative research category. Specifically, a quasi-experimental approach was chosen to collect data from conditions that cannot be fully controlled or manipulated, particularly in relation to the variables under consideration. Employing a posttest-only design, the study is geared towards examining the impact of problem-based learning electronic modules within the realm of physics education, specifically targeting the enhancement of creativity thinking ability among class XI student.. The study's target population comprises students from the Physics Class XI students for the 2022/2023 school year.

Table 2. Research design

Class	**Treatment**	**Posttest**
Experiment	**X**	**T**
Control	**-**	**T**

(Source: [9])

Information provided in Table 1 outlines that "X" represents the treatment involving the application of problem-based learning electronic modules, while "T" signifies the posttest conducted on the sample class. The sample class was selected using saturated sampling, which entails encompassing the entire population as the sample.

The scope of the research was confined to the knowledge dimension, employing a written essay question as the posttest measure. This essay encompassed indicators of creative thinking and was administered to the two sampled classes. Through analysis, five relevant questions were identified for inclusion.

Preceding the administration of the posttest, a four-stage statistical analysis was implemented for the final test. These stages encompassed validity testing, reliability assessment, gauging question difficulty levels, and assessing question discrimination power. These tests were conducted in classes distinct from the sample.

In the data processing phase, the T-test was utilized, preceded by normality and variance tests. The normality test aimed to confirm the normal distribution of the sample class by comparing L_0 and L_t. The homogeneity test utilized the F-test, declaring the sample as homogeneous if $F_h < F_t$.

The next step is to test the hypothesis using the t-test:

$$t = \frac{\overline{X_1} - \overline{X_2}}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \quad (1)$$

In the provided equation, $\overline{X_1}$ *and* $\overline{X_2}$ represent the mean values of the respective samples, S stands for the combined variance, and n indicates the student count in each class. If the calculated value of thitung falls within the range of $-t_{tabel} < t_{hitung} < t_{tabel}$, then the null hypothesis (H_0) is rejected, leading to the acceptance of the alternative hypothesis (H_1). In cases where data conformity lacks normality and homogeneity, the t' test is employed.

III. RESULTS AND DISCUSSION

The results of this study are in the form of quantitative data obtained in the final test conducted at the end of the study. The test was given in the form of five essay questions based on indicators of creative thinking. Before being given as the final test, the questions had been tested to measure their feasibility. The results of the posttest are described in Table 3 below.

Table 3. Results of Data Analysis in Sample Classes

Statistical Parameter	Class	
	Experiment	**Control**
Descriptive Statistic		
a. N	22	22
b. Mean	70,545	59,091
c. S	15,045	13,853
d. S^2	226,35	191,9
Normality Test		
a. α	0,05	0,05
b. L0	0,143	0,110
c. L1	0,19	0,19
d. Description	Normal	Normal
Homogeneity Test		
a. α	0,05	0,05
b. F_h	1,1845	
c. F_t	2,0842	
d. Description	Homogeneous	
Test of Equality of Comparison of Two Averages		
a. α	0,05	0,05
b. t_h	2,6318	
c. t_t	2,018	
d. Description	There are differences	

From the statistical analysis conducted in Table 2 below, it can be seen that there is an increase in the creative thinking ability of students in the knowledge aspect with the application of electronic modules based on the problem-based learning model compared to those who are not given the electronic module. The posttest conducted with five questions containing indicators of creative thinking shows the average final score has a difference of 11.3, the experimental class has a higher average score of 70.45 and the control class has an average score of 59.09. This shows a significant difference between the two sample classes assessed from the knowledge aspect of their creative thinking ability.

The indications of creative capacity included in the exam questions were fluent thinking, flexible thinking, original thinking, and elaboration thinking [10]. The influence of the problem-based learning electronic module on the two sample classes may be assessed by conducting hypothesis testing on both components of students' thinking ability using a two-average comparison test on normally distributed and homogenous data. The following are the findings of the statistical tests:

1. Normality Test

Normality test is conducted to test whether the two samples are normally distributed or not. The results of the normality test that has been carried out obtained l_0 (liliefors count) is smaller than l_1 (liliefors table) at a real level of 0.05 and n_1 with the amount of data each 22 as in the Table 4.

Table 4. Normality Test Results of Both Sample Classes

Class	N	α	L_0	L_1	Description
Experiment	22	0,05	0,143	0,19	Normal
Control	22	0,05	0,110	0,19	Normal

The table shows that l0 in the experimental class was obtained at 0.143 and l0 in the control class was obtained at 0.110. The results of the calculation of the Liliefors value can be seen in the appendix. Because both sample class l_0 values are smaller than l_1 which is 0.19, it can be concluded that $l_0 < l_1$ which states that the data is normally distributed. The results of the normality test of the two sample classes can be seen in the table below.

2. Homogeneity Test

The homogeneity test was carried out on both experimental and sample class data to see whether the two classes had homogeneous variants or not. Data is declared homogeneous if it has an F_h value in the H_0 rejection area. The following table shows the results of F_h for the sample class of 1.16 from the F_t value of 2.08. So that the two variants can be said to be homogeneous if $f_h < f_t$. namely $1.18 < 2.06$ which states that the sample data is homogeneous data. The results of the homogeneity test can be seen in the table. Description of homogeneity test data analysis can be seen in the Table 5 below.

Table 5. Homogeneity Test Results of Both Sample Classes

Class	N	S^2	α	F_h	F_t	Description
Experiment	22	226,35	0,05	1,1845	2,084	Homogeneous
Control	22	191,9	0,05			

3. Hypothesis testing

The sample class data carried out normality test and homogeneity test showed the results that the data were normally distributed and varied homogeneously. So that the hypothesis test carried out is the equality test of two means using the t test for both homogeneous variants in the aspect of creative thinking ability.

The examination of the two sample classes' posttest scores yielded a t_h of 2,6318 and a t value for dk = $(n_1 + n_2)$-2 of t_t = 2.0181. The results of the t test analysis for both homogeneous variants show $t_h > t_t$, namely 2.6318> 2.0181, implying that there are differences in the creative thinking ability of students using electronic

modules based on problem-based learning models and students not using electronic modules based on problem-based learning models in class xi students.

Learning outcomes in both sample classes that have the same initial ability show differences after the application of electronic modules based on problem-based learning models in the experimental class. The difference indicates the effect of electronic modules to improve students' creative thinking ability, as described in the table.

This study produces results to see the use of electronic modules based on problem-based learning has an effect on improving students' creative thinking ability. Based on the data analysis that has been done, the average value of students in the aspect of creative thinking ability obtained from the results of the posttest conducted at the end of the study.

Through the first ability test of students, the average value of students' creative thinking ability is in the low category; however, when the electronic module based on the problem-based learning model is implemented, the average value of students rises. After evaluating the hypothesis with the two mean equality test, it was determined that the creative thinking capacity of high school class xi students improved. The posttest results at the conclusion of the research are used to measure these learning outcomes.

Learners' creative thinking ability increase due to the use of electronic modules. Electronic modules are effective teaching materials to improve students' understanding [11]. The application of the problem-based learning model makes students required to be able to think creatively in finding answers and concepts from the material studied, this will improve the creative thinking process of students in finding ideas, concepts and finding their own answers to a problem that is asked and able to develop the knowledge they have [8].

By helping students recognize and solve original challenges, reach conclusions using their own ideas and skills, and expand their creative thinking, problem-based learning can improve students' capacity for creative thought. This is due to the fact that problem-based learning helps students acquire the flexibility, authenticity, elaboration, and explanation skills that are essential for creativity [12].

Providing electronic modules in the learning process increases students' curiosity [13]. Electronic modules based on problem-based learning models are electronic teaching materials equipped with videos, animations, images, text, graphics and their combinations [14]. The electronic module is built on a software platform called a PDF flipbook, which turns a PDF file into a traditional animation that includes multiple pages of paper into an electronic book [15].

This electronic module is integrated with the Geogebra website which will assist students in working on interactive student worksheets directly on the electronic module. Due to the integration of geometry into the electronic module, students are more motivated to try and independently construct problems and solve them. To minimize learning obstacles, practice solving vector problems, and comprehend vector concepts with abstract information that is maintained in the form of visualization, it is assisted by electronic graphical simulation [16]. The electronic module also provides a final evaluation integrated with a quiz website that will make the evaluation more interesting and interactive.

This research has been carried out to the maximum, but there are still many shortcomings and insights when doing it. First, this research is only limited to physics vector magnitude material. The reason is due to the limited research time and the lack of supply of teaching materials for other materials. The solution is expected that other researchers can conduct research on other physics materials.

Second, the research time is limited, supposedly on the material of vector quantities can be done 15 hours of lessons or three meetings. Then shortened to 10 lesson hours or two meetings. So it is hoped that other researchers can conduct research with full lesson hours.

IV. CONCLUSION

Derived from the outcomes, it can be deduced that the problem-centered learning digital modules play a noteworthy role in enhancing students' cognitive creativity ability, particularly in the domain of problem-solving knowledge, as evidenced by the posttest results. In light of these findings, it is anticipated that the problem-

centered learning electronic modules can serve as a self-directed learning resource for proficient students, aligning with the contemporary progressions in knowledge and technology.

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