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Problem-Based Multimedia E-books: The Effect on Students Creative Thinking Skills in Physics Course

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***Abstract*:** *Creative thinking abilities are essential to address real-world problems and adapt flexibly to changing demands. Teaching materials are very necessary for learning but the existence of books is still dominantly verbal and textual, so it is less interesting for students to read them. The purpose of this study was to determine the influence of problem-based multimedia e-books on students' ability to think creatively. This study used a quasi-experimental design with a non-equivalent control group. The research was undertaken at a public senior high school in Central Java, Indonesia in the physics classroom on sound waves topic. The sampling technique used purposive sampling. The research sample was 68 students consisting of the experimental and control class. Data were collected using a creative thinking ability test instrument in the form of multiple-choice questions. The measured creative thinking skills consist of fluency, flexibility, originality, and elaboration. Data were analyzed quantitatively using the t-test (t-test). The results showed that the Sig. (2-tailed) < 0.005 which means that there is a significant difference between students' creative thinking skills in learning using problem-based multimedia e-books. The effect size result obtained is 0.61 in the medium category. It can be inferred that problem-based multimedia e-books effectively improve students' creative thinking skills in physics courses.*

Keywords: *Multimedia E-books, Sound Waves, Physics, Creative Thinking Skills*

1. Introduction

Sound waves are difficult for most students to understand [1]. Many conceptual errors occur, especially in understanding mathematical equations [2] and the concept of sound propagation [3]. It raises the likelihood of pupils developing misunderstandings and a deficiency in reasoning about situations involving sound waves. To explain the phenomenon of sound, designing learning that integrates the context of everyday life is important [1]. However, the recent study on sound waves is only limited to the relation between the properties of sound waves and their perceptual character [2].

One of the skills needed in the 21st century is thinking creatively [4]. The ability for creative thinking is the capacity for generating and expanding new ideas via the development of current concepts and problem-solving abilities from various perspectives [5]. Creative thinking skills are required to solve real-world issues and adjust to new demands flexibly [6]. Through creative thinking, all students' potential becomes valuable so that creative ideas can be generated.

Creative thinking skills are needed in studying physics to explain various natural phenomena through physics concepts and principles [7]. However, students' creative thinking skills in learning physics are still lacking. In general, students cannot solve complex problems that require creative thinking processes [8]. Students tend to have difficulty identifying a problem and it takes a long time to solve it [9].

Learning must be designed to be student-centered, conducive, fun, and sharpen students' thinking skills [10], including students' creative thinking skills. The problem-based learning (PBL) learning model emphasizes: (1) problem orientation, (2) centered on student activities, including the inquiry process, (3) collaboration, and (4) integration of theory and practice [11]. Creative thinking skills can be enhanced through problem-based learning. The presence of problems is very influential in stimulating students' creative thinking skills [12]. Each phase in PBL can facilitate students to improve their quality, especially to stimulate thinking processes and to build knowledge [13]. PBL trains students to think actively to solve everyday contextual problems [14].

Teaching materials are very necessary for learning because they contain a collection of information, tools, and texts that can help teachers plan and study learning [15]. The existence of books is still dominantly verbal and textual [16], so it is less interesting for students to read them [17]. Along with the rapid development of technology, teaching materials can be presented in digital forms, such as multimedia e-books [18]. Multimedia e-books can be equipped with multimedia content such as images, sounds, videos, animations, and other multimedia features that students can reopen. E-books can also be equipped with interactive evaluation tools that allow interaction with students [19].

This study aimed to find out the effect of problem-based multimedia e-books on increasing students' creative thinking skills. This study can contribute to the renewal of physics learning to enhance students' creative thinking skills, especially in the sound waves.

2. Methods

This research was quasi-experimental which included quantitative research. The research design used was a non-equivalent control group design which aims to determine the effect of a treatment on the object under study. The research design can be seen in Table 1.

TABLE I: Research Design

Class	Pretest	Treatment	Posttest
Experiment	O1	X	O2
Control	O1	Y	O2

O1 : Pretest creative thinking skills
X : Learning with problem-based multimedia e-books
Y : Learning using a commonly used textbook
O2 : Posttest of creative thinking skills

This research was conducted in two classes: the experimental and control class. The experimental class used problem-based multimedia e-books, while the control class used a commonly used textbook. Due to the Corona Virus Disease-19 (COVID-19) pandemic, both classes conducted online learning using Whatsapp Messenger and Google Meet. Learning is carried out for 2 weeks with 2 meetings per week. The material taught is sound wave material.

The e-book used contains content in text, images, animations, and videos. The e-book contains several components, including (1) front page; (2) menu page; (3) introduction consisting of information in the form of basic competencies and learning objectives; (4) instructions for use; (5) concept maps, learning materials and sample questions; (6) student worksheet; (7) summary; (8) practice questions; and (9) developer profile.

The population of this study was all second-year students at one of the public senior high schools in Central Jawa, Indonesia. The school has a moderate level of academic achievement. The sample of this study was 68 second-year students in two classes. These students have an average age between 16-18 years. Sample selection was made using the purposive sampling technique.

The data collection technique was carried out using a creative thinking skills test instrument consisting of multiple-choice questions that expert lecturers and teachers had validated. The creative thinking ability test instrument was given before treatment (pretest) and after (posttest) in both classes. Indicators of creative thinking skills in this study are described in Table 2.

TABLE II: Indicator of Students Creative Thinking Skills

Aspect	Indicator
Fluency	Generating various ways to solve physics problems
Flexibility	Interpreting physics problems through pictures, stories, or problems from various points of view
Originality	Giving ideas and conclusions based on his thoughts through physics problems found in everyday life
Elaboration	Solving problems with detailed steps

Quantitative data analysis begins with a normality test using the Saphiro Wilks and a homogeneity test using the Levene test. Based on the normality test results, the significance values obtained from the pretest and posttest results in both classes were all greater than 0.05, so it can be inferred that the data for both classes came from a normally distributed population. The homogeneity test results showed that the significance value is greater than 0.05, so it can be inferred that the pretest and posttest data between the experimental class and the control class are homogeneous (uniform). Then, the t-test was used to determine the effect of problem-based multimedia e-books on increasing students' creative thinking skills.

The percentage of the students' creative thinking scores in each aspect were analyzed using the equation:

$$\text{Percentage of Students' Creative Thinking Skills} = \frac{\text{Score obtained}}{\text{maximum score}} \times 100\% \qquad (1)$$

The criteria for creative thinking skills based on the percentage obtained are presented in Table 3 [20].

TABLE III: Creative Thinking Skills Category

Interval	Category
80% - 100%	Very creative
66% - 79%	Creative
56% - 65%	Fairly Creative
40% - 55%	Less Creative
30% - 39%	Uncreative

Effect size analysis was conducted to ascertain the influence of using problem-based multimedia e-books on developing creative thinking abilities. The effect size formulation was obtained based on the results of the t-test with the equation [21]:

$$\mu^2 = \frac{t^2}{t^2 + df} \qquad (2)$$

where μ is the effect size, t is the value of t_{count} obtained from the t-test results, and df is the degree of freedom. The effect size criteria are shown in Table 4 [22].

TABLE IV: Effect Size Criteria

Effect Size (μ)	Criteria
$\mu > 1.10$	Very large
$0.75 < \mu \leq 1.10$	Large
$0.40 < \mu \leq 0.75$	Medium
$0.15 < \mu \leq 0.40$	Small
$\mu \leq 0.15$	Very small

3. Results and Discussion

The summary of the data on the pretest and posttest values of students' creative thinking skills descriptively is shown in Table 5. The average pretest score of students' creative thinking skills in the experimental class was 50.79 (SD = 10.962) and the control class was 53.94 (SD = 14.697). Meanwhile, the posttest score of students' creative thinking skills in the experimental class (Mean = 70.18; SD = 10.113) was higher than the control class (Mean = 61.35; SD = 11.303).

TABLE V: Statistics of Students' Creative Thinking Scores

Class	N	Pretest		Posttest	
		Mean	Std. Deviation	Mean	Std. Deviation
Experiment	34	50.79	10.962	70.18	10.113
Control	34	53.94	14.697	61.35	11.303

The subsequent analysis is hypothesis testing. Hypothesis testing was carried out using a t-test (t-test) to determine whether there was a significant difference between the results of students' creative thinking skills. The independent sample t-test analysis results for pretest and posttest data on creative thinking skills can be seen in Table 6.

TABLE VI: Results of Analysis of Independent Sample t-test

Test	Sig. (2-tailed)	Mean Difference
Pretest	0.321	-3.147
Posttest	0.001	8.824

Based on the independent sample t-test, it is known that the value of Sig. (2-tailed) on the creative thinking ability pretest (p) = 0.321 > 0.05. It can be concluded that there is no significant difference between the score of creative thinking ability in the experimental class and the control class before learning. This shows that the initial creative thinking ability of the two classes is the same or almost the same. The Sig. (2-tailed) on the posttest results of creative thinking ability (p) = 0.001 <0.05, so it can be concluded that there is a significant difference in the score of creative thinking ability between the experimental and control classes after learning.

Furthermore, statistical analysis was carried out to determine whether there was a difference in the average value of creative thinking skills before and after learning in the experimental and control classes. The analysis was performed using a paired sample t-test. The results of the analysis are shown in Table 7.

TABLE VII: Result of Paired Sample t-test

Class	t	df	Sig. (2-tailed)
Experiment	-7.195	33	0.000
Control	-3.300	33	0.002

Based on the results of the paired sample t-test analysis, the Sig. (2-tailed) in the experimental class (p-value) = 0.000 < 0.05, so it can be concluded that there is a significant difference between the score of students' creative thinking skills before and after learning in the experimental class. While the score of Sig. (2-tailed) in the control class (p-value) = 0.002 < 0.05 so it can be concluded that there is a significant difference between the score of students' creative thinking skills before and after learning in the control class. Both the experimental and control classes have a significant difference between students' creative thinking skills scores before and after learning. However, the increase in scores in the experimental class was greater than the increase in the control class.The results of the effect size analysis are shown in Table 8.

Table VIII: Effect Size Analysis Results

Class	μ	Category
Experiment	0.61	Medium
Control	0.25	Small

Based on the effect size analysis results, it was found that the effect size in the experimental class is 0.61, which means that the use of problem-based multimedia e-books has a moderate effect on improving creative thinking skills. Meanwhile in the control class, an effect size of 0.25 was obtained, which means that using commonly used textbooks has a low effect on improving creative thinking skills. Based on these data, it can be

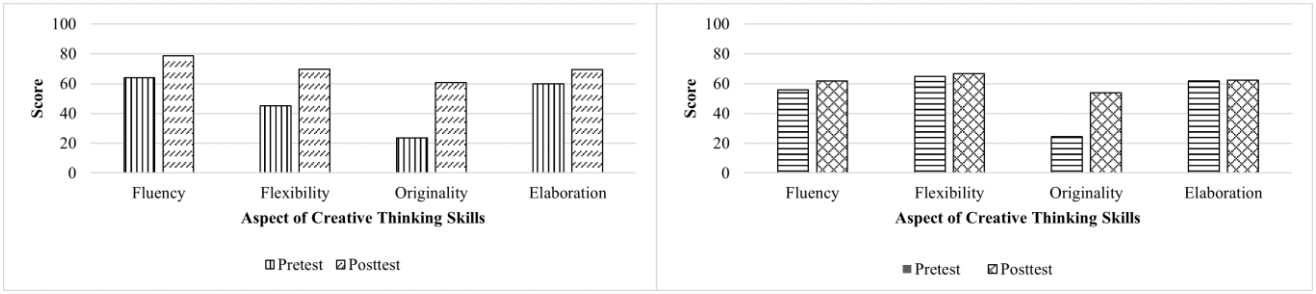
concluded that problem-based learning-based physics e-books better affect creative thinking skills than commonly used textbooks.

The students' creative thinking skills were categorized based on the criteria shown in Table 9. It shows that the increase in the number of students in the experimental class's very creative and creative categories is higher than in the control class.

Table IX: Table of Students' Creative Thinking Skills by Category

Interval	Category	Number of Students			
		Experiment Group		Control Group	
		Pretest	*Posttest*	*Pretest*	*Posttest*
80% - 100%	Very creative	0	9	2	3
66% - 79%	Creative	5	18	7	12
56% - 65%	Fairly Creative	4	4	6	8
40% - 55%	Less Creative	23	3	16	11
< 39%	Uncreative	2	0	3	0

The comparison of the pretest and posttest scores of students' creative thinking skills in the experimental class and in the control class are presented in Fig. 1.



(a) (b)

Fig. 1: Graphics of the Improvement of Creative Thinking Skills: (a) Experiment Class, (b) Control Class

Multimedia e-books present a series of student-centered learning activities and emphasize student memory [23]. In implementing the problem-based multimedia e-books, there are several stages of learning carried out. The first stage is the orientation of students to the problem. Problem identification is made by students based on what they want to know [24]. This stage is very good for investigating students' curiosity [25], motivating them to find solutions to problems, and developing students' thinking skills [26]. When students are faced with problems, students' creative thinking skills will be honed, which are indicated by creative attitudes including: (1) the desire to develop better; (2) seeing a situation/problem from various points of view called "thinking out of the box"; (3) open-minded; and (4) implementing the idea [20].

The second stage is to organize students to learn. At this stage, the teacher helps students to define and organize tasks related to the problem [24]. At this stage, the students' creative thinking skills developed are in terms of flexibility and originality. The third stage is an investigation activity that develops students' thinking skills in detail and authenticity. Investigation activities on problem-based multimedia e-books are written in the worksheets. The fourth stage is to develop and present findings that develop students' creative thinking skills in fluency and authenticity [27].

In addition, in problem-based multimedia e-books, students conclude by first analyzing and evaluating problem-solving. Making conclusions is a process of building knowledge (constructivism) brought by each student [28]. Conclusions explained by students through investigative activities are strengthened through the material presented in the e-books.

The research data shows that problem-based multimedia e-books have a "moderate" effect on improving students' creative thinking skills. The less than optimal increase obtained can be caused by the difficulty of conditioning students in the learning process and assessment during distance learning and the unstable internet network of some students.

There are weaknesses in the application of PBL in learning, including: it takes much time to solve problems and gives great responsibility to the teacher [29]. Teachers play a major role in implementing PBL in the classroom, especially to ask questions and guide investigative activities [30]. This is the implementation of PBL as a learner-centered learning model [12].

4. Conclusions

The results showed that learning using problem-based multimedia e-books significantly affected students' creative thinking skills with an effect size of 0.61, which was included in the medium category. Further research should examine the effect of problem-based multimedia e-books on other variables or topics. In addition, the duration of the research should be extended so that students' creative thinking skills can be improved.

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