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THE EFFECT OF USING PHET IN THERMODYNAMIC PROCESS MATERIAL ABOUT CRITICAL THINKING SKILLS SENIOR HIGH SCHOOL STUDENT

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Abstract

Thermodynamic process material is a study of physics that is microscopic and not visible so that the learning process can use learning media in the form of PhET simulations. Critical thinking skills are one of the skills needed in the 21st century. The target of the study was a high school student with a sample of class XI MIPA MAN 1 Mojokerto. The purpose of this study was to determine the effect of the use of PhET on thermodynamic process materials on the critical thinking skills of high school students. The research method used is a quantitative method with an experimental approach with a pretest-posttest control group design. The result of this study was that there was a difference in the critical thinking skills of students in experimental classes and control classes with gain test scores in experimental classes of 0.73 (high category) and control classes by 0.36 (medium category). For the score of the effect size test with d-cohen's of 0.886. So the conclusion of this study is the effect of the use of PhET on thermodynamic process materials on the critical thinking skills of high school students with the level of effect on high categories.

Keywords: PhET, Thermodynamic, critical thinking skills

PENDAHULUAN

The crisis caused by Covid-19 has affected all aspects of social life, including education. With school conditions that must be locked down, teachers and all parts of the education workforce must use the new curriculum so that the material can still be delivered [9]. In Indonesia, the term Learning From Home or abbreviated as BDR [12]. The reality of this educational technology transformation provides such an important role that it requires teachers and learners to have qualified ICT to be able to implement the BDR process [18]. To still achieve learning goals [20], the learning process carried out face-to-face during the pandemic must still pay attention to health protocols by government rules in Joint Decree No. 384 of 2021 [13].

This condition certainly has a very significant effect on the learning of physics. As in thermodynamic materials related to changes in internal energy, which are related to transfer and work [25]. Using PhET as a medium of learning aims to invite students' attention in exploration [10], increase student involvement in understanding concepts [19], understand material concepts well,

especially in not visible material [14], and act as a contributing factor to enrich the experience in demonstrating the phenomenon of learning concepts interactively [21].

The skills required in the 21st century are the set of skills students need to build competitiveness that includes digital knowledge of social, professional, and academic life [16]. One of those included in these characteristics is critical thinking skills [2]. A student who has critical thinking skills means he can understand concepts effectively and can use critical thinking towards concept development [26]. One of the right tools to develop critical thinking skills is to study science, such as physics [15].

Critical thinking requires knowledge and experience and must appear in everyday life until it becomes a habit as a skill [4]. There are 5 indicators in critical thinking skills [3, 5, 6, 7].

TABEL 1. Indicator of Critical Thinking skills

No	Indicator of critical thinking skills
1	Basic clarification by providing a simple explanation
2	Build basic skills by making decisions
3	Conclude
4	Follow-up clarification
5	Set strategies and tactics

Based on the studies of several researchers as outlined above and reinforced by several previous studies related to the effect of PhET use, such as research conducted by Cecep E Rustana, Wawan, and Serevina [24] related to differences in student learning achievement using PhET simulations in learning that can improve students' motivation and learning achievement on gas kinetic theory materials. Other studies were also conducted by Sunaryo, Cecep E Rustana, Raihanati, S N Khalifah, and I Sugihartono [27]. Supported by research by Dewi Muliyati, Melina Nurindrasari, and Cecep E Rustana [17]. Thus, the study was designed to analyze the effect of PhET use on thermodynamic process materials on the critical thinking abilities of science grade XI high school students. Thus the results of research using PhET as a virtual lab on learning are expected to help efforts to improve students' critical thinking skills as one of the skills needed in this century.

METODOLOGI

The method used in this study is a quantitative method with an experimental approach with a pretest-posttest control group design. The population in this study was the entire class XI MIPA MAN 1 Mojokerto Furthermore, to determine the research sample, observations were made of the population.

Learning conducted during research using inquiry learning methods with experimental activities. This learning method was chosen because of its learning process that allows students to exchange ideas and work together in solving problems so that they can be objective, critical, and open when handling the concept of thermodynamic process materials [1]. For experimental classes, experiments are conducted using PhET simulations while in control classes, experiments are conducted with simple practicum activities. At the fourth meeting, at the end of learning, a post-test was conducted to measure the achievement obtained by students during learning using the critical thinking skills test.

The instruments used in this study are pretest and post-test issues that are adapted to critical thinking indicators. Instrument testing includes validity tests, reliability tests, difficulty level tests, and other power tests.

HASIL DAN PEMBAHASAN

This research aims to find out the effect of the use of PhET on thermodynamic process materials on the critical thinking abilities of high school students in grade XI MIPA. Thermodynamic process matter was chosen because it includes ideal gases that are microscopic. Through a PhET simulation, students can easily observe something not visible. So, it is expected that by learning using PhET, students' critical thinking skills can increase. These critical thinking skills of students are one of the

skills needed in the 21st century, where cognitive processes include problem-solving, decision making, reasoning, and creative thinking [11].

Before the instrument is used to measure a student's critical thinking skills, it is first tested for feasibility with tests of validity, reliability, difficulty level, and differentiating power. Validation tests are obtained through expert materials 1 and 2. After getting an assessment with results that are worth using, then the instrument is tested on students of class XII who have first learned about thermodynamic processes. The problem consists of 10 questions of description with each indicator of critical thinking represented by 2 points of the problem. Here are the results of the critical thinking instrument test.

TABEL 2. Instrument test

Indicator of CT	Number of Question	Test		Difficulty Level	Differentiating power	Info
		Validity	Reliability			
Elementary Clarification	5	0,69	0,834	0.92	0.30	Used
	6	0,74		0.75	0.43	Used
Basic Support	4	0,58		0.87	0.23	Used
	7	0,79		0.73	0.65	Used
Elementary Clarification	3	0,59		0.80	0.40	Used
	9	0,65		0.91	0.20	Used
Inference	1	0,57		0.73	0.25	Used
	8	0,71		0.85	0.23	Used
Strategy and Tactics	2	0,58		0.93	0.13	Used
	10	0,62		0.71	0.38	Used

The number of data for each class is 25 students. Here is the percentage of pretest and post-test average scores in experimental classes and control classes classified based on critical thinking indicators.

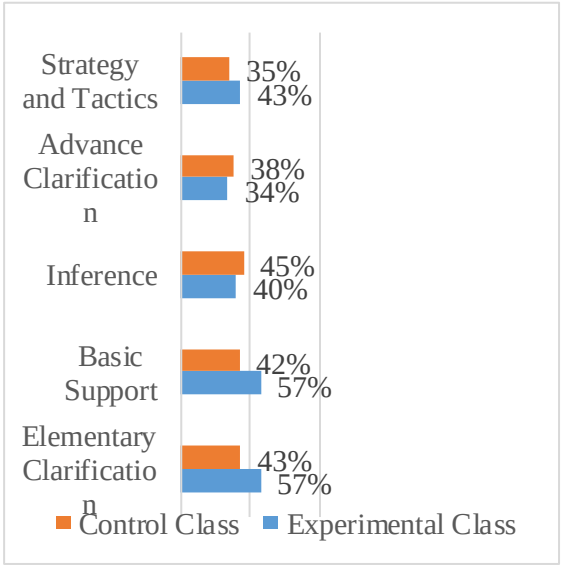

FIGURE 1. Data Pretest

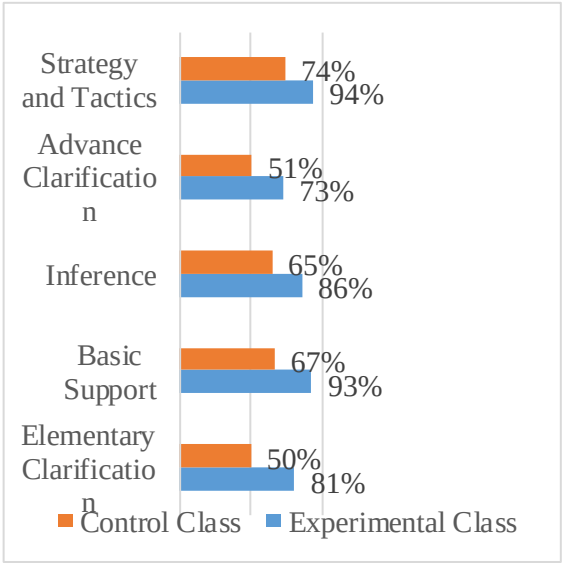

FIGURE 2. Data Post-Test

Based on the pretest and post-test graphs, it can be seen that there is a change in the average grades in the experimental class and control class. Both had increased grades but most significantly improved in the experimental class. These results are verified with statistical tests that will be described below.

For normality tests use the formula Kolmogorov Smirnov and with the help of SPSS. Test normality with α=0.05 and n=25, then D_{table} is 0.264. Here are the normality test results.

TABLE 3. Normality test

Class	Pretest			Post-test		
	D_{count}	SPSS	Information	D_{count}	SPSS	Information
Experiment	0.1067	0.107	Normal	0.2465	0.246	Normal
Control	0.1832	0.183	Normal	0.186	0.186	Normal

Pretest and post-test data homogeneity tests using the F-test with α=0.05. Determines the value of F_{count} using calculations and determines the value of significance by processing data using SPSS. Because the $F_{count}<F_{table}$ value and the significance value of homogeneity $\geq$0.05, H_0 is accepted and H_1 is rejected. That is, the pretest values for experimental classes and control classes are homogeneous or the same.

TABLE 4. Homogenity test and T-test of control class and experimental class

Tes	F_{count}	F_{table}	Sig	Information	t_{count}	t_{table}	Sig	Information
Pretest	1.0630	2.94	0.837	Homogeny	-1.7856	1.677	0.080	No difference
Post-test	1.1232	3.35	0.893	Homogeny	9.4231	1.677	0.000	There are differences

Once the prerequisite test is met, the next is a hypothesis test consisting of a T-test, again test, and an effect size test. The hypothesis test in this study used the T-test. The T-test was conducted to determine the difference in students' critical thinking abilities through pretest and post-test grades in experimental classes and control classes. Testing this hypothesis uses a comparison of t_{count} to the t_{table} and with significance values using SPSS.

The gain test is conducted to determine the improvement of students' critical thinking skills before and after being given learning. The gain test uses the average calculation with the gain formula in the experimental class and control class. Determination of the value of gain with the average value using calculations while with SPSS in the form of a percentage of gain value. It is then classified by category. The effect size test is used to determine how much effect the use of PhET thermodynamic material has on students' critical thinking skills. The effect size test uses Cohen's effect size with calculations on the average post-test grade of the experimental class and the control class.

TABLE 5. Gain test and effect size testof pretest and post-test

Class	Gain count	SPSS	Info	Average	S	d *effect size*	Info
Experiment	0.732	72.91%	High	85.28	9.5110	0.8860	High
Control	0.356	34.96%	Medium	61.28	8.4682		

Based on the table above, it can be seen that the effect size test for the experimental class against the control class has a value of 0.8860 which means it falls into the high category. Thus, the effect of the use of PhET on thermodynamic process materials on students' critical thinking abilities is high.

The final results showed that the hypothesis in the study provided the conclusion of H_0 was rejected and H_1 accepted. That is, there is an effect of the use of PhET thermodynamic material on the critical thinking skills of high school students. This is in line with research that has been conducted by Cecep E Rustana et al related to differences in student learning achievements that use PhET simulations in learning [23]. In addition, the study also indicates an increase in students' motivation in their learning. Another study was also conducted by Syarifah Lely Fithriani et al [8] and research by Ramadan, Jumadi, and Astuti [22] on students' critical thinking skills improved after using PhET.

The use of PhET as one of the applications of virtual experimentation that blends visual with audiovisual, allows students to easily process information and reasoning thinking [7]. In addition, using PhET simulation as a technology-based media is suitable for use in this digital era so that students can familiarize themselves with technology and can prepare for the industrial revolution [17]. During the study, students in experimental classes who used PhET as a learning medium were better able to organize knowledge using the concepts they understood so that their cognitive, emotional, and psychomotor structures could be awakened. Thus, critical thinking skills can increase and develop [23].

The use of PhET as one of the learning media that supports students' critical thinking skills. For physics lessons themselves a lot of the material provided his simulation in PhET. This is in accordance with previous studies that were listed in chapter II. One of them is research by Sunaryo, Cecep E Rustana, Raihanati, and Iwan Sugihartono on the use of PhET to increase mastery of physical concepts in harmony motion matter [27]; research by Ida Puspita related to the use of PhET as a strategy for strengthening distance learning in black body radiation material [21]; etc.

Based on the above exposure, the use of PhET in the learning of physics, especially the material thermodynamic processes can help improve understanding. Thus, that can be used as one of the learning tools during BDR and direct learning to improve the critical thinking skills of senior high school students.

SIMPULAN

Based on the results of the study it can be concluded that the use of PhET material thermodynamic will improve the critical thinking skills of senior high school students class XI MIPA MAN 1 Mojokerto with high category as indicated by the effect size (cohen) test result of 0.886.

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