Jurnal Riset dan Kajian Pendidikan Fisika
Volume. 9, issue. 1 [April 2022], pp. 17-24

e-ISSN: 2355-620X
DOI: 10.12928/jrkpf.v9i1.26

Utilization of PhET simulation in flipped classroom to improve students' critical thinking skills

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Abstrack. This research was conducted at Supra Talibura Junior High School, Sikka Regency, NTT, to determine the effect of increasing students' critical thinking skills after being given treatment using PhET Simulation in a flipped classroom setting. The trial sample used was 50 students divided into two classes. Each class was 25 people with purposive sampling. Data was collected by giving tests and questionnaires. Students are given apperception in videos a week before the learning takes place during the learning process. Giving videos aims to build students' initial learning knowledge to find out for themselves about learning topics: test *t* and *N*-gain analysis. Research results have been obtained; namely, there is an effect of using PhET from hypothesis testing and N-gain. At the same time, the results of the percentage of student response questionnaires indicate the level of student acceptance of the media used in learning.

Keywords: PhET simulation, critical thinking skills, flipped classroom

I. Introduction

The acceleration of technology in the world cannot be separated from the world of education. According to the Industrial Revolution, innovations continue to be developed so that national education goals can be achieved [1-3]. Some of the main factors for the success of education are the contribution of several aspects such as curriculum, teachers, and teaching and learning processes [4,5]. So that in its application, it is necessary to do a strategy. The selection of learning media can give students a positive impression of learning activities [6]. This selection is expected to impact student achievement so that they experience the acceleration of the desired national education goals. One of them is the development of learning media at the secondary level of science.

The development of the world of education, especially in natural science materials, requires experimental activities that are capable of achieving learning objectives. In this case, the learning activities in the Classroom are not centered on the teacher so that the involvement of students can be felt [7]. In addition to this, technological collaboration has a very large role because there are still many inadequate laboratory facilities in schools, especially in eastern Indonesia [8]. So technological assistance in education can help schools, in this case, teachers in the field of study who use virtual laboratories. Several studies have also been conducted by [9-11], which succeeded in improving the quality of students. However, at this time, the world of education, especially at Supra Talibura Junior High School, Sikka Regency, NTT, collided with the Covid-19 pandemic, so it has become a particular challenge for educators with limited facilities.

Flipped Classroom is a verbal space used as a stimulus preparation for students before entering class [12]. Therefore, to support the flipped, students are given learning videos as initial knowledge material to learn before class starts. Syakdiyah et al. (2018) [13] revealed that the application of ICT in the flipped Classroom

improved students' problem-solving skills. Time constraints are not an obstacle to teaching and learning because students can learn independently from the learning videos. In addition to students being able to access material flexibly [14], it is hoped that through videos, students are interested in independent learning even during the current pandemic. Flipped settings also train students' thinking skills about scientific phenomena often encountered in everyday life to create a more conceptual understanding [15].

Virtual experiment is one method of presenting a virtual practicum that can be operated with students' computers or Androids. One type of virtual laboratory used in this research is PhET (Physics Environment Technologies). In its application, PhET simulation is fun and can represent information in various representations [16]. This simulation is reinforced that information presented visually or verbally is more meaningful than information presented in only one way. The flipped classroom, which is integrated with the PhET simulation, has five advantages, including (1) making it easier for students to identify problems, (2) exploring creative ideas, (3) collaborative creativity, (4) elaborating creative ideas, and (5) students can evaluate the processes and outcomes of scientific creativity [17]. These five things can strengthen students' critical thinking processes, even during the current pandemic.

The results of the initial observations that have been made are that during the pandemic, learning activities in schools are very limited. Some even require students to carry out online learning activities. Experimental activities cannot be carried out in school laboratories. So that students' experience, knowledge, and skills are very minimal in the concept of science. From these results, technology is needed to solve the limitations of real experiments [18,19]. So the purpose of this research is to find out the improvement of students' critical thinking skills through the use of PhET Simulation in a flipped classroom setting.

II. Materials and Methods

Methods The research method used is quasi-experimental. This research was carried out by involving two homogeneous classes, namely the control class with a conventional model and the experimental class assisted by PhET Simulation in a flipped classroom setting, as shown in Figure 1. The study was carried out in the even semester of 2020, in class VIII SMP Supra Talibura, by looking at critical thinking skills and students' responses to the use of PhET Simulation. Data from this study were obtained in the form of pretest and post-test, which were then analyzed using t and N-gain analysis with categories seen in table 1. While the response categories of participants used a response questionnaire with categories according to table 2 with four criteria, namely usefulness, ease of use, ease of use. in learning, and satisfaction were calculated using a percentage score.

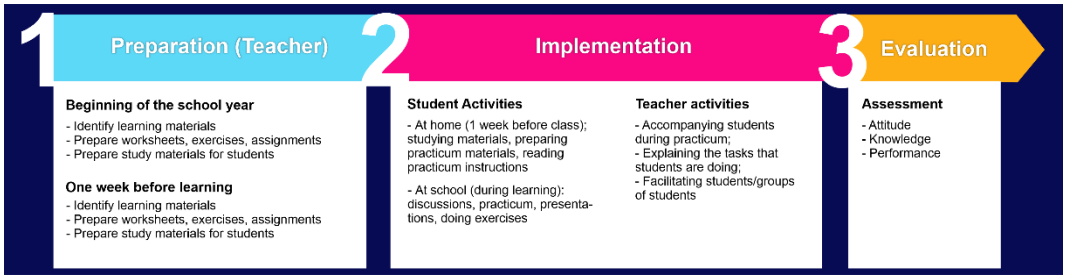

Figure 1. Setting flipped classroom

Teble 1. N-gainscore Category

Presentase	Caterogy
N-gain ≥0,7	High
0,7> N-gain>0,3	Medium
N-gain ≤0,3	Low

Table 2. Percentage Value Category

No	Percentage of interval limit	Rating Category
1	0-20%	Very low
2	21-40%	Low
3	41-60%	Medium
4	61-80%	High
5	81-100%	Very High

While examples of critical thinking questions are presented in Figure 2. This instrument can be used to measure critical thinking skills

Soal bagian B : Untuk soal no. 11 sampai 20 pilihlah
A. Bila jawaban no 1,2,3 benar
B. Bila 1 dan 3 benar
C. Bila 2 dan 4 benar
D. Bila hanya ada satu jawaban yang benar
E. Bila semua jawaban benar

11. Kajian tentang medan gravitasi merupakan rumusan banyak Ahli Fisika, selanjutnya Newton dapat merumuskannya dengan sangat baik, ahli fisika berikut ini yang banyak memberikan sumbaangan pemikirannya adalah ….
    1. Copernicus
    2. Galileo
    3. Keppler
    4. Einstein

12. Hukum yang berlaku pada kajian medan gravitasi tampak jelas dan mudah dipelajari pada gejala intetraksi antara benda di alam semesta yang berupa....
    1. benda sangat besar dan berat
    2. benda makroskopis
    3. benda benda di ruang angkasa
    4. bumi dan bulan

13. Interaksi antara bumi dan bulan dapat menghasilkan gaya tarik menarik dengan munculnya peredaran bulan terhadap bumi, interaksi ini …..
    1. berbanding lurus dengan massa bumi dan bulan
    2. berbanding terbalik dengan kuadrat jarak antara bumi dan bulan
    3. menghasilkan besaran gaya yang bertanda positif
    4. menghasilkan gerak melingkar dari bulan terhapap bumi

Figure 2. Example of critical thinking questions

Completely the research flow is presented in Figure 3.

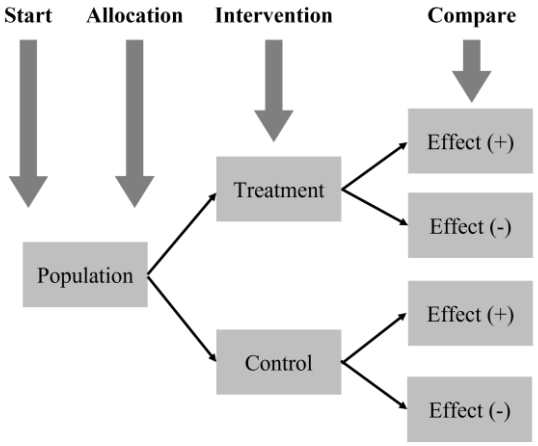

Figure 3. Research flow

III. Results and Discussion

The results of this research are statistically described in table 3.

Table 3. Statistical Description Results

	N	Mean		Std. Deviation	Variance
	Statistics	Statistics	Std. Error	Statistic	Statistic
Control Class Pretest	25	51.40	1.290	6.449	41.583
Control Class Posttest	25	63.44	1.899	9.496	90.173
Experimental Class Pretest	25	52.04	1.301	6.503	42.290
Experimental Class Posttest	25	70.64	2.029	10.144	102.907
Valid N (listwise)	25				

Below is a comparison chart for students' critical thinking skills control class and experimental class in Figure 4.

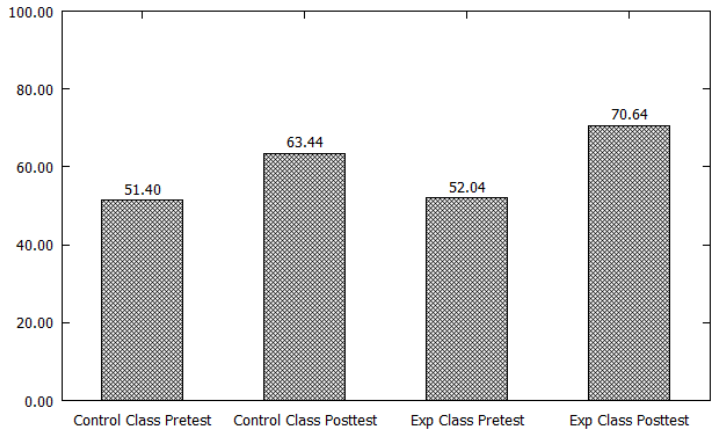

Figure 4. Graph the difference in the average pretest post-test between the control and experimental classes.

Subsequently, a hypothesis test was conducted to see the success of the application of PhET media by showing a pre-requisite test. The pre-requisite tests carried out are the normality and homogeneity tests, which can be seen in table 4 and table 5. If the conditions are met, it can be continued at the hypothesis testing stage. Details are presented in table 6.

Table 4. Normality test

	Sig.	Description
Pretest Control Class	0,141	Distribution Normal
Postest Control Class	0,074	
Pretest Experimental Class	0,200*	
Postest Experimental Class	0,200*	

Table 5. Homogeneity Test

	Sig.	Description
Joining Class Pretest	0,957	Homogeneous
Joining Class Posttest	0,861	

Table 6. Independent Sample Test

		Sig. (2-tailed)	Description
Class Joining Posttest	Equal variances assumed	.013	Accepted
	Equal variances not assumed	.013	

while the N-gain calculation is presented in Table 7.

Table 7. The results of the calculation of the N-gain score

Class	VIII A (Control Class)	VIII B (Experimental class)
S pre	51.40	52.09
S post	63.44	70.64
Gain	0.24	0.40
Category	Low	Medium

The following graph compares the gain value of the control class and the experimental class, presented in Figure 5.

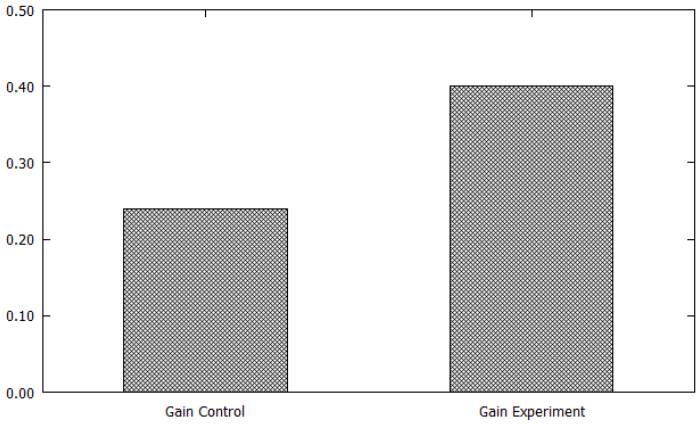

Figure 5. Graph of the N-gain value of the control and experimental class

After the learning was carried out, students were asked to Fill out the student response questionnaire sheet. The questionnaire data analysis of student responses to the PhET simulation is presented in table 8.

Table 8. Reliability Statistics

Cronbach's Alpha	Standard	Criteria
0.7	0.6	Reliable

The following is a graph of student responses after using PhET Simulation in Figure 6.

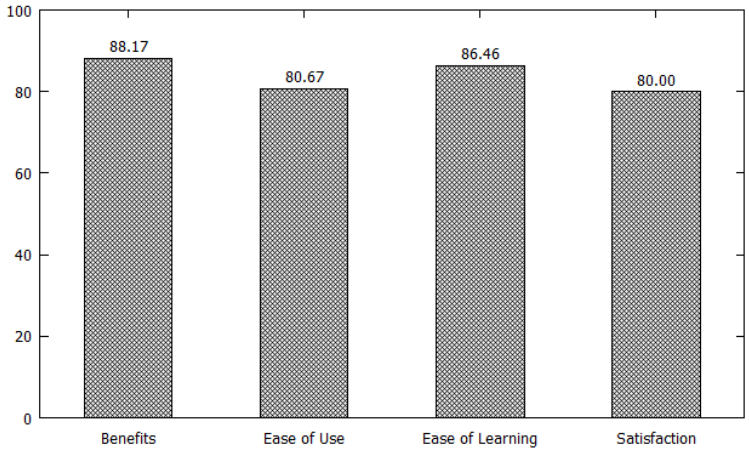

Figure 6. Graph of student acceptance after using PhET Simulation

This research was conducted face-to-face three times. The first meeting was held in the experimental class, class VIIIB, using the flipped Classroom and the comparison class with the conventional model. At this meeting, the researcher conveyed the learning objectives and conducted a pretest (pretest) to determine the students' critical thinking skills. Before the test started, the researcher gave directions to the students to work on the test questions. Then share learning videos as material for the next meeting. The application of Flipped classrooms in the learning process positively influences students. It can be seen from students' initial introduction to the material on the day the learning begins. This influence appears when given apperception before learning. Students can respond well because the initial material has been provided before the class starts in learning videos, compared to conventional courses (without flipped Classroom). These results are following research [20,21,22].

At the second meeting, students began to do learning using PhET according to the material distributed in the form of the previous video. Furthermore, at the third meeting, the researchers gave a final test (post-test) to students to determine whether there was an increase in students' critical thinking skills and distributed response questionnaires to students. Based on table 2, it can be seen that the average value of the control class pretest is 51.40 with a standard deviation of 6.449, and the post-test average value is 63.44 with a standard deviation of 9.496. Meanwhile, the average value of the experimental class was 52.04 with a standard deviation of 6.503 and an average post-test 70.64 with a standard deviation of 10.144. So based on the graph in Figure 3, the average value of the pretest shows that the average between the experimental class and the control class shows that these two classes have almost the same abilities. However, the experimental class showed a superior value after being given treatment. These results are also reinforced by the results of hypothesis testing and gains. Based on the calculation data, the results of the t show that the results of students' thinking skills increase with the value of sig. < 0.05. While the comparison of the gain value of the control class in the low category compared to the experimental class in the medium category.

Furthermore, the calculation of the response questionnaire to the use of PhET Simulation is 84%, according to Figure 6. Based on the interpretation of the questionnaire results, the responses are included in the very high category. The following shows the activities of students in Figure 7.

Figure 7. Student Activities

IV. Conclusions

The results showed that PhET Simulation in a flipped classroom setting could improve students' critical thinking skills. This improvement is indicated by the results of using the independent sample t-test. There is a significant effect on the students' essential thinking results, as seen from the significance value of less than 0.05. So it can be concluded that there is an increase in students' critical thinking results using PhET Simulation. The acceptance of student responses is very high, at 84%. These results show that students feel happy and interested in using PhET simulation.

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