
The effect of PhET simulation communication media on students' critical thinking skills on elementary school class V electrical circuit material

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Abstract

The learning process is the most important stage because at this stage there is direct interaction between teachers, students, and learning materials, which aims to transfer knowledge, build skills, and develop attitudes and values. However, the learning process can be hampered due to the lack of learning media that attracts students' attention. The existence of additional interactive learning media makes learning more interesting and fun, so that students can be active in learning. This study uses a quasi-experimental method with a nonequivalent control group design involving an experimental class with PhET simulation learning media and a control class using conventional learning without physical tools. The population taken was 56 students from two different classes. The instruments used include a multiple-choice test based on critical thinking indicators, according to Robert Ennis. To determine the significance of the difference between the two groups, the data were analyzed using a T-test. The results showed that, compared to conventional learning media, PhET simulation learning media had a significant influence on students' critical thinking skills. This is shown by better posttest results for students in the experimental class compared to the control class. In addition, students in the experimental class are more active in group discussions and are able to identify and explain the concept of electrical circuits critically. The conclusion of this study is that PhET simulation media is effective in improving students' critical thinking skills in electrical circuit learning in elementary schools. This media can be an innovative alternative in improving the quality of science learning.

Keywords: learning media; PhET simulation; critical thinking skills

INTRODUCTION

The digital era in education presents challenges as well as great opportunities in the world of education. In the midst of rapid technological developments, innovation in the learning process is important in improving the quality of education. One of the innovations that is developing is the use of interactive learning media, such as PhET simulations. This medium provides an exciting new way to understand science concepts visually and deeply. Rizal *et al.* (2016) and Nurfadhillah (2021) stated that learning media is a tool used by teachers as communicators to convey material to students as communicators, which facilitates communication in the learning process.

PhET "simulation" is an interactive multimedia that aims to assist students in learning science process skills through animation, static images, videos, and simulations that allow students to interact directly with the subject matter. Although the PhET was originally developed for learning physics, it has now been applied to a variety of other disciplines such as mathematics, biology, chemistry, and earth sciences (Verawati & Sukaisih, 2021).

One of the topics taught through this medium is electrical circuit material, which is part of physics learning that is usually taught at the elementary school level. This material covers

the basic concept of electricity, circuit components, types of circuits, and how electrical circuits work (Handayani *et al.*, 2020). At the elementary school level, the electrical circuit is found in the science subject, which is a new idea in the Independent Curriculum combined between Natural Sciences and Social Sciences, to develop students' potential, increase curiosity, as well as research skills, creativity, activeness, care, and understanding of science concepts. In this context, technology-based learning such as PhET simulations can play an important role in helping students understand theory while practicing critical thinking skills that are so much needed in the 21st century. Mahrannisya (2023) states that 21st century learning refers to an educational approach that focuses on skills that are relevant to the modern era, where technology and information are rapidly evolving (Wanti & Chastanti, 2023).

One of the essential skills that students must master in the digital age is critical thinking skills, which are defined as the ability to think logically and rationally in making decisions in situations that require in-depth analysis. However, while these critical thinking skills are essential, there are still many challenges in developing these skills among elementary school students, especially in abstract materials such as electrical circuits (Tumanggor, 2021).

Previous research has shown a positive effect on the use of simulation-based learning media on students' critical thinking skills, but there are still few studies that examine the application of PhET simulation media to electrical circuit materials in grade V of elementary school. The focus of this study is to measure the influence of the use of PhET Simulation on the improvement of students' critical thinking skills in learning electrical circuit materials. This research aims to identify whether simulation-based learning media can be a solution in improving students' critical thinking skills, as a step towards more innovative and meaningful learning. This research will focus on the role of interactive learning media and critical thinking skills. This research is expected to contribute to the development of more effective learning in the digital era.

METHODS

This study uses a quantitative approach with an experimental method. Mustafa *et al.* (2022) say that the experimental method is a research design that tests hypotheses with high accuracy and precision. The method used is to use quasi experimental with nonequivalent control group design, namely the researcher involves two classes, one experimental class, which is the class that receives treatment, while the control class does not receive treatment.

Table 1. Pretest and Posttest Nonequivalent Control Group Design Results

Group	Pretest	Treatment	Posttest
Experiment	O1	PhET simulation learning media	O2
Control	O1	Conventional Learning Media	O2

This study involved all grade V students at SD Negeri Pasar, which totaled 56 students. The research sample was taken with a saturated sample, meaning that the entire population was involved in the study. The number of students in the control class (VA) was 28 and the students in the experimental class (VB) were 28 students. The research instruments applied were tests (pretest and posttest) with Robert Ennis' critical thinking indicators to evaluate students'

understanding as well as observation sheets of student activities and teachers' teaching skills to see if there were differences that could affect the two classes. The data obtained from the pretest and posttest will be analyzed using IBM SPSS Statistics version 20 software, with the T-test using an independent samples test to determine if there is a difference between the results of the control class and the experimental class posttest. If there is a difference, then the significance value < 0.05 . In addition, the researcher also analyzed the observation sheets to see the differences between the two classes.

RESULT AND DISCUSSION

The research was carried out at SD Negeri Pasar which is located in Serang Regency, Banten. The research sample consisted of 56 students in grade V of SD Negeri Pasar which were divided into two classes, namely the experimental class (VA) with 28 students and the control class (VB) with 28 students. The research was conducted on November 19-22, 2024. The arrangement of activities carried out by the researcher was pretest, treatment, and posttest in the control class and the experimental class. The pretest is conducted to find out the extent of students' critical thinking skills on electrical circuit materials. Furthermore, treatment was carried out for the control class with conventional learning media, and the experimental class with PhET simulation learning media on electrical circuit material. After the treatment, the two classes were given a posttest to find out if the students' critical thinking skills improved.

Results of Data Analysis of Critical Thinking Skills Test

The critical thinking skills test of students in the control class resulted in an average pretest score of 40 and a posttest of 60. Meanwhile, the average result in the experimental class received a pretest score of 38.21 and a posttest score of 74.29. Figure 1 shows the average value of the pretest and posttest results in the control class and the experimental class.

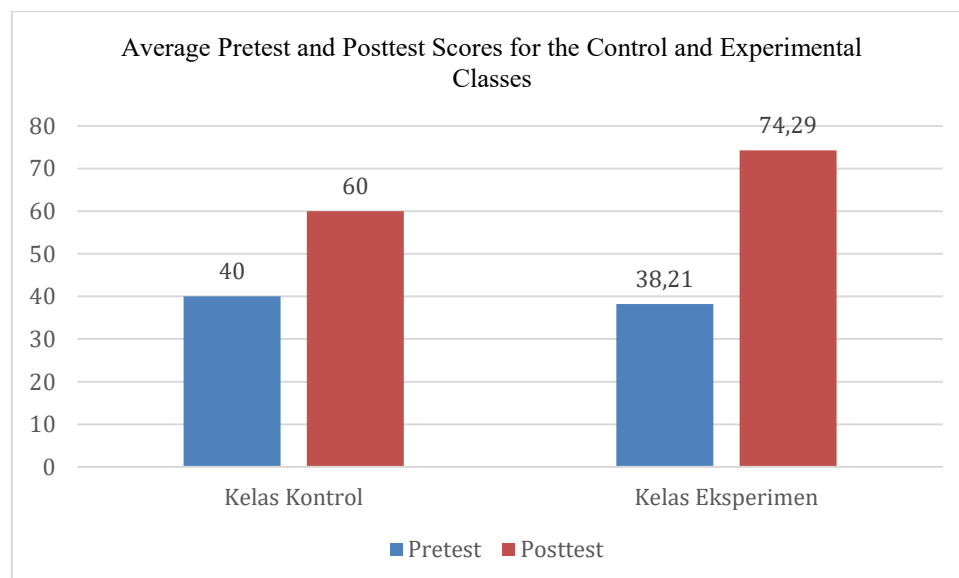


Figure 1. Average Result Chart of Pretest and Posttest Scores of Control Class and Experimental Class

Results of Observation Sheet Data Analysis

In this study, observation sheets were used to compare student activities and teachers' teaching skills in the control class with conventional learning media and experimental classes using PhET simulation learning media. This observation sheet was obtained from the observers, namely each homeroom teacher from the control class and the experimental class. The results of the calculation from the observation of student activity observation in the control class and the experimental class are presented in Table 2.

Table 2. Results of Student Activity Observation

Class	Results of Student Activity Observation		Category
	Total Score	Percentage	
Control	44	92%	Very High
Experiment	46	96%	Very High

Table 2 shows that there is a difference in student activity between the control class and the experimental class. The control class got a score of 44 with a percentage of 92% in the Very High category, while the experimental class got a score of 46 with a percentage of 96% in the Very High category. Although the two classes received the same category, in the application of the PhET simulation, the scores in the experimental class were superior. Based on the results of the calculation from observations, teachers' teaching skills can be seen in the following table.

Table 3. Observation Results of Teachers' Teaching Skills

Class	Observation Results of Teachers' Teaching Skills		Category
	Total Score	Percentage	
Control	28	80%	Very High
Experiment	31	88%	Very High

The table above shows that the control class scored 28 with a percentage of 80% that was categorized as Very High, while the experimental class scored 31 with a percentage of 88% that was categorized as Very High. There was a difference between the control class and the experimental class even though it was a score difference of 4. But teachers' teaching skills in experimental classrooms are higher due to the use of PhET simulation learning media. This is in line with Wibowo *et al.* (2025), who stated that the use of PhET simulations has the potential to increase student activity and have a positive impact on students' academic scores.

The pretest and posttest results of the control class and the experimental class showed that the data was distributed normally. After the data is declared to be normally distributed, the researcher then conducts a homogeneity test and the results of the homogeneity test of the control class and experimental class data are declared Homogeneous. Then, after the data is normally distributed and homogeneous, the researcher conducts a T-test using an independent samples test with Levene's test on the posttest results of both classes. The following are the results of the T-test after the treatment.

Table 4. T-Test Results Independent Samples Test

		Independent Samples Test								
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
Critical Thinking Skills Test	Equal variances assumed	.143	.707	-4.033	54	.000	-14.286	3.542	-21.387	-7.184
	Equal variances not assumed			-4.033	53.503	.000	-14.286	3.542	-21.389	-7.183

Based on table 4, the results of the T-test data from the control class and the experimental class obtained a significance result of $0.000 < 0.05$. The statement indicates that H_0 is rejected and H_a is accepted, or that there is a difference in students' critical thinking skills between the control class and the experimental class. This statement is in line with Pramesti & Perdana (2024), if the value of Sig. (2-tailed) < 0.05 , then there is a difference between the control class and the experimental class. The existence of these differences indicates that when compared to conventional learning media in the control class, the PhET simulation learning media affects the critical thinking ability of students in the experimental class. This means that there is an influence of PhET simulation learning media on students' critical thinking skills in the experimental class compared to conventional learning media in the control class.

From the results of the analysis of the observation sheet, there was a difference in student activities and teachers' teaching skills between the control class and the experimental class. Student activities in the control class scored $92\% < 96\%$ of the experimental class. This is also in line with teachers' teaching skills with conventional learning media in the control class which scored $80\% < 88\%$ of the experimental class. This proves that PhET simulation learning media has an effect on student activities and teachers' teaching skills. Wibowo et al., (2025) also said that PhET simulations can affect activeness and increase student grades. With the PhET simulation, teachers can more easily convey electrical circuit material. In addition, students also become more actively involved in the learning process, such as group discussions and are able to identify and explain electrical circuit concepts critically.

CONCLUSION

From the results of the analysis and discussion, it can be concluded that several things can be concluded related to the influence of PhET simulation learning media on students' critical thinking skills in elementary school class V electrical circuit materials. First, the T-test results get a Sig. (2-tailed) value of 0.000, then based on the independent samples test criteria, if the Sig. (2-tailed) value < 0.05 , then H_0 is rejected and H_a is accepted. It can therefore be concluded that there is a difference in the students' critical thinking test between the control class and the experimental class. Second, the results of observation of the activities of 96% of the experimental class students $> 92\%$ of the control class. The results of observation of the teaching skills of the experimental class teachers were $88\% > 80\%$ of the control classes. Based

on the results of the T-test as well as the observation of student activities and teachers' teaching skills, it can be concluded that the PhET simulation media is effective in improving students' critical thinking skills in electrical circuit materials in elementary schools. This media can be an innovative alternative in improving the quality of science learning.

REFERENCES

- Handayani, A. S., Husni, N. L., Rumiasih, R., Sitompul, C. R., Soim, S., Nurdin, A., Suroso, S., Endri, J., & Nurhaida, N. (2020). Pemanfaatan aplikasi simulasi rangkaian listrik sebagai media pembelajaran fisika. *Aptekmas: Jurnal Pengabdian Kepada Masyarakat*, 3(2), 55-59. <https://dx.doi.org/10.36257/apts.vxix>
- Mahrurnisya, D. (2023). Keterampilan pembelajar di abad ke-21. *Jurnal Pendidikan Jompa Indonesia*, 2(1), 101-109.
- Mustafa, P. S., Gusdiyanto, H., Victoria, A., Masgumelar, N. K., Lestariningsih, N. D., . . . Romadhana, S. (2022). *Metodologi Penelitian Kuantitatif, Kualitatif, dan Penelitian Tindakan Kelas dalam Pendidikan Olahraga*. Insight Mediatama.
- Nurfadhillah, S. (2021). *Media Pembelajaran di Jenjang SD*. CV Jejak.
- Pramesti, A. H., & Perdana, P. I. (2024). Pengaruh PhET terhadap berpikir kritis materi matematika kelas IV SDN Banyuajuh 3. *ALENA: Journal of Elementary Education*, 2(2), 190-199.
- Rizal, S. U., Maharani, I. N., Ramadhan, M. N., Rizqiawan, D. W., Abdurachman, J., & Damayanti, D. (2016). *Media Pembelajaran*. CV. Nurani.
- Tumanggor, M. (2021). *Berpikir Kritis (Cara Jitu Menghadapi Tantangan Pembelajaran Abad 21)*. Gracias Logis Kreatif.
- Verawati, N. N. S. P., & Sukaisih, R. (2021). Keterampilan berpikir tingkat tinggi siswa dalam pembelajaran inkuiri dengan simulasi phet: studi pendahuluan. *Empiricism Journal*, 2(1), 40-46.
- Wanti, L., & Chastanti, I. (2023). Analysis of preparation in the independent curriculum implementation: case study on ipas learning. *BIO-INOVED: Jurnal Biologi-Inovasi Pendidikan*, 5(2), 250-258.
- Wibowo, A., Iwani, A., & Saporso, S. (2025). Penerapan media digital menggunakan aplikasi PhET untuk meningkatkan keaktifan siswa dan nilai akademik siswa dalam pembelajaran fisika kelas 11 di SMA Cita Hati Surabaya. *Ideguru: Jurnal Karya Ilmiah Guru*, 10(1), 126-133. <https://doi.org/10.51169/ideguru.v10i1.1292>