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The Effect of PhET Simulation-Assisted Project-Based Learning Model on Students' Creative Thinking Skills in Elasticity Materials

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Abstract: The problems in this study are related to project-based learning models, PhET simulations, and students' creative thinking skills in elasticity material. This research is experimental, with pretest and posttest control designs. The population in this study were all students of class XI IPA SMAN 1 Wanasaba East Lombok, while the sample was class XI IPA II as the experimental class and class IPA I as the control class; each class had 31 students, which was in accordance with the sampling technique used, namely purposive sampling. The experimental class uses a project-based learning model assisted by PhET simulations, while the control class uses a conventional learning model. The test instrument used is a description of four items on elasticity. The results of the pre-test data analysis of students' creative thinking skills in the experimental class and the control class were not much different. After being given the treatment, the average value of the post-test experimental class was 68.80, and the average value of the control class was 65.51. The results of the post-test t test showed a significance (2 tailed) smaller than 0.050, so it could be concluded that the PjBL model assisted by the PhET simulation had an effect on the creative thinking skills of students on elasticity material.

Keywords: Creative thinking skills; Elasticity; PhET simulation; Project based learning

Introduction

As we enter the fourth industrial revolution in the 21st century, high-tech products are taking over all human endeavors as if no human could exist without technology this demonstrates how quickly science and technology are evolving and that the consequences cannot be ignored but rather must be understood and dealt with (Fitrah et al., 2021). What we mean when we talk about creativity is the capacity to use one's imagination to come up with fresh solutions to issues, being creative means being able to tackle challenging problems or develop novel, intriguing approaches to everyday tasks (Supiadi et al., 2023).

Students' existing talents, especially their critical-thinking abilities, must be emphasized in the classroom in order to motivate them and assist them solve challenges in daily life (Rivalina, 2020). In order for learning to generate students who can think critically and creatively, students must not only be engaged in learning activities but also creative since creativity in learning can create novel scenarios that are engaging and fascinating to encourage student involvement (Kamsinah, 2022).

Higher-order thinking abilities, one of the life skills that every learner must possess, including creative thinking abilities (Fatimah et al., 2022). Thinking creatively is a cognitive process to establish new connections receiving, recollecting, offering critical analysis, and using outcomes in issue solving are just a few examples. Think creatively, which calls for patience and control Self, attentiveness, and mental activity are all included. Creative thinking skills are very important because this thinking process can produce innovative solutions to a problem (Purnasari et al., 2021).

Based on the results of interviews with physics subject teachers at SMAN 1 Wanasaba, East Lombok, learning in class has not yet implemented the 2013

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curriculum. Learning that is not student-centered results in students rarely sparking ideas when learning is in progress. The absence of innovations made by teachers in learning is a problem that must be resolved. The COVID-19 pandemic was the beginning of the problems faced by SMAN 1 Wansaba, East Lombok, with distance learning and the lack of practica both online and offline. Practicums can directly use materials found in everyday life or create virtual practicums using media, one of which is PhET simulation.

The solution that can be given to overcome the problems faced by SMAN 1 Wanasaba East Lombok is to replace the learning center from teacher-centered to student-centered. There are many learning models that can be used for this problem, one of which is project-based learning.

With the help of a project-based learning model, students can create and solve problems as part of a class assignment as a result, they gain knowledge of both conceptual ideas and scientific approaches to solving difficulties (Lumbantobing et al., 2022). With the help of this project, physics learning in class is no longer teacher-centered and instead emphasizes student involvement. Project-based learning can be used as a learning model to help students develop their planning, communication, problem-solving, and decision-making abilities (Nurhadiyati et al., 2020).

The project-based learning model will be very appropriate for use in learning, because in this model the teacher acts as a facilitator and students are required to be more active in learning, so that learning will be student centered, this is in accordance with the demands of K13. Activities carried out by students during learning using the PjBL model tend to collect information and use it to create a project (Hidayat, 2021). Grouping students in solving a project or task will train students' skills in planning, organizing and making regarding the issues of the task to be carried out, the person in charge of each task and the information gathering technique that will be presented (Vebrianto et al., 2021).

The application of this project-based learning model can be assisted by PhET virtual media, (figure 1) where students can create virtual projects to improve their creative thinking skills. Utilizing a virtual lab is a research-based activity that promotes inquiry and exploration using particular methods to find solutions to issues (Ardisa et al., 2022). According to Saputra (2020), PhET simulation is a teaching tool that contains certain content for virtual reality training simulations. Highlights the connection between practical phenomena and underlying knowledge, encourages interaction and constructivism, offers feedback, and creates a working environment (Nurjannah et al., 2021; Susilawati et al., 2021).

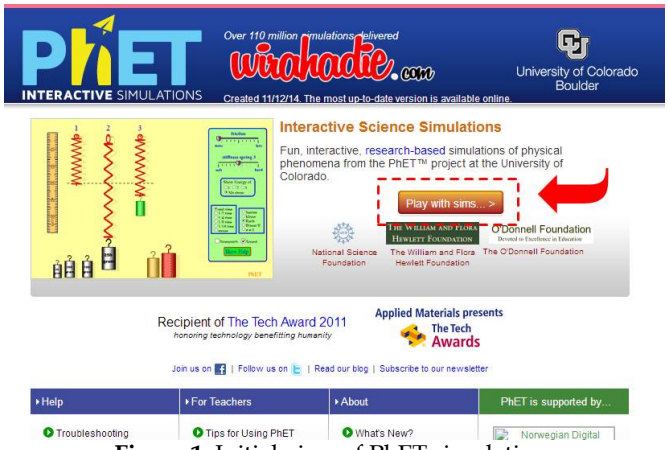

Figure 1. Initial view of PhET simulation

It is envisaged that using the project-based learning model in conjunction with PhET simulation can help students understand physics ideas better the ability of students to think critically will be affected by their increased understanding of physics ideas. Students really require thinking ability to overcome obstacles in life (Kurniawan et al., 2021).

Method

SMAN 1 Wanasaba, East Lombok, for the 2022–2023 academic year was the chosen place to conduct the research. The type of research used is called quasi-experimental research (quasi-experimental) because it is characterized by the presence of a control group and a treatment designed to change conditions. The research design used was the pretest-posttest control group design. This research requires two classes, namely the experimental class and the control class. The experimental class was given treatment, namely learning using the project-based learning model assisted by PhET simulations, while the control class used conventional learning. The research population was all XI IPA classes, where the class selected to be the experimental class was XI IPA 2, and the control class was XI IPA 1. The sample used was taken using a purposive sampling technique. According to Paramita et al. (2021), purposive sampling is a technique with certain considerations in accordance with the objectives or research problems.

The 4 item description questions become the test instrument that will be used in this study. Before the test instrument is used in research, it is first tested for validity, reliability, discriminatory power and level of difficulty first. The validity test aims to find out whether the instrument is valid or not (Kartini et al., 2019). The reliability test is a test that is used to find out whether an instrument can be said to be reliable or not (Rosita et al., 2021). The differential power test aims to distinguish individuals or groups who are able and unable (Widhiyani et al., 2019). The difficulty level test aims to

level the questions in terms of difficulty. After conducting the instrument test, questions that meet the criteria will be used for the pre-test and post-test. The next step is to carry out the prerequisite test, namely the normality test using the chi-square and homogeneity using the F test on the pre-test, then carry out the normality test, homogeneity and hypothesis testing on the post-test, the test carried out to test the hypothesis is the independent sample t test all the test was carried out with the help of SPSS 21.

The normality test aims to find out whether the data is normally distributed or not (Fahruddin et al., 2022). The homogeneity test was carried out to find the level of homogeneity of the two parties taken from the separate data group from one sample to test the homogeneity of the variance of the sample data (H. D. Lestari et al., 2020). Meanwhile, the hypothesis test aims to find out whether the hypothesis can be accepted or not (Purnabhakti et al., 2020).

Result and Discussion

The results of this study consist of the results of the analysis of instrument trials, analysis of pre-test and post-test for students' creative thinking skills, results of analysis of prerequisite tests (homogeneity test and normality test), and analysis of hypothesis testing.

Table 1. Instrument Test Results

Question	r_{tabel}	r_{xy}	r_{11}	df	dl	Information
X_1	0.3€	0.82	0.70	0.75	0.78	Accepted
X_2	0.36	0.95	0.70	0.82	0.50	Accepted
X_3	0.36	0.67	0.76	0.55	0.38	Accepted
X_4	0.36	0.67	0.67	0.67	0.62	Accepted

Based on Table 1, all valid and reliable questions are obtained, 2 good questions and 2 very good questions. This is concluded based on references from Purnasari (2021), 3 moderate questions and 1 easy question. This is taken from the opinion expressed by Hadi et al. (2019).

Before being given treatment the two classes were given a pre-test first, this aims to find out the initial abilities of the students (Doyan et al., 2020; Prihandoko et al., 2021). Before being given treatment to the two classes, a pre-test was given to both classes, which were then tested for normality and homogeneity, with the aim of knowing the initial abilities and whether the two classes had the same abilities.

Table 2. Pre-test Data Creative Thinking Skills

Decryption	Pre-test	
	Experiment	Control
The highest score	41.00	43.00
Lowest Value	13.00	13.00
Average	26.12	29.93
Normality test	Normal	Normal
Homogeneity Test		Homogeneous

Based on the normality test, the two samples are normally distributed and based on the homogeneity test that has been carried out, it can be seen that the samples come from a homogeneous population.

After giving the pre-test, the experimental class was given treatment by applying a project-based learning model assisted by a PhET simulation and the control class was given a conventional learning model. After the two classes are given treatment, then both classes will be given a post-test to determine the effect of the treatment given.

Table 3. Post-test Data Creative Thinking Skills

Decryption	Post-test	
	Experiment	Control
The highest score	100.00	100.00
Lowest Value	50.00	43.00
Average	68.80	65.51
Normality test	Normal	Normal
Homogeneity Test		Homogeneous

Based on the table 3, the experimental class and the control class experienced an increase in the results of creative thinking skills, the experimental class and the control class experienced an increase.

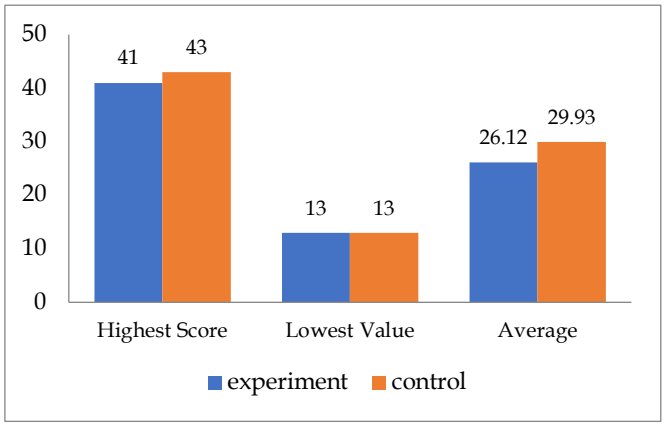

Figure 2. Pre-test data creative thinking skills

In Figure 2 it can be seen that the average score in the control class is higher than the experimental class, as well as in the highest score which has a difference of 2, this is because the two classes have not been given treatment and answered the instrument questions with their previous abilities.

In Figure 3 it can be seen that there was a very large increase in the experimental class and the control class, this could have happened due to the treatment given to the two classes, but the experimental class experienced a greater increase than the control class from the highest, lowest and highest scores. average.

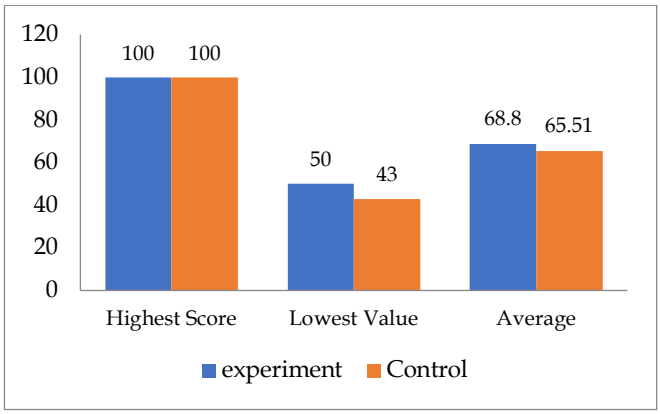

Figure. 3 Post-test data creative thinking skills

The data of the two samples were declared normal and homogeneous so that the t-test equation used was the independent sample T test. Based on the calculation results, it was found that the significance number (2 tailed) is 0.00 which means it is smaller than 0.05, this indicates that H_a is accepted, meaning that there is an influence of the project-based learning model assisted by PhET simulation on students' creative thinking skills. The results showed that the class that was given treatment with the PhET simulation-assisted project-based learning model had an influence on students' creative thinking skills and the class that applied the project-based learning model got better grades than the class that used the conventional learning model.

The project-based learning model is a learning model that inspires students to have the courage to express knowledge in making projects and share information with other friends in discussing learning material so that the learning atmosphere will be more effective through group collaboration. The project-based learning model also requires students to be more active in class, the activeness of students in class has an impact on students' creative thinking skills, this is evidenced in the results of the final test, classes that apply learning with project-based learning models get higher scores than in the class that is given treatment in the form of learning with conventional models (Ihsani et al., 2020).

The application of the project-based learning model assisted by PhET simulations in the classroom not only improves students' creative thinking skills, but can also train students to work together, this is in line with the syntax of the project-based learning model itself. The use of PhET media as a tool in making projects is also felt to be very effective, because students are more enthusiastic about something virtual-based besides that students can also try to do experiments without having to bother carrying or buying practicum tools, just with a cell phone or PC, they have can practice wherever and whenever (Susilawati et al., 2022).

Learning that involves students in carrying out an experiment can have an impact on student creativity, this is supported by research conducted by Lestari et al. (2021) concluding that the application of the project based learning model assisted by PhET simulations has a good impact on creativity or creative thinking. Another study conducted by Rosmiati et al. (2022) states that the application of a project-based learning model assisted by a PhET simulation can improve students' high-level thinking skills in physics subjects, where the results of class interpretations that apply project-based learning models are at moderate interpretation, whereas the class that applies conventional learning is at a low interpretation. This is due to the advantages of the project-based learning model which involves students in a complex real world that allows students to define issues or problems that are meaningful to them.

Conclusion

Based on the results of the research and discussion, it can be concluded that there is an influence of the PhET simulation-assisted project based learning model on students' creative thinking skills in the material of elasticity.

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Conceptualization: Aris Doyan, data curation: Dian Faisal Hadi, funding acquisition: Aris Doyan methodology: Aris Doyan, visualization: Dian Faisal Hadi, writing–original draft: Aris Doyan, Jannatin 'Ardhuha, writing–review & editing: Aris Doyan, Jannatin 'Ardhuha.

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Conflicts of Interest
No Conflicts of interest.

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