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The Effectiveness of Guided Inquiry-Based on Nuclear Physics Learning Devices with PhET Media to Increase Student Creativity

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Abstract: This study aims to test the effectiveness of developing core physics learning tools using an inquiry model with the help of PhET media in increasing student creativity. The development of the learning device uses a 4D model consisting of define, design, develop and disseminate. The sample of this research is all undergraduate students who take nuclear physics courses, totaling 50 people. The sample consisted of two classes, namely class A as the experimental class and class B as the control class. The pre-test and post-test data were analyzed using the t-test at a significant level of 5%, while the increase in student creativity was analyzed using the N-gain test. The results of the t-test show that the t-count value is greater than the t-table, which means that the nuclear physics learning device using an inquiry model with the help of PhET media affects student creativity. The results of the N-gain analysis show that the experimental class is in the high category, while the control class is in the medium and low category. These results indicate that the use of nuclear physics learning tools using an inquiry model with the help of PhET media is effective in increasing student creativity.

Keywords: Guided inquiry model; core physics learning; creativity; PhET.

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Introduction

Physics is a part of science that is organized based on natural phenomena, facts, thoughts, and experiments (Kanginan, 2016). Natural phenomena and non-living objects are objects of study in physics learning so that some concepts are abstract and difficult for students to understand (Kusdiastuti et al., 2017). This is no exception for core physics material which is rich in abstract concepts so that the material is quite difficult for students to understand. Therefore, an alternative is needed so that the learning process can be following the actual goal (Khasanah et al., 2019).

The rapid development of the world of technology and information can provide an alternative for educators to use various learning media (Istiqamah et al, 2016; Rahayu et al., 2017; Kartini et al., 2019). One of the learning media in question is Physics Education and Technology (PhET) (Ekawati et al., 2015; Susilawati et al., 2019). The PhET media can help students understand core physics concepts, most of which are abstract. The PhET simulation media was developed to help students understand concepts of visual physics using dynamic graphics that can explicitly animate the visual and conceptual models used by expert physicists (Susilawati et al., 2019). This simulation will be more effective if applied with an inquiry learning approach because it can facilitate students to learn independently to increase creativity (Lewa et al., 2018).

Inquiry learning can involve students making observations, measurements, hypotheses, interpretations, building theories, planning investigations, experiments, and reflections. So that the PhET simulation can be used by students to help find

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or clarify the concepts being studied through an inquiry learning approach. Several studies on the use of PhET simulations in learning can increase students' creativity as carried out by (Astutik et al., 2018; Rizkiana et al., 2020) resulting that the use of PhET simulations in learning can increase students' creativity, especially in physics material that seems abstract. Based on this description, it is necessary to conduct research using an inquiry model combined with PhET media so that students' creativity can increase.

Method

The development of core physics learning tools using an inquiry model with the help of PhET virtual media is carried out using a 4D model design. The development stages using a 4D model consist of define, design, develop and disseminate (Fraenkel et al., 2012). The sample of this research is all undergraduate students who take core physics courses, totaling 50 people. The sample consisted of 2 classes, namely class A as the experimental class and class B as the control class. The data obtained from this study were in the form of pre-test and post-test data with a total of 10 questions for creativity tests. The pre-test and post-test data were analyzed using the t-test at a significance level of 5%. The increase in student creativity was analyzed using the N-gain test (equation 1) (Doyan et al, 2020), with the provisions that the categories were low (N-gain < 0.30), medium (0.70 > N-gain 0.30), and high (N-gain > 0.70) (Doyan et al., 2020). The data obtained in this study were analyzed using equation 1:

$$\text{N} - \text{gain} = \frac{S_{post} - S_{pre}}{S_{max} - S_{min}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

Result and Discussion

The core physics learning device using an inquiry model with the help of PhET virtual media was developed using a 4D model design which includes four stages, namely define, design, develop and disseminate. The purpose of developing the device is to determine the effectiveness of the device to increase student creativity. The learning tools that have been developed are tested for their effectiveness on 50 undergraduate students taking core physics courses. As for the data obtained in the form of data from the creativity of students.

The analysis of student creativity in this article consists of an analysis of each indicator of student creativity and each sub-material. The first analysis is the analysis of each indicator of student creativity. These creativity indicators include Fluency, Flexibility, and Originality. Table 1 shows the results of the t-test for each indicator of creativity. These results indicate that the value of the t-table is smaller than the t-count. This means that the use of these devices affects the creativity of students.

Table 1. T-test Results for Each Indicator of Creativity.

No	Indicator of Creativity	t-count	t-table
1	Fluency	2.23	
2	Flexibility	5.77	1.67
3	Originality	2.45	

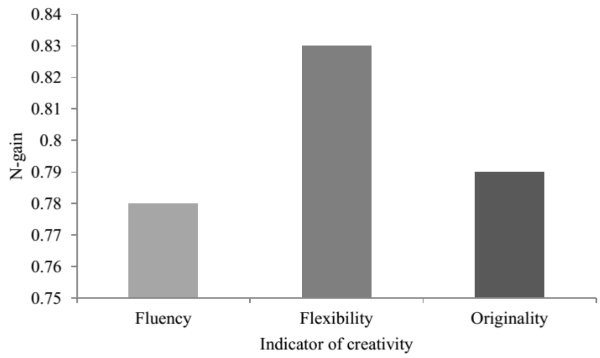

Figure 1. Comparison of the N-gain value of each creativity indicator (experimental class).

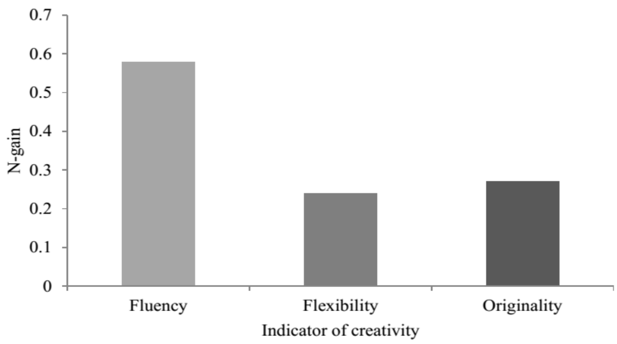

Figure 2. Comparison of the N-gain value of each creativity indicator (control class).

The data on the increase in the value of student creativity (N-gain) for each creativity indicator are shown in Figures 1 and 2. Figure 1 shows that for the experimental class, the N-gain value is obtained with a high category on all creativity indicators. While the control class (Figure 2), the N-gain score is in the medium category obtained on the fluency indicator, while the indicators, flexibility, and originality are in the low category.

The second analysis is the analysis of each sub-material. Table 2 shows the results of the t-test for each sub-material. These results indicate that the value of the t-table is smaller than the t-count. This means that the use of these devices affects the creativity of students (Ramlee et al, 2019; Susilawati et al., 2019).

Table 2. T-test results for each sub-material.

No	Sub-Material	t-count	t-table
1	Atomic Nucleus	10.59	1.67
2	Radioactivity	7.93	
3	Radioactivity Decay	7.83	
4	Core Reaction	5.76	
5	Radiation Interaction	4.58	
6	Radiation Detector	3.22	

The data for increasing the value of student creativity (N-gain) for each sub is shown in Figures 3 and 4. Figure 3 shows that for the experimental class, the average N-gain value is above 0.70 in the atomic nucleus sub-materials, Radioactivity, Radioactivity Decay, Nuclear reactions, Radiation interaction, and Radiation detector. This shows that the increase in student creativity for the experimental class is in the high category. As for the control class (Figure 4), the N-gain value is below 0.30 (low category) in the sub-atomic nucleus, radioactivity, decay of radioactivity, and nuclear reaction. In the interaction sub-material of Radiation and Radiation Detector, the N-gain value is between 0.30 to 0.70 and is in the medium category. These results indicate that the increase in creativity in the experimental class that learns to use core physics learning tools with the PhET simulation-assisted inquiry model is better than the control class that learns without the use of these tools. These results are following research (Habibi et al, 2020; Rais et al., 2020; Verawati et al., 2020) which shows that the use of PhET virtual media can increase student creativity.

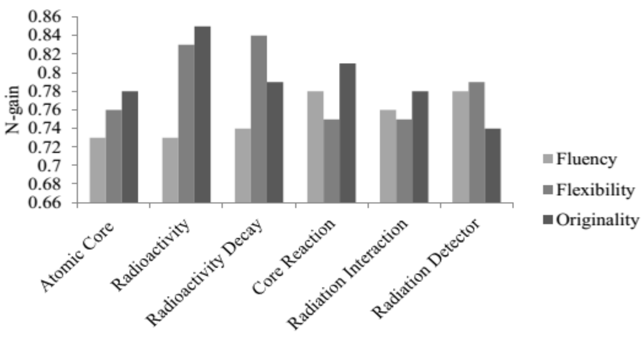

Figure 3. Comparison of the N-gain value of each sub material (experimental class).

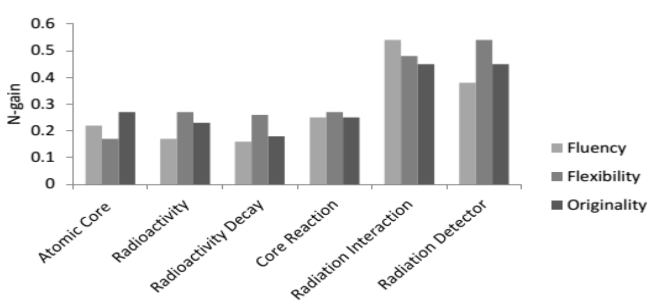

Figure 4. Comparison of the N-gain value of each sub material (control class).

Based on the results of the analysis that has been carried out, it shows that students who are taught using core physics learning tools using an inquiry model with the help of PhET virtual media have better creativity. This happens because the guided inquiry model encourages independent learning students to be actively involved in activities learning (Moore et al, 2014; Haryadi et al, 2020) and when they carry out learning through their own designed investigations, they will develop creative thinking skills to solve problems that arise (Rahmat et al, 2018). Similarly, according to (Bjønness et al, 2015; Yusnaeni et al, 2017), giving responsibility to students for independent learning, such as: what open inquiry class students do, will help them improve creative thinking skills.

Conclusion

Based on the results of the study, it can be concluded that nuclear physics learning tools using an inquiry model with the help of PhET virtual media can increase student creativity. This is indicated by the t-count value is higher than the t-table. In addition, the N-gain value of the experimental class is in the high category, while the control class is in the medium and low category.

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