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THE EFFECT OF PROBLEM-BASED LEARNING MODEL USING PHET SIMULATION ON PHYSICS STUDENT'S ACHIEVEMENT

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ABSTRACT

The purpose of this study is to determine the effect of a problem-based learning model supported by PhET Simulation media on student physics learning results. The type of study conducted was a design of quasi-experimental. The study design used was a posttest-only control design. Samples were selected from Class X Senior High School the study population for the 2021/2022 school year, using a targeted technique of sampling. XI 1 class as the experimental class and XI 2 as the control class. The data collection instrument used is a test instrument. The analysis of data techniques used are descriptive statistical analysis the tes are, normality, homogeneity, and U test (Mann-Whitney). From the analysis of the research data, it was found that in the competence of knowledge the results of testing the hypothesis obtained z_{count} = 7.245 and z_{table} = 1.96. On the attitude competency results z_{count} = 7.257 and z_{table} = 1.96. And on the competency skills results z_{count} = 5.066 and z_{table} = 1.96. The results of testing the hypothesis obtained values according to the criteria for rejecting Ho, namely rejecting Ho if $z_{count} < -z_{table}$ or $z_{count} > z_{table}$. The conclusion that the effect of problem based-learning model using PhET Simulation on phisics student's achievment.

Keywords : Problem-Based Learning Model, PhET, and learning results.

I. INTRODUCTION

To achieve the aims of education, the Indonesian government has issued several policies to train 21st Century skills to boost the quality of education in Indonesia, including improving the education curriculum from KTSP 2006 to Curriculum 2013. The curriculum is expected to produce a quality generation with the integrated strengthening of knowledge, skills, and attitudes [1]. Improvements to the 2013 Curriculum continue to be pursued. So the 2013 Curriculum was revised in 2017, which contains several important points as the main objectives of the government, namely Strengthening Education of Character, 4C skills (creative, critical thinking, communicative, and collaborative), literacy, and Higher Order Thinking Skills (HOTs) [2]. The application of 4C skills in 2013 curriculum learning will have a remarkable impact on the nation's next generation in facing the challenges of 21st-century life. In the 21st century, developments in the field of Science and Technology ("IPTEK") especially in the field of education, it is increasing rapidly and now is the age of knowledge. Learning activities should be tailored to the needs of the knowledge period. Materials should also offer a more authentic design that encourages students to work together to find solutions to their learning problems. [3].

Problem-Based learning are a strategies where students learn through applicable problems related to real life. Then learners directed to solve their problems were being discussed through a series the systematic learning [4]. Problem Based Learning provides students with the opportunity to be more fully involved and assume greater responsibility for learning. In line with the previous statemen[5], [6] . The function of the model Problem-Based Learning will be maximized if collaborated with the use of medium learning both in the form of simple and

technology-based media. The media used in this research is the PhET[7]. Student worksheets is a worksheet containing guidelines for students to carry out activities that reflect the process of science ("KPS") so that students gain the knowledge and skills they need to master. Student worksheets (LKPD) is one of the learning media. Student worksheets can be used simultaneously with other learning resources or learning media [8]. One type of virtual laboratory developed today is PhET (Physics Education Technology). PhET simulations are moving images or interactive animations made like a game where students can learn by exploring. The simulations emphasize the correspondence between natural phenomena and computer simulations and present them in conceptual physical models that are easy for learners to understand [9]. PhET Simulation has advantages, among others. It has an attractive animation display, is easy to operate, is free to download, and can adjust laptop / PC. The simulation package download, java, and flash works online or offline and presents physical models that are easy for students to understand [10]. Teachers will observe students' understanding through learning results during the process of learning. From the learning results, it is possible to see the success of teachers in teaching their students. Learning results provide evidence of student's ability to get tested at the end of a lesson by assessing knowledge, attitudes, and skills in students with behavioral changes. The results of a learner's formative and summative assessment are not compared with the results of other learners but are compared with the mastery of the specified competencies. The competency set is the minimum learning completeness[11][12].

Learning outcomes can also be described as a series of evaluations of the learning process. Tests are used as an efficient method to evaluate learning outcomes which are very important for evaluation. Evaluation can reveal learning outcomes, which can be used to determine student learning outcomes after learning. Based on previous observations, students often experience difficulties in understanding physics material during the learning process. Students may become accustomed to being passive as a result. Therefore, we need a learning model that places students as the center of learning activities. Teachers are expected to improve student learning outcomes and self-efficacy by utilizing this criterion-based model.

The part of science is Physics a that deals with identifying the most principles of fundamental. It has many abstract concepts that are difficult for students to understand [13]. One of the physics materials is static fluid. Fluid is a substance that can flow. The term fluid is used for both liquids and gases. The difference between liquids and gases lies mainly in their compressibility. Gas is compressible, while the liquid is incompressible. A liquid has a fixed volume, but its shape changes according to its container, while gas has neither a reparied shape nor volume. Static fluids have density, pressure, hydrostatic pressure, Pascal's principle, Archimedes's principle, viscosity, capillarity, and surface tension [14][15][16].

Based on the description above, the researcher observed that there was a need related to the learning model and was assisted by a PhET Simulation that could change student learning patterns to become more active in the learning process, so the researchers used a problem-based learning model using PhET Simulation media which was considered suitable as an alternative in research. This. Therefore, the purpose of this research is to find out the implications of using Physics Education Technology (PhET) simulations. So the research conducted was entitled entitled “the effect of problem based-learning model using PhET Simulation on phisics student’s achievment”

II. METHOD

The sort of studies performed is experimental studies. The purpose of experimental research is that treatment is provided to the unit under study. The experimental research method is used to seek the effect of treatment on others under controlled conditions [17]. The research used was a posttest-only control design. In this research design, there are two groups, each of which is randomly selected. (R) The research was conducted at Senior High School 6 Padang. The research was conducted in class X IPA Senior High School 6 Padang, registered in the second semester of the 2022/2023 school year. This research was conducted from September 20, 2022 to October 11, 2022 at Senior High School 6 Padang.

The population was all students in class X Senior High School 6 Padang divided into three classes. The sampling technique used a targeted sampling technique, with Class XI IPA 1 as the experimental class and the class XI IPA 2 as the control class. The experimental with the problem-based learning model using the PhET Simulation, and the control class received a scientific approach using the PhET Simulation. The study design is shown inTable 1.

Table 1. Posttest-Only Control Design

Groups	Treatment	*Posttest*
Experiment	X	O
Control	-	O

(Source: Ref [17])

Description:

X : The treatment given to the experimental group

O : *Posttest (final test)*

Data collection in this study was performed by a test method using a 40-question multiple-choice test selected according to instrumental test analysis criteria, including validity analysis, reliability, difficulty, and question differentiation—rice field. Post-tests are therefore intended to determine a student's learning results after a learning activity on a particular topic. Data analysis of results after testing knowledge, attitudes, and skills includes normality testing, homogeneity testing, and hypothesis testing. Normality test is used to determine the normality of data to determine statistical tests in hypothesis testing. It is intended to determine whether two samples have constant variance. A hypothesis test will be conducted to determine the effect of her PhET-based problem-based learning model using PhET Simulation media on student learning results in physics.

III. RESULTS AND DISCUSSION

The research was organized at the Senior High School 6 Padang from 27 September 2022 to 11 October 2022. This study utilized two sample classes, the experimental and control classes. The experimental class was given treatment using the Problem-Based Learning learning model. In contrast, the control class was given treatment using a scientific approach, and both classes used PhET Simulation. The material used in this study is inert fluid material in class XI Senior High School 6 Padang. The researchers obtained data on learner competence for attitude, knowledge, and skill competence. The description of the data on each is explained as follows. Obtained the average value of attitude competence, knowledge competence and skill competence contained in the bar chart can be seen in Figure 2.

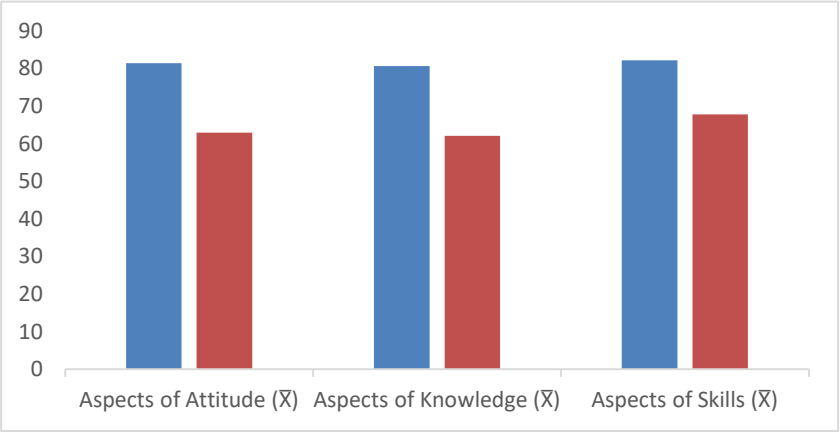

Fig 2. The Average Competency Score of the Two Sample Classes

Using Figure 2, the average performance of the two sample classes find out that the experimental class has average is higher than the other class average. To see if applying a problem-based learning model using PhET Simulation would work, we can confirm by testing the hypothesis. However, before testing hypotheses, we first perform normality and uniformity tests on attitudes, knowledge, and skill competencies.

1. Attitude Competency

The results of the assessment of skills and attitudes are carried out by the observation cards obtained during the learning process. The evaluation aspects are discipline, trust, courtesy, cooperation, responsibility and honesty. Description of attitude skills data of experimental, and control classes can be viewed in the table 2.

Table 2. Data on Attitude Competency of Experimental and Control Classes Attitude Competency

Class	N	$\bar{X}$	S	S^2	Normality Test	Homogeneity test	Hypothesis Test
Experimental	36	81,48	9,1	82,89	Not Normal	Homogen	Z_{count} >
Control	35	63,01	18,17	330,32	Not		

					Normal		z_{table}

Table 2 shows that the mean value ($\bar{X}$), standard deviation (S), and variance (S2) of students' attitude competency data for the experimental is 81.48 and the control is 63.01. Based on the data above, it shows that the average value from attitude competence of the experiment class is higher than that of the control class. The post-test results were then tested for normality using the Liliofors test, it was found that the data of both classes were abnormal. The results from test of homogeneity calculation obtained that both classes are homogeneous. This means that hypothesis testing using the U test is an alternative to the t test because the data does not meet parametric statistics so that the 5% significant level. Hypothesis testing using the U test (Mann-Whitney) Z_{count} is 7,257 and $Z_{\alpha/2}$ is 1.96. The price of z table can be seen in the Appendix. The criteria for rejecting Ho if $Z_{count} < -Z_{\alpha/2}$ or $Z_{count} > Z_{\alpha/2}$. In this study Z_{count} <-1.96 and Z_{count} > 1.96. The value of Z_{count} = 7,257 is in the Ho rejection area. Based on these results, H1 is accepted, meaning that there are a difference between the learning results of the two samples so that it can be said that the application of the Problem Based Learning model using PhET Simulation can affect the learning results of students' attitudes.

2. Knowledge Competency

The results of the assessment of skills obtained during the completion of the final exam (posttest). Researchers using writing tools form of multiple-choice questions can see up to 20 entries in the table 3.

Table 3. Data on Knowledge Competency of Experimental and Control Classes Attitude Competency

Class	N	$\bar{X}$	S	S^2	Normality Test	Homogeneity test	Hypothesis Test
Experimental	36	80,69	8,87	78,78	Not Normal	Homogen	Z_{count} > z_{table}
Control	35	62,14	9,01	81,3	Not Normal		

Table 3 shows that the mean value ($\bar{X}$), standard deviation (S), and variance (S2) of students' attitude competency data for the experimental class is 80.69 and the control class is 62.14. Based on the data above, it shows that the average value from attitude competence of the experimental class is higher than that of the control class. The post-test results were then tested for normality using the Liliofors test, it was found that the data of both classes were abnormal. The results from test of homogeneity calculation obtained that both classes are homogeneous. This means that hypothesis testing using the U test is an alternative to the t test because the data does not meet parametric statistics so that the 5% significant level. Hypothesis testing using the U test (Mann-Whitney). Z_{count} is 7,245 and $Z_{\alpha/2}$ is 1.96. The price of table can be seen in the Appendix. The criteria for rejecting Ho if $Z_{count} < -Z_{\alpha/2}$ or $Z_{count} > Z\alpha/2$. In this study Z_{count} <-1.96 and Z_{count}> 1.96. The value of Z_{count} = 7,245 is in the Ho rejection area. Based on these results, H1 is accepted, meaning that there are a difference between the learning results of the two samples so that it can be said that the application of the Problem Based Learning model using PhET Simulation can affect the learning results of students' knowledge competencies.

3. Skill Competency

The results of the assessment of the competence of the skills are carried out using the job performance rubric obtained on the basis of the results observed during the internship activities. The skill data obtained from the experience of the experimental class and the control class have the same results as the table 4.

Table 4. Data on Skill Competency of Experimental and Control Classes Attitude Competency

Class	N	$\bar{X}$	S	S^2	Normality Test	Homogeneity test	Hypothesis Test
Experimental	36	82,22	6,37	40,63	Not Normal	Homogen	Z_{count} > z_{table}
Control	35	67,80	22,49	505,84	Not Normal		

Table 4 shows that the mean value ($\bar{X}$), standard deviation (S), and variance (S2) of students' attitude competency data for the experimental class is 82.22 and the control class is 67.80. Based on the data above, it shows that the average value of the attitude competence of the experimental class is higher than that of the control class. The post-test results were then tested for normality using the Liliofors test, it was found that the data of both classes were abnormal. The results of the homogeneity test calculation obtained that both classes are homogeneous. This means that hypothesis testing using the U test is an alternative to the t test

because the data does not meet parametric statistics so that the 5% significant level. Hypothesis testing using the U test (Mann-Whitney) Z_{count} is 5,066 and $Z_{\alpha/2}$ is 1.96. The price of Z table can be seen in the Appendix. The criteria for rejecting Ho if $Z_{count} < -Z_{\alpha/2}$ or $Z_{count} > Z_{\alpha/2}$. In this study $Z_{count} < -1.96$ and $Z_{count} > 1.96$. The value of $Z_{count} = 5,066$ is in the Ho rejection area. Based on these results, H1 is accepted, meaning that there is a difference between the learning results of the two samples so that it can be said that the application of the Problem Based Learning model using PhET Simulation can affect the learning results of students' skills competencies.

The application of the Problem-Based Learning model in research has provided researchers with additional choices of learning models that can improve learning outcomes [18]. Providing unstructured problems serves as the basis for learning in PBL, which is recognized as the development of student-centred active learning[19]. Students benefit from integrating the Problem Based Learning learning model into the learning process. According to the Ministry of Education and Culture in 2013 [20]. The benefit of the problem-based learning model is that it will increase the meaning of learning.

To maximize the learning model can also be collaborated with learning media either in the form of simple media or technology-based. PhET is a medium that can be applied in learning physics simulation activities. the use of simulated Phet in student learning not only learns about formulas, numbers, and theory but also learns about collecting data, obtaining data, presenting data or studying graphs so that students can understand concepts and integrate existing knowledge [21]. This shows that the use of PhET Simulation in the physics learning process can help students improve learning outcomes. Through learning that makes students learn actively, creatively, effectively and fun [22].

In conducting this research, the class used was divided into two groups. The first group is the modeling class and the second group is the implementation class. From the results of data analysis it was stated that the results of the normality test indicated that the two sample classes were not normally distributed. this data is not normal. Usually, some values are too extreme, so the data becomes outliers. According to Sari et al, the cause of the data being abnormal is due to the many unusual events such as extreme data, data that follows a normal distribution, and other causes [23]. Data with extreme values are values that are too high or too low, which can cause the score distribution to be skewed to the left or right. For the homogeneity test in this study, the two sample classes had the same variance. Looking at the abnormality of the data, the U test (Mann-Whitney) is used to test the hypothesis. This study uses large data (> 20), so that the U test does not only look for U values and z values. From the U test conducted, the Z_{count} value is in the area of Ho rejection, so that H1 is accepted. From the results of research data analysis, it was stated that there were differences in student learning outcomes in knowledge competence between students who used the problem-based learning model and those who used the scientific approach model.

IV. CONCLUSION

based on the results of the calculation of student learning outcomes it is known that rejecting Ho and accepting H1, in which the use of a problem-based learning model using phet simulation gets a high score compared to using a scientific approach. It can be concluded *the effect of problem based-learning model using PhET Simulation on phisics student's achievment.*

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