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The Effect of Using a Virtual Laboratory on Students' Motivation and Learning Outcomes in Physics Learning

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Abstract – *The use of virtual laboratories in the physics learning process can bridge abstract material into concrete. This study aims to analyze the differences in motivation and learning outcomes of physics taught with and without using a virtual laboratory. This type of research uses a quasi-experimental with static group comparison design. The subjects of this study were physics students in the third semester at Tadris Physics study program, UIN Mataram. The results obtained for the learning motivation variable by comparing the values of t-count and t-table are t-count (3.03) > t-table (2.03). It means that there is a significant difference in learning motivation between students taught with and without virtual laboratories. Furthermore, the results obtained for the learning outcomes variable by comparing the values of t-value and t-table are t-value (4.90) > t-table (2.03). This means that there is a significant difference in learning outcomes between students taught with and without virtual laboratories. So, it can be concluded that the use of virtual laboratories has an effect on students' motivation and learning outcomes in physics.*

Keywords: *motivation; physics learning outcome; virtual laboratory*

I. INTRODUCTION

The development of science and technology encourages renewal efforts in the use of technological results in the teaching and learning process (Ismail et al., 2016; Sirait et al., 2017; Nurazmi & Bancong, 2021). The use of media in the physics learning process can bridge material that is abstract into concrete (Azmar & Nurhilaliati, 2021; Sudirman et al., 2020). One of the benefits of using computer-based media is that it can help the teacher's role in providing subject matter. By displaying subject matter through the help of application software programs in the teaching and learning process, teachers can display subject matter that is more interesting, effective, and efficient.

A virtual laboratory is a series of laboratory equipment in the form of interactive multimedia-based computer software that is operated with a computer and can simulate activities in the laboratory as if the user was in a real laboratory (Maksum & Saragih, 2020). In line with this, Saputra et al. (2021) revealed that the laboratory-based virtual practicum is a learning innovation that can be a solution during the Covid-19 pandemic. A virtual lab uses a computer program to simulate a series of experiments without physically doing them. It provides students with tools, material, and laboratory sets virtually on the computer to carry out experiments subjectively anytime and anywhere (Ismail et al., 2016). Pandemic conditions require learning to be done from home and are impossible to do face-to-face in a real laboratory (Nainggolan, 2014).

Learning outcomes are changes that occur in students both in cognitive, affective, and psychomotor aspects through learning activities (Chrisandi & Koeswati, 2019; Bancong & Putra, 2015). The cognitive domain with regard to intellectual learning outcomes consists of six aspects, namely knowledge, understanding, application, analysis, synthesis, and assessment. The affective domain with regard to attitudes and values includes five levels of ability, namely accepting, responding or reacting, assessing, organizing, and characterization of value. While the psychomotor domain includes motor skills, manipulation of objects, and neuromuscular coordination (connecting, observing). The cognitive learning outcomes are more dominant than affective and psychomotor because they are more prominent. However, psychomotor and affective must also be part of the assessment results in the learning process at school. The learning outcomes of students are influenced by internal factors and external factors. Internal factors include learning motivation, interest, attention to lessons, attitudes, student habits in learning, and perseverance in learning, while external factors include the socioeconomic status of parents and the environment around students' lives (Marisda, 2019).

According to Damanik (2019), motivation is a shift in a person's energy that is characterized by the emergence of feelings and preceded by a response to the existence of a goal. The indicator of learning motivation is described from two dimensions, namely internal and external dimensions. Internal dimensions are indicated by indicators: (a) having responsibilities in doing assignments, (b) carrying out tasks with clear targets, (c) having clear and challenging goals, (d) providing feedback on their learning outcomes, (e) having a feeling of pleasure in learning, (f) trying to outperform others, (g) prioritize the results of what is done, and (h) improving self-ability. Indicators indicate the external dimensions: (a) happy to get praise for what they do, (b) work with the hope of getting good grades, and (c) work with the hope of getting attention from friends and teachers (Astiani, 2019).

Several previous studies have implemented virtual laboratories in the learning process. For example, Bunyamin et al. (2021) explored the effectiveness of virtual laboratories to improve the competence and character of vocational students. The results of the study concluded that learning outcomes using virtual labs were better, especially in the implementation of practicum activities so as to make students understand abstract and complex concepts (Bunyamin et al., 2021). In their study, virtual laboratories were seen as effective in improving physics learning outcomes, especially in the psychomotor realm. Jaya (2012) also said that the use of virtual laboratories could improve students' competence in terms of cognitive and psychomotor. In addition, the use of virtual laboratories can also increase student motivation because virtual laboratories make it easier for students to provide virtually available tools and materials (Adi et al., 2016).

Based on the literature review, it can be concluded that the use of virtual laboratories can increase learning motivation and physics learning outcomes. Therefore, the objectives of this study were to analyze the level of students' learning motivation and learning outcomes of physics as well as the differences between students who were taught and without using a virtual laboratory at the Tadris physics study program, UIN Mataram.

II. METHODS

The type of research used is quasi-experimental research. In this study, two research dimensions were used: one class as an experimental class and another class as a comparison or control class. The experimental class was given treatment using a virtual laboratory, while the control class was not given treatment in the form of using a virtual laboratory. The design of this research is a static group comparison design. Static group design is a type of experiment in which the treatment group is given a post-test without a pretest, and subjects are not randomly assigned to the treatment group. The steps involved in the static group comparison design were as follows: (a) one group of subjects was given the experimental treatment and then post-tested, and (b) the other group of subjects was given the post-test only. Figure 1 shows the design of this study.

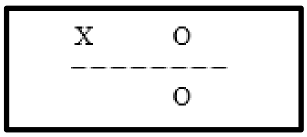

Figure 1. Static-group comparison design

The population in this study were all students of Tadris Physics UIN Mataram and the samples were 3rd-semester students who were taken by simple random sampling. One class was an experimental class taught using virtual laboratory media, and one class was a control class taught using presentation media. This technique uses the assumption that the population is homogeneous because, for the first time, the class determination of students has been randomized.

In order to avoid differences in perceptions regarding the definition of research variables, the operational definitions of the research variables are explained. The independent variable in this study is virtual laboratory learning. This is a tool used in teaching and learning activities, where the presentation of the material uses learning media in the form of simulations. Learning media uses a computer and is displayed on an LCD. The program (software) used is a PhET simulation, containing a combination of animation, text, and images packaged in an experimental simulation based on a design that has been programmed in a computer.

On the other hand, the dependent variable in this study is learning motivation and learning outcomes. Learning motivation is the entire psychic driving force that exists in individual students who can provide encouragement to learn in order to achieve the learning objectives. In this study, learning motivation can be shown through the answer scores on the questionnaire. The indicators of learning motivation in question include encouragement and needs in learning, a passionate and active attitude in learning, the ability of students to overcome learning obstacles, the urge to compete in learning with friends, and the desire to excel. In contrast, physics learning outcomes are scores obtained by students from giving physics tests after being taught with and without virtual laboratories, which only cover the cognitive domain: remembering (C1), understanding (C2), applying (C3), and analyzing (C4).

The data obtained were then analyzed using descriptive and inferential analysis. The descriptive analysis includes possible max. score, possible min. score, maximum score, minimum score, score range, average score, standard deviation, and variance. While inferential analysis uses a t-test to answer the research hypothesis. Before the t-test, the normality test and homogeneity test were first performed. The hypothesis of this study is that there are significant differences in learning motivation and physics learning outcomes between the group taught using a virtual laboratory and the group being taught without using a virtual laboratory.

III. RESULTS AND DISCUSSION

This stage discusses matters relating to data processing, hypothesis testing, and discussion based on the data obtained in accordance with the data collection techniques and procedures. The data processing includes descriptive analysis, normality and homogeneity testing of data, and hypothesis testing. The results of the descriptive analysis of the physics learning motivation of the experimental class and control class can be seen in Table 1.

Table 1. Description of students' physics learning motivation scores in the experiment class and control class

Score	Experiment class	Control class
Possible max. score	120	120
Possible min. score	24	24
Maximum score	109	112
Minimum score	76	82
Score range	33	30
Average score	86.97	85.38
Standard deviation	8.06	9.21

Based on Table 1, the experimental class learning motivation obtained an average score of 86.97 with a standard deviation of 8.06, and the range of the highest and lowest scores was 33. As for the learning motivation in the control class, the average score was 85.38, with a standard deviation was 9.21, and the range between the highest score and the lowest score was 30. The comparison of students' learning motivation scores in the experimental class and control class in each category can be seen in Figure 2.

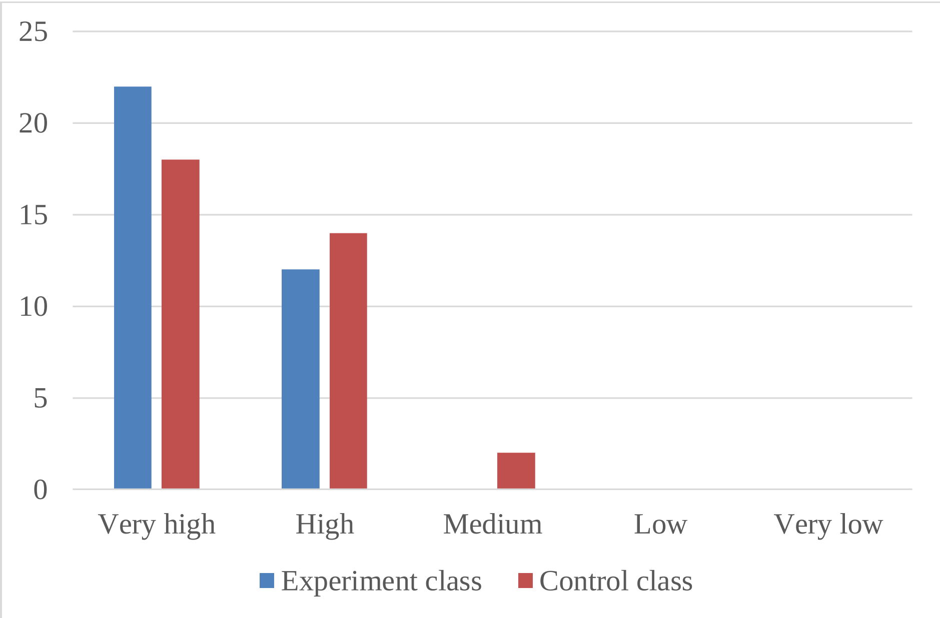

Figure 2. Percentage of students' learning motivation scores

As we can see in figure 2, the percentage of students in the experimental class is smaller than in the control class for the medium and high categories. Meanwhile, the percentage of students in the experimental class was greater than in the control class for the very high category. This shows that the average score of learning motivation in the experimental class is higher than the control class. Furthermore, the results of the descriptive analysis of the physics learning outcomes of the experimental class and control class students can be seen in Table 2.

Table 2. Description of students' physics learning outcomes scores in the experiment class and control class

Score	Experiment class	Control class
Possible max. score	33	33
Possible min. score	0	0
Maximum score	31.00	28.00
Minimum score	22.00	17.00
Score range	9	11
Average score	27.59	22.70
Standard deviation	4.77	4.99

Based on table 2, the average score of learning outcomes in the experimental class is 27.59 with a standard deviation of 4.77, and the range of the highest and lowest scores is 9. While the average score of learning outcomes in the control class is 22.70 with a standard deviation of 4.99, and the range of the highest and lowest scores is 11. The comparison of students' learning outcomes scores in the experimental class and control class in each category can be seen in Figure 3.

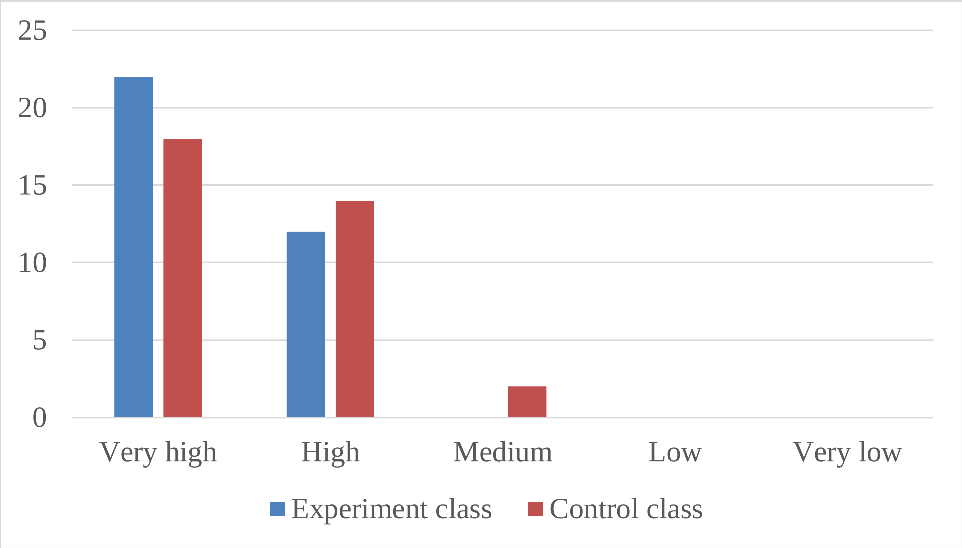

Figure 3. Percentage of students' learning outcomes scores

As shown in figure 3, the percentage of students in the experimental class is smaller than in the control class for the medium and high categories. Meanwhile, the percentage of students in the experimental class was greater than in the control class for the very high category. This indicates that the average score of the experimental class learning outcomes is higher than the control class.

Based on the results of the pre-requisite test, it was found that the data has been normally and homogenous distribution both on the physics learning outcomes and the student motivation in the third semester of Tadris Physics students at UIN Mataram. So, the next step is a parametric test. The hypothesis in this study was tested using a two-party test that was calculated manually. After comparing the values of T_{count} and T_{table}, it is found that $T_{count} > T_{table}$ (3.03 > 2.03) means that H_0 is rejected and H_1 is accepted. So it can be concluded that There is a significant difference in learning motivation between those taught with and without a virtual laboratory. This result is also the same in learning outcomes. After comparing the value of T_{count} and T_{table}, it is found that $T_{count} > T_{table}$ (4,90 > 2,03) means that H_0 is rejected and H_1 is accepted. So it can be concluded that there is a significant difference in physics learning outcomes between those taught with abd without a virtual laboratory.

Based on the results of descriptive and inferential analysis, it is known that there are significant differences difference in learning motivation and learning outcomes between those taught with and without a virtual laboratory. The difference in learning motivation scores and physics learning outcomes indicates that learning physics using a virtual laboratory has different results compared to learning physics using conventional learning models. This happened because the treatment was given to the experimental class and the control class was different.

The results of this study are in line with research conducted by Jaya (2012) that learning with a virtual laboratory makes learning activities more enjoyable. Students' interest in learning by using the virtual laboratory can increase students' enthusiasm for learning and make students more active so that it can help them understand the concepts. Another research also suggests that learning using virtual laboratories is well integrated in terms of analyzing problems so that students can come up with good reasoning ideas (Astiani, 2019).

Jaya (2013) also said that the use of virtual laboratories could improve students' competence in terms of cognitive and psychomotor. In addition, the use of virtual laboratories can also increase student motivation because virtual laboratories make it easier for students to provide virtually available tools and materials (Adi et al., 2016). The developed virtual laboratory model is proven to be able to increase the creativity of prospective physics teachers. We agree with what was stated by Supurwoko et al. (2017) and Putra (2015) that teachers can process abstract material into material that can be seen directly through computer-based animation. Especially in the realm of learning outcomes, virtual laboratories show favorable results both in the cognitive aspect and in the science laboratory environment (Maulidah & Prima, 2018). Budi et al. (2021) concluded that virtual technology laboratories provide a promising medium for educational researchers, especially in achieving student learning outcomes. Likewise, the study by Saputra et al. (2021) concluded that a virtual laboratory could be utilized as a learning solution during the Covid-19 pandemic.

IV. CONCLUSION AND SUGGESTION

Based on these results, it can be concluded that the use of a virtual laboratory in physics learning has a significant influence on learning motivation and learning outcomes for third-semester students in the tadris physics study program, UIN Mataram. Some suggestions for further research are that this study indicates that learning physics using a virtual laboratory can increase students' learning motivation and physics learning outcomes, so it is recommended for educators and schools to apply this learning. It is also hoped that future researchers will be able to develop and strengthen the results of this study by conducting further research.

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