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The Effect of Using Virtual Laboratory in Guided Inquiry Learning on Cognitive Learning Outcomes of Physics

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Abstract : *The cognitive learning outcomes of physics is an indicator of success in learning. To obtain good physics learning result, it needs combination of media and learning model which able to construct students understanding. The use of virtual laboratory in guided inquiry learning models aims to train students to discover concepts independently and construct their knowledge. This study aims to determine the effect of the use of virtual laboratory in guided inquiry learning model to the cognitive learning outcomes of physics students. This research is a quasi experimental research with posttest only control group design. The study involved 58 students divided into two groups, the experimental group and the control group. Data were analyzed using Anova one way test. The results showed that the students' cognitive learning outcomes differ significantly between the experimental group and the control group. It can be concluded that the use of virtual labs in guided inquiry learning model influences the students' cognitive learning outcomes.*

Keywords: *cognitive learning outcomes, guided inquiry model, virtual laboratory.*

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I. Introduction

Learning outcome in the cognitive domain is one of the indicators used to determine whether or not a learning goal is achieved by students. By looking at the results of learning, it is easy to know the ability and quality of each learner. Learning objectives can be achieved if learning activities lead students to gain scientific experiences. However, based on observation, it is found that the learning presented by the teacher is contrary to the way to achieve the learning objectives. Teachers have been more often inculcating the concepts of subject matter through the transfer of information and giving examples that tend to be memorized by students through the use of lecture methods that make teachers solely as information centers and students are given less freedom of thought, developing ideas and imagination, conducting independent learning activities, conducting investigations on facts, concepts, principles or theories of their findings in laboratory activities [3]. This causes the students find difficulties in understanding the concepts of physics and even students cannot form the correct conception and are not able to construct knowledge of the physics material, thus affecting the low learning outcomes of students especially in cognitive field C1 to C6.

Laboratory activities are considered very important to support students' understanding of the concepts of physics. [15] states that the psychological advantages of learning through laboratory activities are enriching the experience with objective, realistic, and eliminating verbalism, and the benefits of laboratory activities are to increase students' interests and learning activities and provide a more precise and clear understanding . But in practice, laboratory activities are not fully implemented. This is caused by the limited tools and laboratory materials that support the laboratory activities perfectly. In addition, laboratory activities cannot be fully implemented because learning through laboratory activities requires a fairly expensive lab tool, the use of practicum tools that are still not effective and technically takes longer time in experimental activities, as well as in the presentation of abstract physical concepts such as the concept of temperature and heat in the learning process is very difficult to visualize or display the process directly even through laboratory activities.

Those weaknesses create various innovations in learning especially in the field of physics. One of the innovations is the utilization of virtual laboratory as a medium in the learning process and in laboratory activities which development is adjusted with the concepts of physics to be conveyed to students. Through the virtual labs students get feedback through computers and activities can be repeated in accordance with the ability of students. The use of virtual laboratory with computer guides involves the user in activities that demand mental processes in learning. [4] suggests a number of forms of interaction that can be generated through computer media such as presentation of practices and exercises, tutorials, games, simulations, inventions, and troubleshooting. Utilization of virtual laboratory to support the implementation of practicum activities is expected to meet the achievement of the goals of physics learning.

The use of virtual laboratory in learning cannot be done well if it is not supported by learning models that can lead students in finding facts, concepts, principles or new theory. Inquiry learning model where the students guided by the teacher is a learning approach involving students in finding and using various sources of information to improve their understanding. This model is appropriate to be applied in physics learning as it has been facilitated by steps to develop basic scientific abilities that include observing, classifying, calculating, formulating hypotheses, designing experiments, measuring, collecting data, interpreting data, drawing conclusions, and communicating . [9] states that inquiry activities are not just answering questions and getting the right answers but also involving interest and challenging students to connect their world with education. Some research shows the influence of a combination of virtual labs and learning models. [7] which states that the use of inquiry-based virtual laboratory learning model influences students' learning outcomes compared to conventional learning models. In line with that [6] who states that the use of virtual laboratory affect the mastery of the concept and creative thinking skills of students. [5] states that the use of virtual labs affects the ability of problem solving students on electrical concepts.

II. method

This study is a quasi experimental research aimed to determine the effect of treatment on the dependent variable under controlled conditions [1].The research was conducted at SMAN 4 Mataram academic year 2017/2018. The populations of this study are 148 students which are all students of XI IPA SMAN 4 Mataram. The sampling technique uses cluster random sampling. Samples are XI IPA 3 which consist of 29 students as a control group and XI IPA 4 which consist of 29 students as an experimental group. This study uses posttest only control group design. Data of physics cognitive learning result obtained after treatment. Test results of cognitive learning are given at the end to find out the mean value of the cognitive learning outcomes of the two sample groups.

Data collection of cognitive learning outcomes using instruments in the form of multiple choice there are 26 items with five alternative answer. The results of cognitive learning of physics here are the learning outcomes in the cognitive domain of C1 (remembering), C2 (understanding), C3 (applying), C4 (analyzing), C5 (evaluating), and C6 (creating) on temperature and heat materials. The obtained data was first tested the normality of the distribution and homogeneity of the variance as well as the prelate test before being analyzed using the one-way Anava test to determine the effect of virtual lab utilization in the inquiry learning model toward the cognitive learning outcomes of the students.

III. Result And Discussion

The obtained average grade of cognitive learning outcomes of the experiment group and control group is presented in Table 1.

Table 1. Average Score of Students Cognitive Learning Outcomes

Group	Number of Students	Average Score
Experiment	29	70.56
Control	29	58.22

Based on the average value obtained in Table 1, it is found that the average score of experimental group students is 70.56 and the control group average is 58.22. This shows that the average score of cognitive learning outcomes of the experimental group is much higher than the control group. Comparison of achievement of cognitive learning outcomes between experimental group and control group is shown in Figure 1.

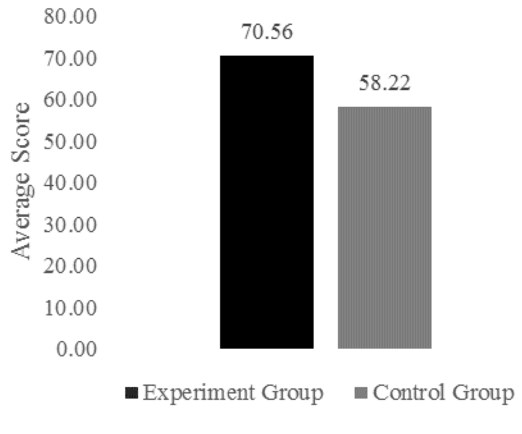

Figure 1. Comparison of Average Score of Student Learning Outcomes

Normality test and homogeneity test that has been done show that the data of cognitive learning result of both groups are normally distributed and variant of both groups is homogeneous. Furthermore, parametric test is conducted on one path. Based on the test results Anova one path the value of F count is 25.46 with a significance level of 0.00. Due to the significant level of $0.00 < 0.05$ it can be generally concluded that there is a significant difference in cognitive learning outcomes between the experimental group and control group, where the cognitive learning outcomes of the experimental group are better than the control group. The results of this study are in line with the opinion of [2] which states that there are differences in cognitive learning outcomes of students who follow the guided inquiry learning model than the students who follow the conventional learning model, so that the guided inquiry model influences the cognitive learning outcomes of students . [11] states that there are differences in cognitive learning outcomes of students between control groupes and experimental groupes, which means there is influence of the use of guided inquiry learning model to the cognitive learning outcomes of students. In addition [16] states that there are differences in physics cognitive learning outcomes among students who learn using guided inquiry learning model assisted virtual experiments with students who learn using conventional learning model. In line with the results of this study, [12] stated that science learning with guided inquiry method using a virtual laboratory is better than science learning using inquiry method using real laboratory.

Differences in achievement of cognitive learning outcomes between experimental group using virtual laboratory in guided inquiry learning models with control group using conventional learning model happen because in the implementation of inquiry model guided by virtual laboratory consist of computer program as a medium of learning that provides opportunities for students to learn independently and to find a concept of physics so that learning is more meaningful, can improve the ability of students in solving problems and increase interest in learning because the use of virtual laboratory in learning physics is something new for students. This is in line with research conducted by [18] which states practicum using a virtual laboratory more effective, interesting and more useful and enable students to repeat experiments compared to group that use the real laboratory because not all students active in the experimental.

In addition, learning with guided inquiry model in virtual lab assisted also provides time for students to gain a hands-on learning experience. [19] argues that learner will easily remember the knowledge gained independently longer compared to the information that he or she gets from listening to others. The findings are supported by the results of research conducted by [17] who argue that the learning experience obtained is better and stored in the memory in a longer period through the investigation when the learning process takes place.

The process of inquiry is considered as an open process which means students have their own questions and seek their own answers [8]. Little by little the group of students communicates more effectively and enhances their ability to reason and solve problems together on a task-based [13]. The guided inquiry model in virtual labs centered more on students than on conventional learning models. The opinion of Hsieh & Wu in [10] suggests that the goal of science learning is not only to obtain the existing scientific explanation, but more importantly, to form a scientific explanation through the process of inquiry.

Although, in general, there is a significant difference in cognitive learning outcomes between experimental and control classes, when the data were reviewed more specifically, the cognitive learning outcomes of students on each sub temperature and heat matter, some interesting thing that shows the differences between the two classes. This is based on the analysis on each sub-material, in which the use of virtual laboratory in guided inquiry study gives a significant influence on the cognitive learning outcomes in sub temperature, heat, substance, and Black principle. While in the sub material of expansion and heat transfer, the use of virtual laboratories in guided inquiry learning has no significant effect. Comparison of achievement of cognitive learning outcomes between experimental class and control class on each sub subject is shown in Figure 2.

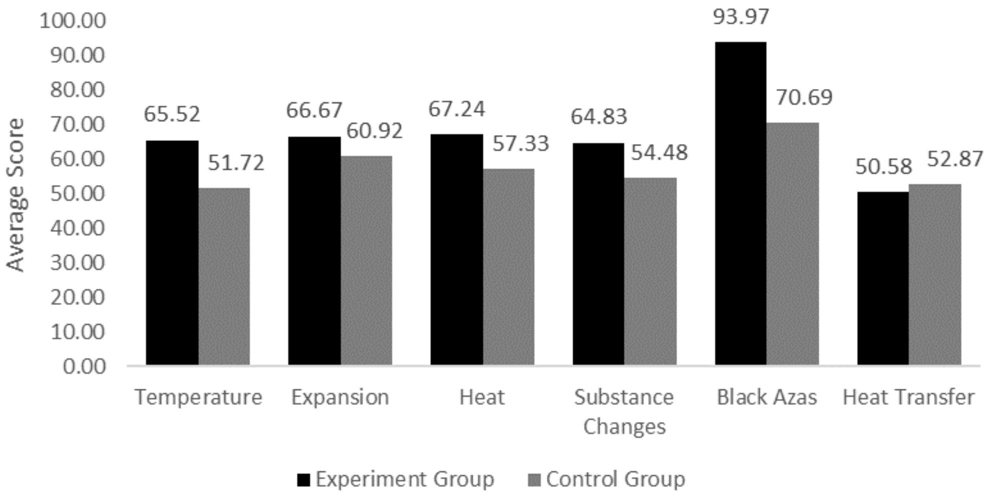

Figure 2. Comparison of Cognitive Learning Outcomes On Each Sub Material

Based on Figure 2, the highest cognitive learning score of experimental group is 93.97 on Black principle material sub-material and the lowest is 50.58 on the heat transfer material sub-material. While the control class obtained the highest score on the Black matter sub-material that is 70.69 and the lowest on the temperature sub material of 51.72. In temperature and heat sub-materials, the use of virtual laboratories in guided inquiry learning has a significant effect on the cognitive learning outcomes of students. Where this is proved by the average score of the experimental class is much higher than the control class. This can be due to the information presented in the virtual lab facilitate students in understanding the definition and theories about the temperature and ease students in understanding the variables that can affect the temperature of an object.

In sub-material expansion and sub-material heat transfer, the use of virtual laboratory in guided inquiry learning has no significant effect on cognitive learning outcomes of students. This is because the sub material of expansion and heat transfer in the implementation of students are not able to find new concepts through practicum using a virtual laboratory that can help, so that students in answering the items about cognitive learning outcomes have difficulty.

In the sub-material changes of substances, the use of virtual laboratory in guided inquiry study significantly influence the cognitive learning outcomes of students, where the average value of the experimental class is much higher than the control class. This is because students are able to draw conclusions about the variables that affect the occurrence of changes in the form of substances through scientific activities conducted with the help of a virtual laboratory.

In the Black principle sub-material, the use of virtual laboratories in guided inquiry learning significantly influences the cognitive learning outcomes of students, where the average score of the experimental class is much higher than the control class. This is because the implementation of the practicum conducted by students using a virtual lab with inquiry stages helps students to understand the concept of the Black principle.

In addition to each sub-material, researchers also want to know the effect of the use of virtual laboratory in guided inquiry learning to cognitive learning outcomes in each cognitive domain. Indicators of cognitive learning outcomes used are remembering, understanding, applying, analyzing, evaluating and creating. An interesting finding shows the difference between the experimental class and the control class in the cognitive domain. Based on the results of the analysis, it can be concluded that there are significant differences in overall cognitive domain. This means that the guided inquiry model assisted by virtual laboratories had a significant positive effect on cognitive learning outcomes in the overall cognitive domain of the learner, except in the domain of analyzing and creating where the control class scores higher than the experimental class on both domains. Comparison of achievement of cognitive learning outcomes between experimental class and control class on each cognitive domain is shown in Figure 3.

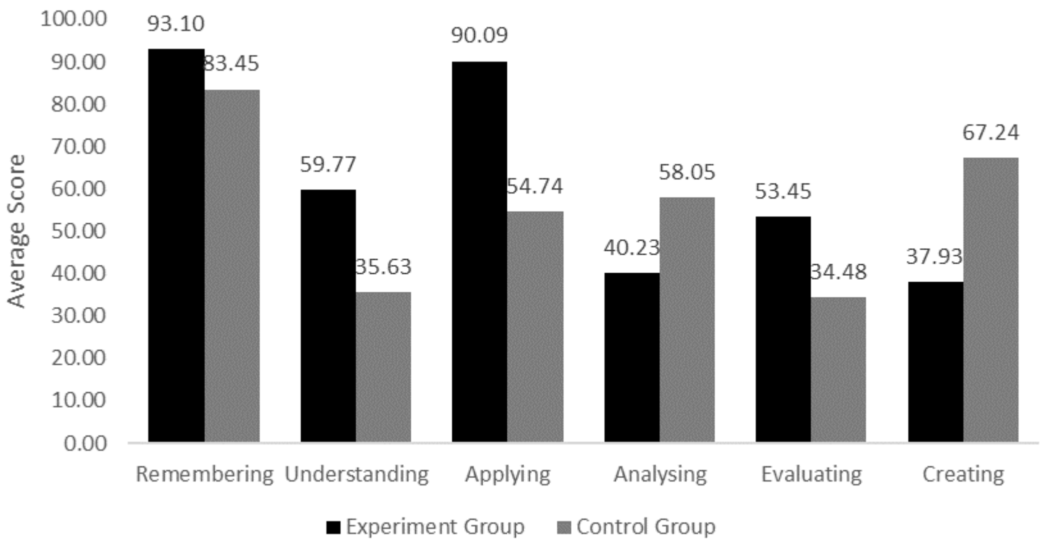

Figure 3. Comparison of Cognitive Learning Outcomes on Each Domain

The effect of the use of virtual laboratory in guided inquiry learning toward cognitive domain considering, understanding, applying, and evaluating cannot be separated from the role of learning model that requires students to find the concepts of temperature and color independently with the assisted of virtual laboratories that provide materials that facilitate students in obtaining it. In the domain of analyzing and creating, the average score of the control class is much higher than the experimental class, due to the lack of students' ability to analyze problems that require deeper analysis of interacting variables in solving problems in temperature and heat. In addition, the ability of students which are still lack in concluding the results of experiments and the lack of ability in making experimental graphs in the learning process, so that implicate the low cognitive learning outcomes of learner in the domain of analyzing and creating.

IV. Conclusion

Based on the results of the analysis and discussion, it can be concluded that the use of virtual laboratory in guided inquiry learning model as auxiliary media on temperature and heat materials affect the cognitive learning outcomes of students.

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