

**The Implementation of Virtual Laboratory Based Learning Using PhET Simulation
on Kinetic Theory of Gases Topic for Increasing The Learning Outcome of Grade XI Students
At Kanjeng Sepuh Sidayu Islamic Senior High School**

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ABSTRACT

The research entitled “The Implementation of Virtual Laboratory Based Learning Using PhET Simulation on Kinetic Theory of Gases Topic for Increasing The Learning Outcome of Grade XI Students At Kanjeng Sepuh Sidayu Islamic Senior High School” aimed to analyze students learning outcome after joining virtual laboratory based learning using PhET Simulation on kinetic theory of gases topic at Kanjeng Sepuh Islamic Senior High School. This research used pre-experimental design with one group pre-test post-test design. The participants of this study were students of XI MIA 1 which are chosen using purposive sampling technique as an experiment class. The results of this study on the form of pre-test and post-test data were analyzed using normality test, homogeneity test, t test and normalized gain test. The result of this study shows that the research sample comes from normal population. The students learning outcome after joining the learning activity is better than before which was showed by one tailed t test analysis had t_{calc} of 15,30. For the enhancement of students learning outcome based on n-gain test was 0,64 which are categorized as middle enhancement. The implementation of virtual laboratory based learning using PhET Simulation at Kanjeng Sepuh Islamic Senior High School gained very good mark.

Keywords : virtual laboratory based learning, PhET Simulation, kinetic theory of gases

INTRODUCTION

Physics is the field of science that is encountered at various locations in the universe and being related to the events that we use and observe in the universe and enabling individuals to find solutions for daily life events or analyze them from various perspectives. Because physics has an important role in the universe, then the physics learning that is taught and applied effectively in schools needs to be improved. Physical learning is expected to enable students to achieve the skills needed for scientific thinking, which are able to generate knowledge, keep up with technological developments, understand and interpret events occurring in nature (Aykutlu, Bezen, & Bayrak, 2015).

Sutrisno (2006), stated that physics can be considered as a body of knowledge, a way of thinking, and a way of investigating. Physics as the body of knowledge means that physics is the knowledge generated from any kind of research and investigation conducted by physicist. Physics as the way of investigating means that physics can describe how physicist works in order to produce an invention throughout laboratory activities. While the way of thinking and scientific attitude such as honest, objective, open-minded, and self confidence are needed while conducting research and investigation.

Physics is a discipline established on a conceptual basis and is grounded in experiments (Ince, et al., 2015). Toplis (2011) stated that experiment has vital role in science including physics. Experiment can develop students' skill, knowledge,

and understanding about science. It can also help students to appreciate that science is based on evidence and acquire hands-on skills that are essential if students are to progress in science. Thus students should be given the opportunity to do various experiment and investigation works.

The fact on schools showed that not all topics in physics curriculum can be conducted in laboratory activities easily, such as any topics related to microscopic and massive objects. Based on preliminary research to physics teacher, it gave raised that some topics such as kinetic theory of gases, relativistic theory, quantum phenomena, and atomic nuclei are quite difficult to be conducted in real laboratory activity. Thus, teachers never teach those topics by conducting laboratory activity.

In spite of real laboratory, an experiment can also be conducted in virtual laboratory. Real laboratory has advantages on physics topics that require hands-on activity and interaction with objects being studied. On the other hand, there are several domains that virtual laboratory is the only way to dynamically depict the phenomena being studied, such as the topics related to massive and microscopic objects (Farrokhnia & Esmailpour, 2010).

PhET Simulation is one of several software that can be used to conduct a virtual laboratory activity. PhET (Physics Education Technology) is a simulation that was created by University of Colorado consists of physics, biology, chemistry, and mathematic simulations for learning in a class or individual learning. PhET Simulation emphasizes on the relation

between real life phenomena and the underlying science, supports the interactive and constructivist approach, gives feedback, and provides creative workplace.

PhET (Physics Education Technology) has been trusted to be a real laboratory alternative with its completeness and facilities is a site that provides simulations of physics learning. Until 2010, PhET Simulation has been downloaded more than 15 million times in over 200 countries worldwide. Another advantage of PhET Simulation is that it can be downloaded for free so it can be used without the need for an internet connection (<http://phet.colorado.edu>).

On the basis of that, it has been conducted a study entitled "Implementation of Virtual Laboratory Based Learning Using PhET Simulation on Kinetic Theory of Gases Topic for Increasing The Learning Outcome of Grade XI Students At Kanjeng Sepuh Sidayu Islamic Senior High School".

METHOD

This research was a quantitative pre-experimental research using one group pretest-posttest design. The participants of this research were 29 students on grade XI-science of Kanjeng Sepuh Sidayu Islamic Senior High School. The research took place on second semester in Kanjeng Sepuh Sidayu Islamic Senior High School.

Before starting the research, the instruments firstly were tested using validity and reliability test. The valid and reliable instruments were then used in the research.

Students in the beginning of research were tested to find out their initial cognitive competence about kinetic theory of gases topic. They later were given four meetings of virtual laboratory – based learning using PhET Simulation "Gas Properties". In the process of learning, students were divided into group of five heterogenic members. They conducted the Boyle Law experiment in the first meeting, Charles Law experiment in the second meeting, Gay-Lussac Law experiment in the third meeting, and Root Mean Square Velocity experiment in the last meeting. The learning processes and students skills on experiments were observed and scored by two observers. After joining four meeting of virtual laboratory – based learning, students were tested with the same test instrument as before to find out their final cognitive competence. Students were also given questionnaires in order to find out their response about the learning activities.

The result obtained were pretest and posttest score, the students skills on experiment score, the learning process score, and students' response to learning activities. The pretest score was analyzed using normality test to determine if the participants were normally distributed. Then the posttest score was tested using two tail and one tail t-test to

determine if there is a significant enhancement on students' learning outcome in kinetic theory of gases topic.

DISCUSSION

Based on test instrument trial on 30 students of grade XII-Science, it has been obtained 28 valid and reliable questions from the total 35 multiple choices questions consist of 5 easy questions, 26 medium questions, and 7 difficult questions. Based on the result, it has been chosen 20 valid and reliable questions consist of 3 easy questions, 14 medium questions, and 7 difficult questions as pretest and posttest instrument.

Based on the result of observation, the learning processes were marked as very good. But there were some difficulties during the first meeting because students were not used to conduct virtual laboratory activity.

The pretest score was tested using normality test and it was obtained that the participants were normally distributed. The result t_{calc} of two tail t-test on the posttest score was 15,30, more than t_{table} 2,00. It means that there was a significance difference between pretest and posttest score. Based on the one tail t-test, it was obtained that t_{calc} 15,30 was more than t_{table} 1,67. It means that the students' posttest score was better than their pretest score. Besides being tested using t-test, the pretest and posttest score were also tested using n-gain test. It has been obtained that all students' learning outcome increased with medium category.

While students' skills on experiment were increasing during the learning processes as shown on Figure 1.

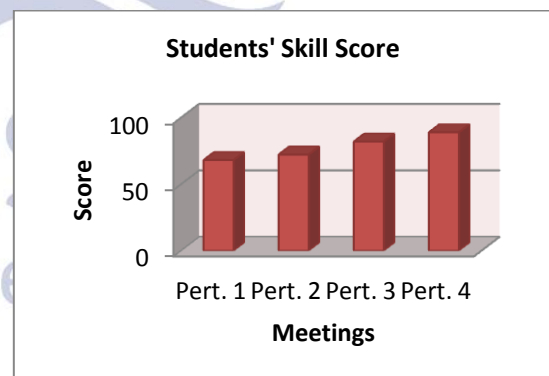


Figure 1 Students' Skill Score

Students in the beginning were not used to conduct such experiments. During the learning processes, they were taught and accustomed to conduct virtual laboratory activities. Thus their score was getting better during the meetings.

Students' response to the learning activity was categorizes as very good with 81,92 % of students had good response to the learning activity. The students' response is shown on Figure 2.

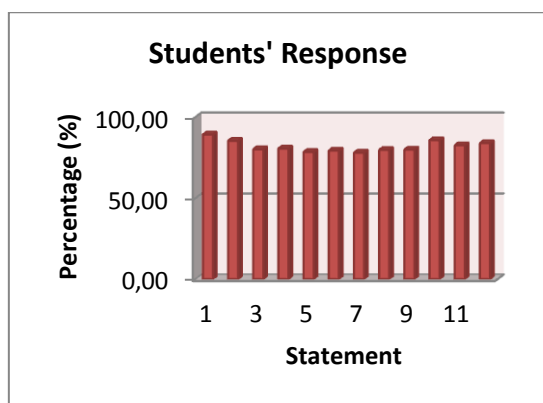


Figure 2 Students Response to The Learning Activities

Students agreed that the learning activity was fun and can improve their scientific skills. They also agreed if the virtual laboratory based learning would be implemented for other topics in physics curriculum.

CLOSING

Conclusion

Based on the analysis and discussion of the research, it can be concluded that:

1. The implementation of virtual laboratory-based learning using PhET Simulation on kinetic gas theory topic for increasing the learning of grade XI students at Kanjeng Sepuh Sidayu Islamic Senior High School was categorized as very good. This was indicated by the percentage of the average score of learning implementation that was 87.04%.
2. Student learning outcomes after joining the virtual laboratory-based learning using PhET Simulation on kinetic gas theory topic is higher than before. This was shown based on the analysis of one tail t-test with t_{calc} was 15,30.
3. The implementation of virtual laboratory-based learning using PhET Simulation on kinetic gas theory topic that has been applied in grade XI students at Kanjeng Sepuh Sidayu Islamic Senior High School got very good response from students. This was indicated by the percentage of student response 81.92%.

Suggestion

Based on the experience that has been done during the research, the researcher would give some suggestions as follows:

1. The implementation of virtual laboratory-based learning using PhET Simulation can be used as an alternative of physics learning that requires experimental activities but constrained laboratory tools or materials that are difficult to be experimented to improve student learning outcomes, especially on the kinetic theory of gases topic. This learning was able to cultivate students' scientific skills and attitudes. In addition, this learning can help students to find

and investigate their own material concepts received so that students are expected to train their confidence in solving problems encountered in real life.

2. For other researchers who want to research using virtual laboratory-based learning using PhET Simulation should consider the shortcomings that exist to anticipate the occurrence of things outside the plan such as aspects of time management. This is because the PhET Simulation is new software for most students, so students need the initial guidance to operate the software, so the teacher should be able to really manage the time well at the beginning of the meeting.

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